FARM PROFITABILITY AND RESOURCE USE IN RUBBER AND OIL PALM SMALLHOLDERS OF BATANGHARI, JAMBI, INDONESIA

M.Sc. Thesis

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I. INTRODUCTION

1.1. Background

Land use change phenomena are getting more attention since it is always associated with deforestation. Deforestation mostly occurred in Sumatera, one of the largest islands in Indonesia. It is mainly caused by the high land requirement. In Indonesia, loggers, smallholders, and estate crops are the main driving actors of deforestation (Pagiola, 2000). In 1995, logging has given a high incentive for loggers to export timber because of low fee charged by the government. He also mentioned that in smallholder side, many of agricultural land use alternatives let smallholder to use forest more than before, which can be found as jungle rubber or rubber monoculture. In comparison to smallholder farming, plantation estates have a larger role in determining the land use changes, where oil palm is often cited as a major crop responsible for these changes. However the high incentive of this commodity attracted many smallholders to built its farms and become an expense to the forest.

An increase in land requirement for oil palm production, as well as rubber production, leads to the agricultural extensification, one of land use change reasons. The more demand for those commodities, the more land will be needed. One of provinces that experiences this phenomena in Indonesia is Jambi Province. Table 1 shows that land use of forest was reduced significantly from 1992 to 2012. In contrast, land use of oil palm, jungle rubber and rubber monoculture were increasing. It can be an indication that there are large-scale changes in the land use system.

Table 1.Land Use in 5 District in Jambi Province (Ha)

Properties	**1992**	**2002**	**2012**	**Change 1992-2012 (%)***
Oil Palm	46,628	98,751	136,899	193.60
Jungle Rubber	73,836	85,887	84,452	14.38
Rubber Monoculture	139,805	165,436	166,244	18.91
Forest	167,179	79,120	44,694	-73.27
Bare Land	76,088	71,209	64,638	-15.05
Paddy	16,523	13,514	9,204	-44.30
Other Agriculture	6,064	5,868	6,096	0.53
Other	20,034	36,482	45,470	126.96

Source: Gatto (2013) *Own Calculation

In the early of 20th century, rubber (*Hevea brasiliensis*) was introduced in Jambi province by using jungle rubber system. Jungle rubber is a form of rubber farm which is combined with other useful trees like timber, fruit, rattan and bamboo (Feintrenie and Levang, 2009). A large expansion of rubber commodity, which was occurred because of its high incentive from international markets caused some land use changes. Farmers' fields for temporary cultivation were converted to permanent jungle rubber, which after the intensification rapidly altered complex jungle rubber to a simple monoculture rubber in later years. On the other hand, oil palm, introduced to farmers of Jambi about 20 years ago, fast became one of the new land use change alternatives. The high demand of oil palm, domestically and internationally, was a strong incentive to boost its production. The export of this product has also increased until now, due to its high utilization as cooking oil, soap, plastic, cosmetics, and biofuel.

The high incentive of rubber and oil palm induces the land use change in Jambi particularly from forest areas. BPS (2012) states that there is an increase in the use of land for rubber (1 percent per year) and oil palm (25 percent per year) production in Indonesia. The land scarcity phenomena lead the rubber and oil palm smallholders to compete each other to get more land or even to convert from one to another. Generally, the direction of land use change among forest, rubber, and oil palm can be seen in Figure 1.

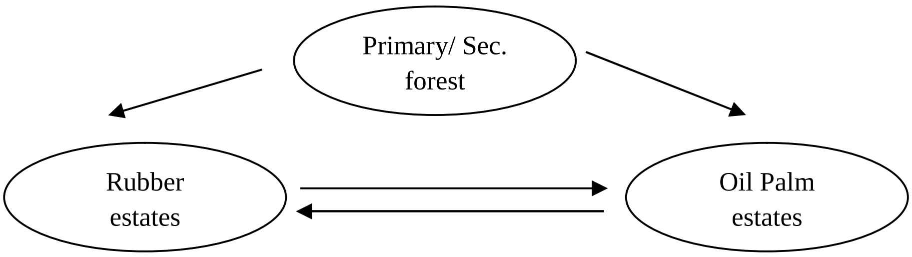


Figure 1.Expected Land Use Direction
(presented by Euler on his seminar 2013)

Land use direction, showed in Figure 1, occurs in almost all regencies in Jambi which produce rubber and oil palm such as Batanghari, the study area of the present study. It is one of the regencies which can produce both products with high production, land uses and productivity. Productivity of rubber reaches 0.56 ton/ha (ranking first, among all regencies of Jambi) while the productivity of oil palm reaches 2.72 ton/ha (ranking fifth, among all regencies of Jambi). These conditions are partly the reasons for land use changes in Batanghari (BKPM, 2012).

1.2. Problem Statement

Land scarcity in Jambi leads rubber and oil palm smallholders to compete one another to get more land. Based on Decree No. 421/Kpts-II/1999, Jambi has no morecompatible production forest. The compatible production forest is the production forest which can be converted to agriculture (Ministry of Forestry, 2012, P. 11). Hence, to develop more rubber and oil palm, the smallholders only depend on bare land or convert the land from one to another type of commodity.

Some land use determination are settlement history, agricultural intensification, non-traditional land use, crop productivity, tenure insecurity, fuelwood extraction and rural in-migration (Aguiar, Camara, Escada, 2007). The monetary incentive is the most influencing factor which can determine the direction of land use changes.

Incentive of rubber and oil palm can be seen from their high profitability. The more profit generated, the more would beneficial incentive to deforest land for cultivation. It also indicates that profit will influence the direction of land use in Batanghari. Smallholders will give more concern to sector that give more income, even though, foreign scientists and Non Government Organizations (NGOs) have warned adverse environmental effects of deforestation (Feintrenie, Levang, 2009). Therefore, in order to discover the direction of land use change in the future, it is required to analyze the profit of rubber and oil palm smallholders and their determinant factors.

1.3. Objective of Research

Referring to the problem statement, this research objectives are:

1. To characterize rubber and oil palm smallholder farming.
2. To compute and compare the profit generated from rubber and oil palm farms.
3. To analyze determinants of rubber and oil palm profitability.

1.4. Hypothesis

Based on some previous research, major hypotheses of this research are:

1. Rubber farms are less profitable than oil palm. This hypothesis is in line with some previous studied which stated that return to land and return to labor of rubber is less than that of oil palm (Papenfus , 2008; Feintrenie, Chong, and Levang, 2009; Belcher et al, 2004).
2. Some farm and household variables critically influence the rubber and oil palm yield and thereby affect profitability.

These factors are land size (Ha), tree age (years), number of productive tree (unit/Ha), hired labor (work day/Ha), herbicide (liter/Ha), urea fertilizer (Kg/Ha), NPK fertilizer (Kg/Ha), farmer age (years), farmer education (year), household member involved in agriculture (people), percentage of output gone as wage for laborers of shared cropping (percent/Ha), ethnicity, presence of land certification,membership in farming cooperatives and region (district).

1.5. Scope of Research

In this study, smallholder farm profit is computedand compared between that of rubber and oil palm farms. Also the determinants of profit per Ha are estimated. Profit calculations had been conducted by several previous studies (Papenfus , 2008; Feintrenie, Chong, and Levang, 2009; Belcher et al, 2004). Most of them have used “return to land” which calculated the Net Present Value per Ha per year for each crop where further the result was being compared.This method is not proper because of the effect of discount factor. In order to cover this problem, this study used Equivalent Annual Annuity (EAA) which would consider the difference of discount factor generated by the difference of the production period.

Furthermore, this study was completed by profit determinant factor analysis. This analysis aims to explain some factors influencing the amount of profit per Ha in both crops.

II. LITERATURE REVIEW

This chapter contains some previous researches related to the land use changes in Indonesia and in other countries. The comparison of oil palm and rubber smallholders with the land use also become part of this chapter, where the comparison is divided into crop system and economic condition. At last, rubber and oil palm economic condition that can be divided into profit analysis and determinant profit factor will be explained.

2.1. Land Use Changes across The World

Land use change issue has become an environmental and developmental concern mainly since 1990s, particularly in Indonesia and Brazilian Amazonia since they have very large natural forest. Actually, peat swamp forest and cropland can also be converted for many reasons (Wicke et.al, 2010), but the number of natural forest changes have been more than the other changes. Thus land use changes are always associated with deforestation.

Some studies focused on the impact of land use change with different assumptions, and methods. For instance, in environmental side, land use change will cause greenhouse gases (GHG) emissions, decreasing carbon stock, changing in hydrological pattern, erosion and downstream sedimentation. In ecological side, forest cover loss will reduce the biodiversity, decrease the species quality and ecosystem health. At last, in social side, land use change also will generate land tenure and human right conflict, such as conflict between ministry and provincial or district government (Crosthwaite et. al, 2004; Wicke et.al, 2010; Pagiola, 2000; Feitrenie and Levang, 2011).

Another focus of previous studies is the determination factor of land use changes. Determination factors of land use changesare divided into: 1) Biophysical variables, such as soil quality and vegetation type, 2) transportation-related variables, such as road network density in the area and in its neighbors, 3) government-related variables such as development policies (Pfaff, 1999 as cited in Aguiar, Camara, Escada, 2007), 4) Social variables, such as settlement history, agricultural intensification, non-traditional land use, crop productivity, tenure insecurity, fluid extraction and rural in-migration (Perz and Skole, 2009 as cited in Aguiar, Camara, Escada, 2007).

2.2. Land Use Changes in Indonesia

In colonial phase, there was a dualism agrarian law in Indonesia. Those are west agrarian law which was applied to western people in Indonesia and adat (custom) agrarian law which was applied for Indonesia people. After the independence of Indonesia, land policy reform started to build. The basic agrarian law of 1960 was built to manage land and natural resources. The state reserves the right to reclaim any land for purposes of the national good. In new order period, Indonesian economic growth was sustainable and attracted the foreign investment. During this period, environmental costs such as converting rainforest to rubber or oil palm were high. In reformation period, decentralized form of government started to build up based on Laws No. 22 and No. 25. District and municipal governments could manage their resources and set the policy. Unfortunately, it also was also not going well because of many distortions. In 2001, government issued Decree No. IX/MPR/2001 on agrarian reform and management of natural resources (Thorburn, 2004).

Rubber (*Hevea brasiliensis*) was introduced in Jambi province, in the early of 20th century. As mentioned before, rubber plantation is divided into two types, jungle rubber and jungle monoculture. Jungle rubber produces high levels of forest biodiversity. Hence that it also has a role as a buffer zone around the primary forests (Feintrenie and Levang, 2011). Unfortunately, productivity of rubber was low by this system. In order to improve productivity of rubber, clonal rubber was developed from a rubber monoculture which then produced up to three times more than on the previous type (William et. al, 2001). In 1950s, jungle rubber started to be replaced by rubber monoculture which generated higher return to land (Feintrenie and Levang, 2009).

On the other hand, oil palm was first introduced in Sumatera together with the transmigration program in 1980. It rapidly became the competitor of jungle rubber. In the early of its arrival, Nucleus Estates and Smallholders (NES) scheme had important roles. NES scheme is cooperation between palm oil company and oil palm smallholders located around the company (Feintrenie, Chong, Levang, 2009). In 2000, independent smallholders spread in many parts of Jambi province because the production of this commodity was also favoured by the government (Feintrenie and Levang, 2009). Nowadays, land-use is changing rapidly with high conversion of forest to rubber monoculture and oil palm.

2.3. Planting System of Rubber and Oil Palm

Papenfus (2000) divided perennial crop period into two parts: pre-production and production period. Pre-production period is years when smallholders have not get income yet and the tree is still immature (but incur cost of production), while production period is years when smallholders get income from the cultivation (Papenfus, 2000).

The length of pre-production period will be an important consideration for smallholders because they have to use their own money for preparing and maintaining the farms without income. On rubber farms, the first tapping usually occurs in 5 or 6 years after planting and the tree will be productive until 30 years old. on the other hand, oil palm farms, the first harvesting is performed in 4 years after planting and the tree will be productive until 25 years old (Wulan et. al, 2006; Papenfus, 2000). These statements show that rubber tree and oil palm tree have different length of pre-production period.

Although rubber has relatively longer pre-production period, it can be harvested/tapped every day, while oil palm tree can only be harvested twice a month. Actually in the harvest season, rubber and oil palm can complete each other because they have different production season. In rainy season, oil palm tree can produce more Fresh Fruit Bunches (FFB) than that in the dry season. Water is important factor for its production that has to be provided every time. On the contrary, rubber tree cannot be tapped in rainy season because it will produce low quantity and quality rubber (Feintrenie and Levang, 2009).

2.4. Economics Characteristics of Rubber and Oil Palm Production

2.4.1. Labour and Input Use

Different crop enterprises have different labour requirement. They are involved in different activities. In rubber farms, labours are more required in pre-production period. Land preparation is the first thing needed to be performed in this period. After, some cultivating and planting activities become important. Fertilizers are added four times a year in the first two years. Some treatments, namely weeding, fertilizer and herbicide application, and tapping are conducted in production period every day.

Murdiyarso et. al (2002) showed that average labour used for rubber farms in the pre production period was 344 person-days per Ha per year. It was more than that in production period which used 166 person-days per Ha per year. Furthermore, Papenfus (2000) informed that rubber monoculture requires more people than jungle rubber does.

Some previous studies stated that the average labour use for oil palm farms in some countries were about 0.1 to 0.18 people/Ha. As the example, labour use to land in Malaysia was 0.1 person/Ha (Adnan, 2012), in Hawaii was 0.063-0.15 people /Ha (Ely, 2012), and in Indonesia (South Sumatera) was 0.18 people/Ha (Nu'man, 2009). These studies suggest that Indonesia used more labour than the other countries. Papenfus (2000) informed that in Indonesia, oil palm smallholders used less labour than estate oil palm, during both pre production and production period. The same with rubber farms, pre production period of oil palm farms also need more labor that production period.

Beside labor, inputs involved in variable cost are seed or seedling (planting material), fertilizers, pesticides that mainly include herbicides. Rubber or oil palm seeds are used in the first planting and replanting activities. The seedling cost is high. It spends only two times. Fertilizer, herbicide and pesticide are the most important input. Papenfus (2000) stated that in oil palm farms those input costs are the largest share of initial establishment cost by 62.4 percent. Purwono, Yusmini, and Tarumun (2012) in their research revealed that from all input costs, fertilizer is the highest variable cost. This result is in line with the estimation of global fertilizer use which stated that Indonesia is the second highest

NPK fertilizer user for oil palm crop in the world (Heffer, 2009). Rubber farms use more single fertilizer than compound fertilizer such as urea, KCl, and SP36 fertilizer where the highest fertilizer cost is cost for SP 36 (Wijayanti and Saefuddin, 2012).

2.4.2. Profitability Analysis

Profitability analysis can provide figure to discover the direction of land use change. There are many ways to calculate profitability. Farm income, investment criteria, return to land, and return to labour are some of them. In some literatures, profitability analysis for perennial crops usually uses investment analysis criteria, such as Net Present Value, Internal Rate of Return, and Net B/C.

Anwar (2006) had investigated profitability of rubber farms in Indonesia with various scenarios. With discount rate 18 percent and normal condition, 1 ha rubber farms could generate NPV, IRR, and Net B/C, Rp 19,200,000, 31.5 percent and 1.17 respectively. According to investment criteria, where NPV is more than zero, IRR more than the market interest rate, and B/C more than 1, rubber farms were economically feasible. Zen (2008) also had conducted analysis of profitability of oil palm production in Labuhan Batu Regency, Indonesia. The result showed that in 30 years this commodity could generate NPV, IRR and Net B/C, respectively are Rp 634,236,100.2, 8.31 percent, and 9.16. Based on investment criteria, this commodity was feasible to develop as well. These researches gave a conclusion that individually, rubber and oil palm are profitable to run.

Limited land available force smallholders to choose which commodity will give more profit than another. Therefore it is necessary to do further research in profitability comparison. Freitrenie and Levang (2009), in some of their papers figured the return to land and return to labour of rubber and oil palm in every single year until the end of production period.

Generally, the highest return to land was generated from oil palm farms, particularly from oil palm smallholders. In the other hand, the lowest return to land was produced by jungle rubber on the basis of their low productivity. Almost similar with return to land, the highest return to labour was generated by oil palm smallholders because they used less labour than large estate oil palm. In contrast, rubber farms used more labour than oil palm farms, thus they received less return to labour (Papenfus , 2000; Feintrenie, Chong, and Levang, 2009; Belcher et al, 2004).

2.4.3. Determinants of Profitability of Smallholder Plantations

Rubber and oil palm profit are the crucial part of farming activities which become the reason of land use change. Therefore, its determinant factor is essential to be analyzed. What factors influencing profit might be the same with what factor influencing income and yield. Thus, this study also uses some literatures determining income and productivity.

Land size is an important factor which determine productivity, income per Ha and profit per Ha because many studies state that land size is significantly influencing them. Berry and Cline (1979) as cited in Ellis (1993) stated that the more land size, the less productivity was generated and so does income per acre. It might be caused by inefficient of land use due to less control to use production factors, labor scarcity, and capital limitation (Budiman, 2012; Ellis, 1993).

Labour is another important factor influencing production, income, and profit. Statistically, labour can influence them with positive sign. The more labour is being used, the more product, income and profit are generated (Onyebinama and Onyejelem, 2010; Husinsyah; 2006; Olujenyo and Olayiwola, 2008; Onoja, Deedam, Achike; 2012). It corresponds with a statement saying that farm activities always require labour in almost all production process. Thus, the use of labour has to notice the quality and quantity of labour (Adiwilaga, 1982 in Husinsyah, 2006). Different result was found by Jayne et. al (2013) which stated that labour has negative impact to profit.

Production capitals, in the form of material input costs may also also have important role to determine amount of production, income, and profit. Most studies found that input use or cost significantly influences production, income, and profit with positive sign (Tumanggor, 2009; Budiman, 2012; Mafimisebi, 2008. Pahlevi (2013) stated that farm cost reflects amount of input used such as seed, fertilizer, and labour, so it will affect the farm production. In 2006, Husinsyah obtained different result which stated that production cost of rubber smallholders were not significant and had negative sign. Thus, they had to decrease the cost to get more income. It may occur when there was inefficiency use of input.

In some literatures, the plant age also influences production which will also affect income and profit. Tumanggor (2009) stated tha, statistically, the plant age significantly affected production with positive sign, because by the time research was conducted, the plants had the ideal age to brought out product. In the oil palm production, the 7-11 year-group plant significantly produces maximum amount of fresh fruit bunches (Prihutami, 2011).

Profit function is also engaged with the price, either output or input prices. Statistically, output price has positive significant in influencing profit (Jayne et. al, 2013) and so has input price (Kolawole, 2006).Beside economic factors, social factors also influence production, income and profit. Those are farmer education, farmer age, farmer experience, and family size.

III. THEORITICAL FRAMEWORK

This chapter provides the theoretical framework which generally consists of farmer economic measurement, in particular about profit, production, revenue, input, and cost. Profit is one of the farmer goals to get incentive from their farming activities which are determined by revenue and cost.

3.1. Profit Maximization

Similar with other economic actors, the farmer has personal and household goal such as profit maximization as rate of return on capital. Some researches stated that it is difficult to define profit for household production because of the differences between peasant households and capitalist enterprises (Ellis, 1996). Due to that, there are some initial understandings about farmer profit maximization, which are: (1) the profit maximizing hypothesis does not require the existence of profit in the form of a sum of money. (2) Profit maximization has both a behavioural content (motivation of the household) and a technical-economic content (farm economic performance as a business enterprise). (3) Profit maximization condition on the goals, constraints, and markets may exist even if strict efficiency is not observed. Warren (1998) defined profit as the divergences between revenue (the output value) and cost (the input value) during production period.

Efficiency and profit maximization influence each other in which we cannot have one without another. There are two types of efficiency, which are technical and allocative efficiency. Technical efficiency is the maximum attainable level of output for a given level of production inputs on the range of alternative technologies available for the farmer. In comparison, allocative efficiency refers only to the adjustment of inputs and outputs to reflect relative prices where the technology of production has already been chosen.

The most efficient level of a variable input depends on the relationship between the input price and the output price. In figure 2, the area from point A to C shows the profit from production activities because in this area the revenue is bigger than the cost. On the left area of point B, the profit is increasing when the unit of input is increasing. In the other hand, on the right area of point B, the profit is decreasing when the unit of input is increasing. Thus, the optimum level of input lies in point B. This condition is also called as a profit maximizing model.

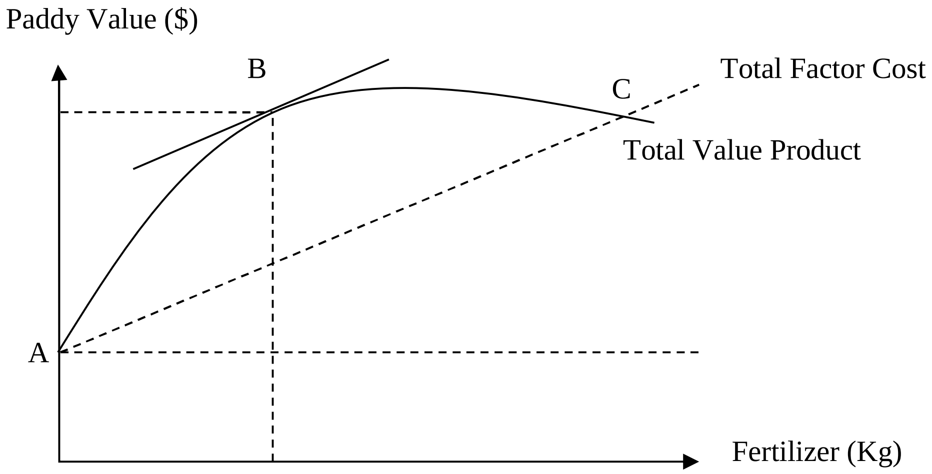


Figure 2.Optimum Use of a Single Input
Source: Ellis (1996)

Economically, the price changes will give impact to the optimum levels of input and output. It is noted that the important thing is the ratio between input and output prices. If the output prices fall, then the ratio between input and output prices will be rising. This condition will change the optimum output level and be derived to become a supply curve.

In general, profit consists of gross margin and net farm income. Gross margin is a difference between total income and total variable costs. Further, net farm income (NFI) is gained from subtracting gross margin with total fixed costs such as depreciation, net inventory changes, and value products consumed at home. The return to farm owner, management and equity capital used in farms can be reflected from NFI; hence it is the best measurement of profit in the accounting period (Johnson, 1982 and Kay, 1986 cited in Onoja et al. 2012).

$Gr \quad M = (P \, x \, Q) - T$

$N \quad F \quad In = G \quad M - T$

3.2. Revenue and Production

Revenue is calculated by taking cash receipts arising during the period, excluding any capital receipts and including changes in the valuation of stock of output item, benefits in kind, and adjustment for opening and closing debtors

(Warren, 1998, P.10). Total revenue depends on the quantity of production and the given price, hence the production and price became the important parts to analyze profit.

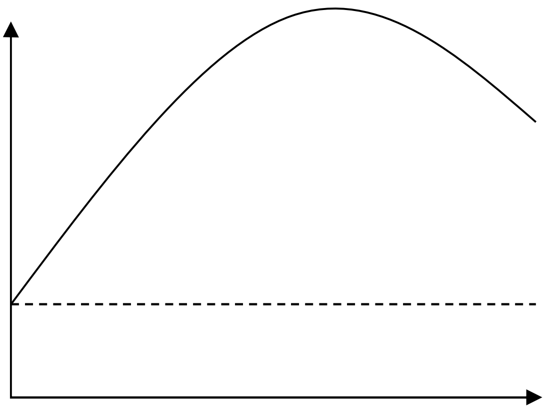


Figure 3.Production Function
Source: Ellis (1996)

The physical relationship between output and inputs is depicted by production function. Inputs are the rates of resource used and output is the rate of production over a specified time period. In general, production function in economics describes the technical or physical relationship between output and one or more variable input (Ellis, 1996). By the production function (Figure 3), there are several behaviours of production that can be explained, such as (1) there are some output which would be produced without any application of input, (2) there is the highest output which can be achieved by successive increasing in the application of input, (3) there is a situation in which although the input use is increasing, the output is decreasing.

3.3. Input and Cost

Expense or cost is calculated by taking cash payments, excluding any capital payments, personal drawings, or tax payment, and including changes in the valuation of stocks of purchasing inputs, benefits in kind, adjustments for opening and closing credits, and depreciation of 'wasting' possessions such as buildings and machinery (Warren,1998, P. 10). Total cost consists of variable cost and fix cost. Variable cost is associated with the number of output, the more output the more variable cost, while fix cost is not considering about the number of output.

Input and its price are the main part of the total cost. Different crop will lead to different input required; nevertheless there are some major inputs which have to be explained. Land is the most important input which has to be available. It also distinguishes the small and the large farm. Ellis (1996) stated that the small farms use resources more efficiently than larger farms. The proximate technical reasons for this proposition collected by various studies, which are: (1) The underutilization of the total land area leads to declining in land productivity, (2) The large farm is more directed to the land extensive enterprises, (3) The large farms use less variety of crops than the small farm does, for the same crop, (4) The small farms have more fertile soils than the large farms on average because the large farms only develops the best part of its land and ignores the less favourable land within its total farm area, (5) Perhaps, not all land of large farms are irrigated, (6) The large farms use less labour per unit area than the small farms do.

Labour utility in farming activities is a little bit different with the other activities because of the existence of family labour. The farm household behaviour, according to family labour use, was explained by Chayanov model. This model stated that utility (happiness) of farm household is determined by income and leisure time. Subjective wage level shows the amount of income which the household would need to gain in order to compensate for the loss of one unit of leisure. Barnum and Squire (1979) also built a farm household model which consider labour market. The farm responses of changes in domestic (family size and structure) and market (output prices, input prices, wage rates, and technology) are covered by this model.

Beside land and labour, there are so many inputs used in farming activities such as seed, fertilizer, herbicide, and pesticide which form part of variable cost and hence, production capital.These inputs also play an important role in determining the amount of cost. Optimum use of a single input is determined by the value of product and its cost as depicted in the last subchapter in figure 2.

IV. RESEARCH METHODOLOGY

This chapter describes all methodsused in this study. Starting from research design such as when and where the primary data were collected, how the samples were selected, what kind of data were used in this study until how the data will be processed to get the result. The data processing and analysis consist of profit pattern, profitability analysis, and determinant factor analysis.

4.1. The Research Site and Time

This research was a part of big research conducted by The Collaborative Research Center (CRC)Goettingen in Indonesia in 2012. This research focused on rural area in the lowland of Jambi Province. Thus, there were5 regencies which were suitable with this criteria. From 5 regencies, Batanghari was the most suitable for land use change analysis based on rubber and oil palm profitability, on the basis of its rubber and oil palm production and productivity. Primary data used were collected by a research team from Georg-August University of Goettingen in collaboration with University of Jambi (UNJA) in October-December 2012.

4.2. Data Types and Sources

Most of the data used in this research were primary data, but we also use some secondary data as supporting information. Primary data involved in this research were on production, output price, input price, input uses, labor, and farmer characteristics. This primary data set were collected by face-to-face interviews with household heads. The respondents were farmers who have been involved in agricultural production for the last five years. Most of the farmers were found cultivating either rubber or oil palm. In some cases, there are some smallholders having both these crops.

Secondary data involved in this research were production and area of rubber and oil palm in Jambi province and in Batang Hari. Beside those, forestry data were also used in this research. The data were collected from some institution such as Province or Regency government and some official websites such as Statistics Indonesia and International Rubber Study Group. Literature reviews were also conducted to get other secondary data and more understanding.

4.3. Sampling Method

Districts and villages were randomly sampled. After researcher designed the number of samples from all populations, then the researcher chose samples randomly (Frankfort, Nachmias, 1996; Zinkmund, 2009). In this research, there were 4 of 8 districts in Batanghari and from each district, there were 2 selected villages. Figure 4 shows the districts and villages selected.

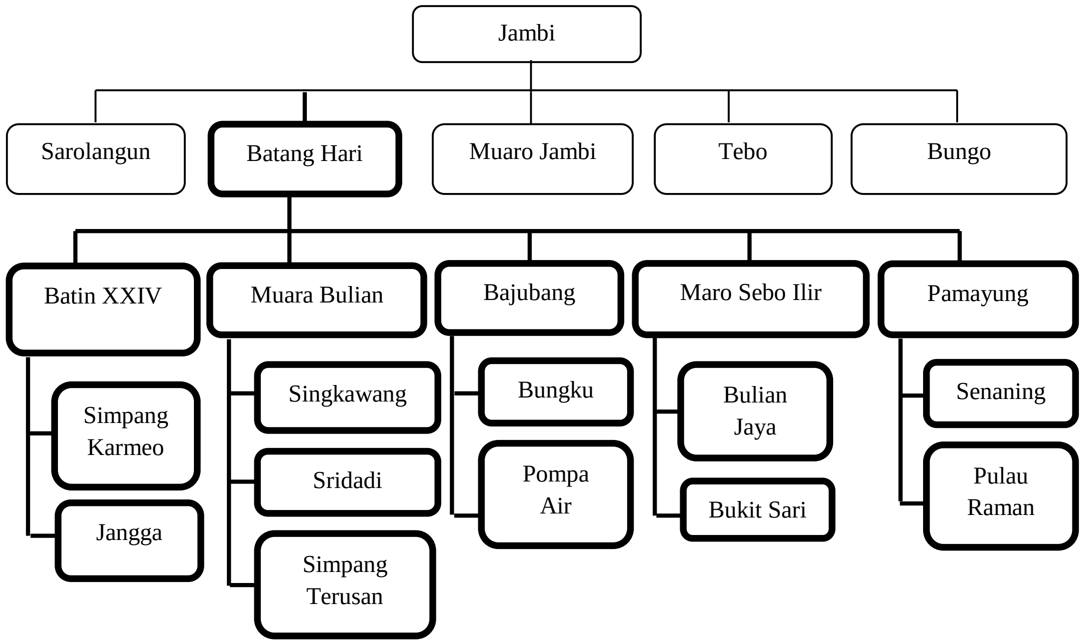


Figure 4. District and Village Selection
Source: Euler and Krishna, 2012

The amount of population differences (from less than 100 to over 2000 households) in all districts gave the reason to use stratified random sampling. Stratified random sampling procedure select respondents randomly from different strata by any characteristics that will upgrade the level of assurance of representation (Frankfort, Nachmias, 1996; Zinkmund, 2009). In this research, villages were separated to 4 strata based on their total population and then samples were taken from each strata. Table 2 shows the stratification of villages. This sampling technique expects the number of samples will be distributed proportionally based on villages area. As additional information, there were some villages which were not randomly selected since the land use transformations are were more rapid.

Table 2. The Number of Sample in Targeted Villages

No	Village	Total Households	Total Sample
1.	SimpangKarmio	504	18
2.	Jangga	355	12
3.	Singkawang	332	20
4.	Sri Dadi	1245	24
5.	SimpangTerusan	554	18
6.	Bungku	2000	24
7.	Pompa Air	631	20
8.	Bulian Jaya	718	24
9.	Bukit Sari	369	12
10.	Senaning	194	6
11.	PulauRahman	300	12

Source: Euler, Krishna (2012)

4.4. Data Processing and Analysis

4.4.1. Descriptive Analysis

This descriptive analysis was used to compare the socio-economic characteristics of rubber and oil palm smallholders. Beside tabulation data, hypothesis test was also used for this analysis. Hypothesis test was used as a complementary method to know “are there significant difference between characteristics of both commodities?” (Lind, Marchal, Wathen, 2008). There are 5 steps to test the differences between rubber and oil palm.

a. State null hypothesis and alternative hypothesis (H_0 and H_1).

b. Select a level of significance

   Significance level (α) explains the error probability when statistical result states that we have to reject null hypothesis whereas it is true (Lind, Marchal, Wathen, 2008).

   Selecting significance level depends on the confident interval desired by researcher but the common significance level are 1 percent, 5 percent, and 10 percent.

c. Identify the test statistic

   There are three statistical test instruments which usually used for comparing means between two or more samples.

   - z test is a method to compare the means of two samples when the population variance of each sample is known.

- t test is an alternative method to compare means of two samples when the population variance of each sample is unknown. For replacing the population variance, we have to calculate the sample variance.
- F test, called analysis of variance (ANOVA), is a method used for comparing mean from more than two samples.

According to its definition, t test is the most suitable for comparing the characteristics of rubber and oil palm farms and smallholders because population variance is unknown. Mathematically, sample variance and t test use this following formula:

$$S_p^2 = \frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{n_1 + n_2 - 2} \qquad (1.1)$$

Where:

S_1^2 : the variance of the first sample.

S_2^2 : the variance of the second sample.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{S_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \qquad (1.2)$$

Where:

$\bar{x}_1$: the mean of the first sample.

$\bar{x}_2$: the mean of the second sample.

n_1 : the number of observations in the first sample.

n_2 : the number of observations in the second sample.

S_p^2 : the pooled estimate of the population variance

d. Formulate a decision rule

This decision rule will be decided based on value of t table. To get this value, we have to determine degree of freedom (df) which is equal to the total number of items sampled minus the number of samples (n_1+n_2-2) and significance level (α). From data, the rubber samples are 235 plots and the oil palm samples are 127 plots. With using previous formulation, this research can get df equal to 360 and to get region of rejection, significance level is set at the 5 percent level.

e. Make a decision

The last step is decision step by comparing the test statistic (t value) with t table as critical value or comparing α with p value.

4.4.2. Profitability Analysis

There are two types of profit, gross margin and net income. Due to unavailability of data on fixed cost, this research calculated only gross margin as profit.

Rubber and oil palm are the perennial crops which can generate products for many years, whichlead to the need for considering about time value of money through calculating the present value of revenue, cost and profit in every single year. The sum of all present value of profit is called NPV. NPV also shows the difference between present value of revenue and present value of cost (Klemperer, 2003, P. 112). The NPV of rubber and oil palm can use the following formulation:

$$N = \sum_{y=0}^{n} \left[\frac{R_y}{(1+r)^y} - \frac{C_y}{(1+r)^y}\right] \qquad (2.1)$$

Where :

R_y = Income in year t

C_y = Cost in year t

y = Years

r = Discount Rate 5%, 10%, 15%

Actually, comparing each NPV will generate biased results because the difference in production period between rubber and oil palm is(was) not taken into account. For example, an investment in long term period might have higher NPV than that in short term period. To solve the bias issue, profit calculations were carried out using Equivalent Annual Annuity: an equal annual real income with the same present value, over the project life (Klemperer, 2003, P. 182).

$$E = N \frac{r}{1-(1+r)^{-n}} \qquad (2.2)$$

4.4.3. Determinants of Profit Factor Analysis

Determinant profit factor analysis was analized by regression analysis. By this model, we can assume the relationship between dependent variable and independent variables. This research used multiple regression model which can control many other factors that simultaneously affect the dependent variable, thus it can construct more precise models for predicting the dependent variable. The general multiple regression for the populationcan be written as:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots\ldots\ldots + \beta_k x_k + u \quad (3.1)$$

Where:

β_0 : Intercept

β_1: Parameter associated with x_1 (the same meaning until β_k). These parameters are also called as slope parameter which determine the relationship between dependent and each independent variable.

u: Error term or disturbance

It is too difficult to built the model from all population, so we need sample to estimate the model. In general, the estimation model for multiple regression model is:

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_{i1} x_{i1} + \hat{\beta}_{i2} x_{i2} + \hat{\beta}_{i3} x_{i3} + \ldots\ldots\ldots + \hat{\beta}_{ti} x_{ti} \quad (3.2)$$

and the residual for observation is

$$\hat{u} = y_i - \hat{y}_i \quad (3.3)$$

To obtain $\hat{\beta}_1$- $\hat{\beta}_k$, ordinary least square (OLS) method can be used. This method undertakes to minimize the sum of squared error.

$$u^2 = \sum_{i=1}^{n} (y_i - \hat{\beta}_0 - \hat{\beta}_1 x_{i1} - \cdots - \hat{\beta}_k x_{ti})^2 \quad (3.4)$$

Thomas (1997), in his book, explained the simple matrix form to ilustrate how OLS method operate.

$$Y = X\beta + \underline{u} \quad (3.5)$$

Where:

$$Y = \begin{pmatrix} Y_1 \\ Y_2 \\ Y_3 \\ \vdots \\ Y_n \end{pmatrix}, \quad X = \begin{pmatrix} 1 & X_2 & X_3 & \ldots & X_{k1} \\ 1 & X_2 & X_3 & \ldots & X_{k2} \\ 1 & X_2 & X_3 & \ldots & X_{k3} \\ \vdots & \vdots & \vdots & & \vdots \\ 1 & X_{2m} & X_{3m} & \ldots & X_k \end{pmatrix}, \quad \beta = \begin{pmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \vdots \\ \beta_k \end{pmatrix}, \quad u = \begin{pmatrix} u_1 \\ u_2 \\ u_3 \\ \vdots \\ u_k \end{pmatrix}$$

Note that m is the order of individual and k is the order of variables. Now, to define every β by minimizing error square, we can use matrix form.

e = Y - X$\hat{\beta}$ (refers to 1.3 formula) (3.6)

$$S = e'e = (Y - X\hat{\beta})'(Y - X\hat{\beta}) \quad (3.7)$$

$$= (Y - X\hat{\beta})'(Y - X\hat{\beta})$$

$$= Y'Y - \hat{\beta}'X'Y - Y'X\hat{\beta} + \hat{\beta}'X'X\hat{\beta}$$

$$= Y'Y - 2\,\hat{\beta}'X'Y + \hat{\beta}'X'X\hat{\beta}$$ (Where $\hat{\beta}'X'Y = Y'X\hat{\beta}$ are scalar)

to get minimum S, next step is the differentiation of S with respect to $\hat{\beta}$.

$$\frac{\partial}{\partial\hat{\beta}} = -2\,X'Y + 2X'X\hat{\beta} = 0 \quad (3.8)$$

$$X'X\hat{\beta} = X'Y$$

$$(X'X)^{-1}X'X\hat{\beta} = (X'X)^{-1}X'Y$$

$$\hat{\beta} = (X'X)^{-1}X'Y \quad (3.9)$$

The formula of OLS estimator (1.8) might be well-known formula in statistics or econometrics. By this formula, we can know $\hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3, \dots \dots, \hat{\beta}_k$ and construct the regression model. This research used STATA 11 to solve the econometric calculation and construct the model computerized.

Some result interpretations that need to be made are:

1. Coefficient interpretation.

   Coefficient is an important part in the model which describes the relationship of independent and dependent variable with ceteris paribus assumption. $\hat{\beta}_j$explain the changes of independent variable when one of dependent variables changes withother dependent variables hold constant.

2. Goodness of Fit (R^2) or Coefficient of Determination

   It is a proportion of the total variation in Y that can be attributed to variations in all the explanatory variables acting together (Thomas, 1996, P.. 179).

   $$R^2 = 1 - \frac{\Sigma e_i^2}{\Sigma y_i^2} \quad (3.10)$$

   However, adjusted R^2 ($\bar{R}_2$) is consider as ´fairer´ measure than R^2 to compare multiple models since only the important variables will increase $\bar{R}_2$.

$$\bar{R}^2 = 1 - \frac{\sum \frac{e_i^2}{n-k}}{\sum \frac{y_i^2}{n-1}} \quad (3.11)$$

3. t-test

This test is used to identify what independent variables are significantly influence the dependent variable. β_j *area parameter of the population which we did not know, so that we use hypotheses testing to guess the effect of it by our model* (Wooldridge, 2006, P. 127).Generally,there are two types of alternative hypotheses and they have different decision rule.

Table 3. Alternatives for t test

One-Sided Alternative	Two-Sided Alternatives
$H_0 : \beta_j = 0$	$H_0 : \beta_j = 0$
$H_1 : \beta_j > 0$	$H_1 : \beta_j \neq 0$
or	
$H_1 : \beta_j < 0$	

Source: Wooldridge (2006)

This study used two side alternatives which under this alternative, H_1 states that the independent variables has a ceteris paribus effect on the dependent variable without specifying whether the effect is positive or negative. Decision rule is based on the rejection rule of H_0, where we have two ways to test whether we reject the H_0or not.

- ***t statistic*** **or** ***t ratio***

$$t_{\hat{\beta}_j} = \frac{\hat{\beta}_j}{se(\hat{\beta}_j)} \quad (3.12)$$

Rejection rule is $\left|t_{\hat{\beta}_j}\right| > c$, where c is a value on t distribution with $n - k - 1$ degrees of freedom (df) and αsignificant level.

Table 4. Data for Calculating *t statistic*

Properties	Rubber	Oil Palm
n: number of sample	235	127
k: number of variable	15	15
α:the propability of rejecting H_0 when in the fact it is true	10%, 5%, 1%	10%, 5%, 1%

Source: Own Calculation

- **P-value**

  P-value is the probability of rejecting $H_0$when H_0 holds true, and the rule to follow is P-value < α.

4. F-test

   F-test is a multiple hypotheses test about the underlying parameters $\beta_0, \beta_1, \dots, \beta_K$. *By this test we want to know whether a group of variables has no effect on the dependent variable.* For example, we want to test β_1, β_2, $a \quad \beta_3$, so the hyphotheses we have to construct are:

   $H_0 : \beta_1 = 0, \beta_2 = 0, \beta_3 = 0$

   $H_1 : H_0$ is not true

   H_1 states that a group of $x_1, x_2 a \quad x_3$ is significantlyaffecting the dependent variable. Like t-test, F-test also has two ways to decide whether we have to reject H_0.

- ***F statistic***

  $$F = \frac{(S \quad_r - S \quad_u)/q}{S \quad_u/(n-k-1)} \tag{3.13}$$

  where $S \quad_r$ is the sum of squared residuals from the restricted model, $S \quad_u$ is the sum of squared residuals from the unrestricted model, q is numeretor degrees of freedom $(d_r - d_u)$ *and* $n-k-1$ *is denominator degrees of freedom* (d_u). The decision rule (by rejecting H_0) is $F > c$.

- **P-value**

  The rejection rule is P-value < α.

To fulfill the good model requirement, the model has to free from interference such as:

1. Multicolinearity.

   Multicolinearity is "*correlation between two or more independent variable*" (Wooldridge, 2006, P. 102). One of the methods to test the multicolinearity is Variance Inflation Factor (VIF). Usman and Nachrowi (2006) stated that multicolinearity occurs if VIF value is more than five.

   $$V \quad (\beta_j) = \frac{1}{1-R_j^2} \tag{3.14}$$

2. Heteroskedasticity

The homoskedasticityassumption states that the variance of error of dependent variables should be constant, which is one of the assumptions to make best linear unbised estimators (BLUE). There are *heteroskedasicity-robust* procedures provided by some statistical tools which is a method to estimate the valid OLS estimator in the presence of heteroskedasticity (Wooldgride, 2006).

The model constructed in the research is shown below:

$$y = \beta_0 + \beta_1\,PlotSize + \beta_2\,TreeAge + \beta_3\,ProdvTree + \beta_4\,HiLab + \beta_5 Herb + \beta_6 Urea + \beta_7 NPK + \beta_8\,FarAge + \beta_9\,FarEdu + \beta_{10}\,HHmemInv + \beta_{11}\,ProdWage + \beta_{12}\,Ethnic + \beta_{13}\,District + \beta_{14}\,CertSpo + \beta_{15} CoopInv + u$$

Where:

PlotSize	: Land size per Plot (Ha)
TreeAge	: Average tree age per plot (Year)
ProdvTree	: No. of productive trees (Unit/Ha)
HiLab	: Hired labor (Work day/Ha)
Herb	: Herbicide applied (Litre/Ha)
Urea	: Urea fertilizer applied (Kg/Ha)
NPK	: NPK fertilizer applied (Kg/Ha)
FarAge	: Farmer age (Year)
FarEdu	: Time spent on education (Year)
HHmemInv	: No. of household member involved in Agriculture (People)
ProdWage	: Percentage of total production used as wage for shared cropping
Ethnic	: Farmer ethnicity (1=Melayu, 2=Javanese, 3=Others)
District	: Location of the Plot (1= Bathin XXIV, 2 = MuaraBulian, 3 = Bajubang, 4 = MaroSeboIlir, 5 = Pamayung)
CertSpo	:Farmer Having Certificate or *Sporadik* Land Title (0 = No, 1 = Yes)
CoopInv	: Cooperative Involvement (0 = No, 1 = Yes)

This research consisted of three linear regression analyses which include the same variables mentioned above. Two of them were used for explaining the determinant factor of rubber and oil palm where the commodities were analyzed in different models. Since sharecropping in oil palm farms has seldom conducted, the *ProdWage* will be not included in oil palm model. The last linier regression was conducted through combining rubber and oil palm data. This model emphasized the role of crop selection, whether different commodity planted would influence farmer profit, hence it used additional variable namely *ComSelect*(0=rubber, 1=Oil Palm).

4.4.4. Operational Definition

Operational definition tries to explain the definition of some terms in order to give obvious understanding. Some operational definitions found as follows:

1. Land size is total area used for rubber or oil palm farms (Ha). Each plot have different land size.
2. Hired Labor (HL) is total labor outside family member which work in rubber or oil palm farms per Ha for a year. To equalize calculation, this research used work day per Ha (1 work day = 7 hours work) as unit. Some formula we used in this research are:

   $$W = \frac{N\ .o\ \ o\ \ \ x\,Ti\ \ f\ \ 1o}{7} \quad (4.1)$$

   $$T\ \ H\ = (M\ \ H\ + F_{i}\ \ H\ )\ x\ W\ \ d$$

   In rubber farms, there were some sharecropping activities where some labors were paid by certain percentage of total production (we more concern to value of it, then it is calculated as percentage of total revenue). This percentage of total revenue used for wage is also a part of total hired labor. Wage per work day of sharecropping (Sc) labor is calculated by the following formulation:

   $$W = \frac{(\%\ o\ \ R\ \ \ u\ \ \ t\ S\ )}{To} \quad (4.2)$$

   Further, wage Sc is considered in total hired labor cost which is applied in the formula below.

   $$T\ \ H\ C\ = (M\ \ \ )x\ \ \ + (F_{t}\ \ \ )\ x \quad (4.3)$$

3. The tree age is the average age of rubber or oil palm planted on a plot in 2012. If there are some trees replanted, we use weighting formula:

$$A = \frac{(N\ .o\ t \quad x\,a\ )_1 + (N\ .\ o\ t \quad x\,a\ )_2}{N\ .\ o\ t \quad _1 + N\ .\ o\ t \quad _2} \quad (4.4)$$

4. Family members are all family which live at the same home as farmers with the same financial management.
5. Farmer education quantifies total years spent by farmer to get education, such as elementary school (6 years), junior high school (3 years), senior high school (3 years), and bachelor (4 years).
6. Income is calculated per season (rainy and dry) because the amount of production and price are often diferrent per season. Total income calculation use this formula:

$$T \quad r \quad =$$
$$(r \quad s \quad p \quad sha \quad x\,p \quad p \quad y \quad x\,r \quad s \quad p \quad)$$
$$+\ (d \quad s \quad pr \quad sha \quad x\,p \quad p \quad y \quad x\,d \quad s \quad p \quad)$$

7. Profit is derived from subtracting the total cost to total income.

$\pi = T \quad R \quad - V \quad C$

8. Ceteris Paribus is an assumption stating that when a variable is changed, the other variables hold constant.
9. Profit, income, cost and price are calculated in Rupiah (Indonesian Currency), where 1 Euro is equal to Rp 12,488.45 as exchange rate in October 2012 (Indonesian Bank, 2013).

V. RESULTS AND DISCUSSION

This chapter explainsthe differences between rubber and oil palm farms which consist of four subchapters. The first three subchapters explain the result and discussion of the research question. First, characteristics of rubber and oil palm farms and farmers, which provided by descriptive analysis.Second, profitability analysis whichcalculated by NPV and EAA method. Besides comparing the profit, this analysis also explained income and cost on the cultivation activities. Third, explains about a determinant profit factorof rubber or oil palm farms which consists of comparativeanalysis of the determinant profit factors and also crop selection analysis.The last subchapter explained the policy implication might be performed by government.

5.1. Characteristics of Rubber and Oil Palm Farms and Farmers

In general, rubber and oil palm farms in Batanghari growth in various land size, tree age, and number of productive trees per Ha. The planting system for rubber is divided into two ways, which are monoculture system and jungle system. The jungle rubber system is a rubber planting which uses local seed, has a low density per Ha,where farmersusually do not use any fertilizer and herbicide, and also combined with the other crops. Nevertheless, found that there are no profit differences between rubber monoculture and jungle rubber system (Table 5). Hence, practically in the field we can combine them. Hereinafter, we call them as rubber data.

Table 5. Average Profit of Rubber Monoculture and Jungle Rubber (Rp 000)

Profit	Mean	Std. Deviation
Rubber monoculture	12,409.45	22,929.62
Jungle rubber	7,668.56	8,100.00

Note: not significant
Source: Own Calculation

Figure6 illustrates that both rubber and oil palm data have some outlier in the upper tail of the distribution. To avoid the biased result, 2 percent outlier are eliminated from the profit data where the data elimination is conducted in uppermost data. Distribution of used data can be seen in figure 7.

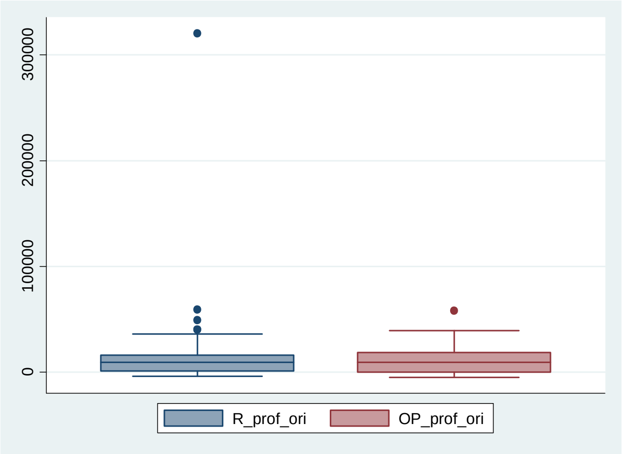


Figure 5. Rubber and Oil Palm Data Distribution with Outliers
Source: Own Calculation

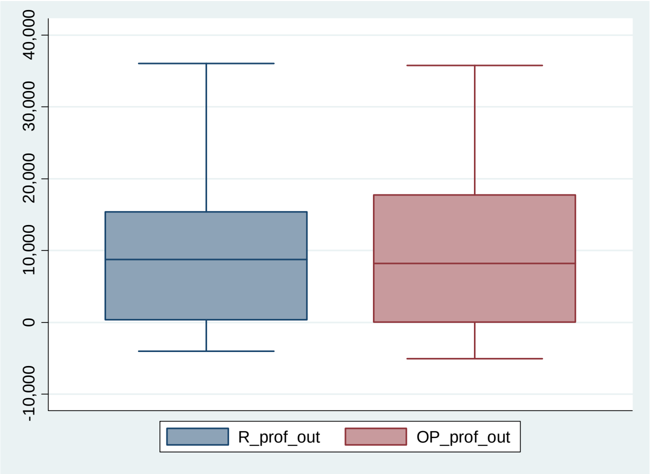


Figure 6. Rubber and Oil Palm Data Distribution without Outliers
Source: Own Calculation

5.1.1. FarmCharacteristics

Oil palm and rubber are plantedin different land size. Typically, the land size of rubber farms ranges from 0.5 until 11 Ha, while the oil palm farms about 0.25 until 25 Ha. However, statistically rubber and oil palm land size are not different onaverage, there are 2.21 and 2.66 Ha respectively (Table 6). This condition is due to the fact that most rubber and oil palm land size is about 2.0-2.5 Ha.

Table 6. Farm Characteristics Comparisons

Farm Characteristics	Mean		Std. Deviation	
	Rubber	Oil Palm	Rubber	Oil Palm
Plot size (Ha)	2.21	2.66	1.89	3.52
Tree age (Year)**	15.24	10.99	10.4	6.99
Percentage of Productive Tree (%)**	64.19	74.85	38.77	41.37

Note: ** significant at 5 percent
Source: Own Calculation

Table 6 statistically explains that the average age of the rubber tree is older compared to oil palm tree, it is 15.24 and 10.99 years old respectively. This condition influenced by the fact that rubber plant was introduced in 1900, while oil palm was introduced 80 years after in 1980. This is why oil palm trees are grown more by the newer farms than the rubber trees. Rubber farms had beenestablished in the period 1958 until 2012 while the replanting activities were done in the period 1980-2012. Different with rubber farms, oil palm farms had been established in the period 1992-2012 and replanting activities was done in the period 1995-2012.

Since there are numbers of old rubber trees, it causes many unproductive rubber trees per Ha. Table 6 explains that statistically oil palm farms have more productive tree per Ha than rubber farms with 74.85 percent and 64.19 percent of percentage respectively. Beside age factor, unproductive trees are also caused by some diseases such as white root rot and *Colletorichum* disease for rubber plant (BPTP Jambi, 2007) and basal decay, charcoal based rot and genetic orange spotting for oil palm (Corley, 2003).

5.1.2. Farmer Characteristics

Farmer characteristics include farmer age, education, number of householdmembers involved in agriculture, the ownership of area under other crop, other income source, ethnicity, and cooperative involvement.Table 7 shows the comparison between rubber and oil palm farmers based on those characteristics. In general, the range of age between rubber and oil palm farmer are not significantly different. About 50 percent rubber and oil palm farmers are 37-51 years old. Different with age variable, education is found higher in oil palm farmer than in rubber farmer. Most rubber farmers only have their elementary school finished, but there are also several farmers tryingto finish their education until senior high school.

Table 7.Farmer Characteristic Comparisons

Farmer Characteristics	Mean		Std. Deviation	
	Rubber	Oil Palm	Rubber	Oil Palm
Farmer age (Year)	46.26	48.24	12.46	10.92
Farmer education (Year)**	6.94	7.88	3.58	3.83
Household member involved in agriculture (people)**	40.15	34.75	28.31	30.19
Area under other crop (Ha)	0.05	0.01	0.31	0.08

Note: ** significant at 5 percent
Source: Own Caluculation

Rubber and oil palm farms use a different ratio of labour, rubber farms use more labour than oil palm farms. This explained by the percentage of household member involved in agriculture that is found bigger in rubber farm than on oil palm farms (table 7). Labour used particularly in tapping or harvesting activities. Technically, rubber trees are needed to be tapped and collected more frequently (five days a week), than oil palm trees (twice a month). Although tapping rubber only needs a half day, this still needs more labor than harvesting oil palm (Feintrenie and Levang, 2009).

Most farmers, both rubber and oil palm, make their farm as the main source of income. Figure 8 explains that 72 percent of rubber farmers and 65 percent of oil palm farmers have no other occupations, while the rest of them gained their income from being an employee or a businessman. This is supported by the result where the average of land size under other crop by rubber and oil palm farmer is only less than 0.03 Ha and not significantly different.

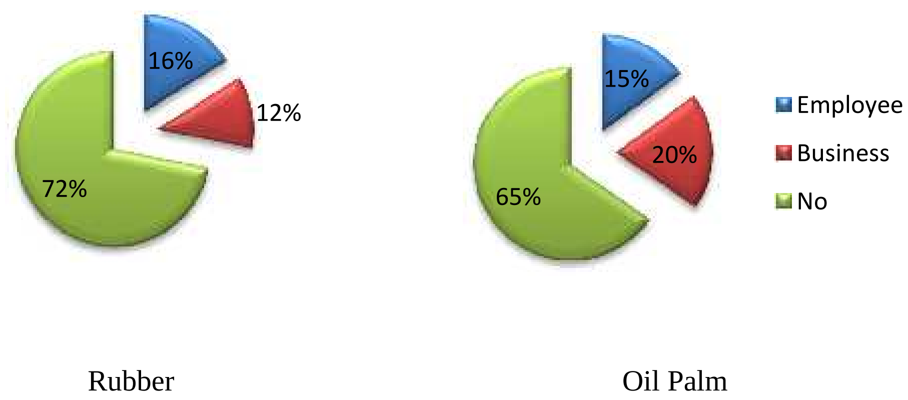


Figure 7.Other Income Source of Rubber and Oil Palm Farmers
Source: Own Calculation

Originally, the majority of indigenous people in Jambi are Melayu which also become an indigenous in almost provinces in Sumatera Island. But beside Melayu, there is also another ethnic group living in Jambi, called Suku Anak Dalam. Unexpectedly, the data show that the majority of the farmer of both commodities is Javanese people, respectively are 56 and 69 percent (Figure 9). Nevertheless, beside Javanese people, in most rubber farmers are Melayu people, while in oil palm farmers are mostly coming from other ethnic group such as Batak, Bugis, Padang, and Sundanese people. These are also influenced by the transmigration program which were conducted gradually from 1905-1994. The biggest number of transmigrant movements was in the 1979-1984 and 1984-1989 period, which also the period of oil palm farms introduction (Fearnside, 1997).

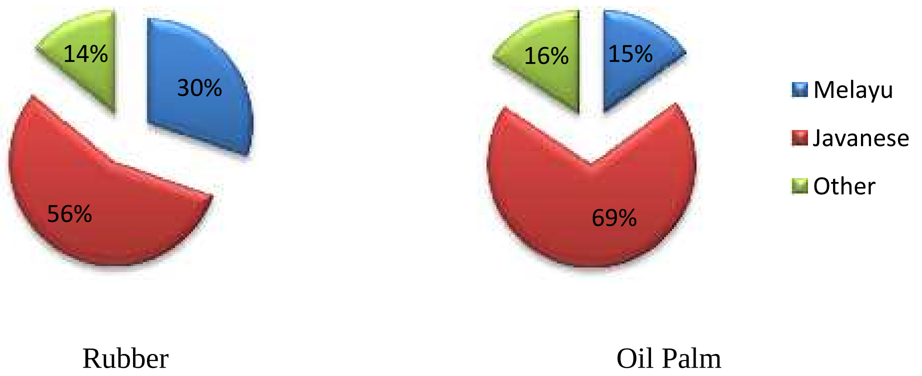
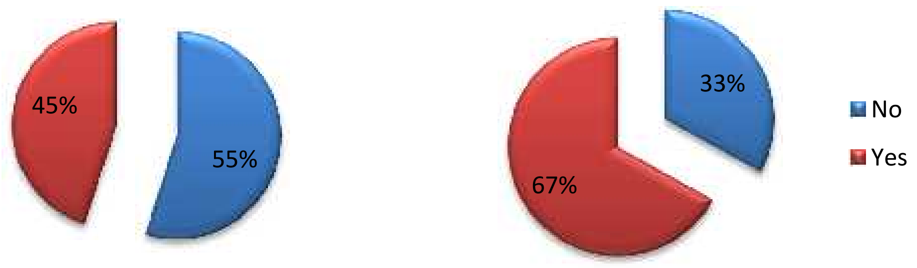


Figure 8.Ethnicity of Rubber and Oil Palm Farmers
Source: Own Calculation

Regarding to the issue of transmigration, some programs provideagricultural facilities to support the transmigrant. One of the most well known program called Nucleus Estate Settlement (NES) is made to support transmigrant by providing agriculture facilities such as land. NES also gives transmigrant facilities in certification or commonly called *sporadik*(Fearnside, 1997). Since NES is provided specifically to support oil palm farms, this is caused the certification/*sporadik* ownership in oil palm farmer is higher than in rubber farmer, respectively are 67 and 45 percent (Figure 10).

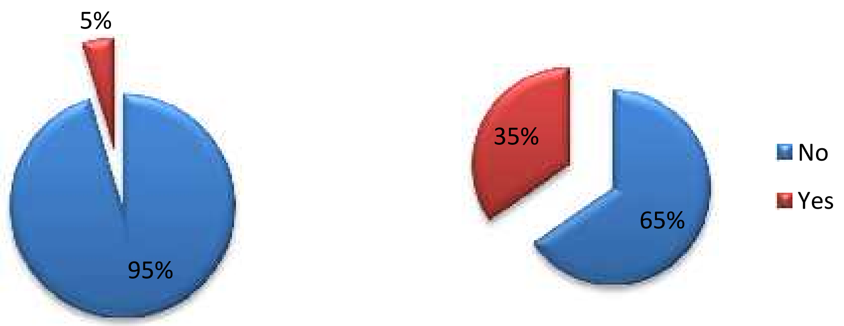


Rubber Oil Palm

Figure 9.Land Certification/*Sporadik* Ownership of Rubber and Oil Palm Farmers

Source: Own Calculation

There are some supporting institutions for agriculture built in Jambi. One of them is cooperative. Figure 11 states that the involvements in cooperative by rubber farmer and oil palm farmer are really different. About 35 percent of oil palm farmers are involved in cooperative while only 5 percent of rubber farmers are involved in it (Figure 11). It might be caused by the rubber farmers who have not used the function of these institutions optimally yet or these institutions which have not been improved well.



Rubber Oil Palm

Figure 10.Involvement in Cooperative of Rubber and Oil Palm Farmers

Source: Own Calculation

5.2. Profit Comparison of Rubber and Oil Palm Farms

This analysis was started with the determination of the range of production period, both rubber and oil palm farms. On rubber farms, the first tapping usually occur in 5 or 6 years after planting and the tree will be productive until 30 years old, while on oil palm farms, the first harvesting is performed in 4 years after planting and the tree will be productive until 25 years old (Wulan, Budidarsono, Joshi, 2006; Papenfus, 2000). According to them, this analysis just considered the profit from 0 year-old tree until 30 year-old tree for rubber farms and from 0 year-old tree until 25 year-old tree for oil palm farms. This analysis used cross section data with different tree ages and sort them based on the age, in order to make a figure of cash flow per year.

5.2.1. Revenue Analysis

Price and harvesting or tapping quantity become the main factors which influence the amount of revenue per Ha. Rubber farmers sell their product in *slab* form. The *slabs* are latex collection solidified by acid. The latex is usually collected from 500 trees in a week, thus the weight of a *slab* can reach 100 kg. Otherwise, oil palm farmers sell their product in fresh fruit bunches (FFB) formwithout any processing.

Production of slabs and FFB vary highly. Tree age and season are two of many reasons of different productivities. Figure 12 and 13 show that productivity and tree age tend to have quadratic relationship, where the production will increase with the increase of tree age, and in certain agethe production will decrease.

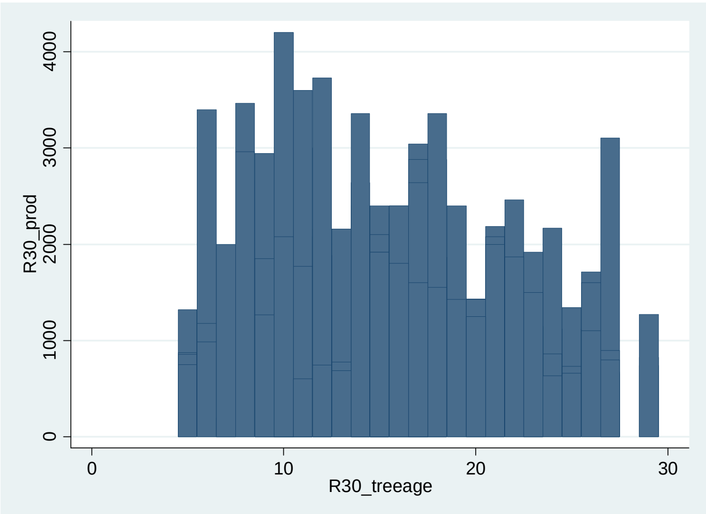


Figure 11. Rubber Productivity Based on Tree Age
Source: Own Caluculation

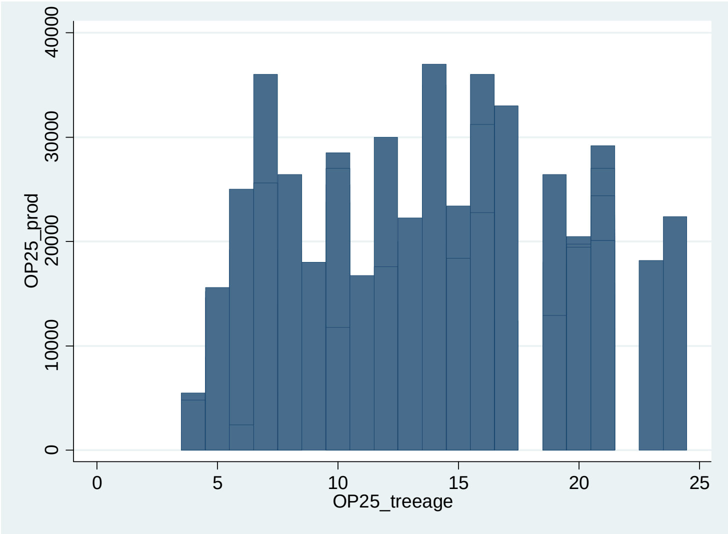


Figure 12. Oil Palm ProductivityBased on Tree Age
Source: Own Caluculation

The season also influences the variation of productivity of rubber and oil palm trees. Feintrenie and Levang (2009) stated that in the dry season, rubber trees can produce more latex, while oil palm trees can generate less FFB. These statements are in line with the data, although those are not significant (Table 8).

Table 8. Average Productivity of Rubber and Oil Palm Farms per Season (Kg/Ha)

Average Quantity	Dry Season	Rainy Season
Rubber	**567.59**	562.31
Oil Palm	6,310.05	**6,436.68**

Source: Own Calculation

Rubber and oil palm price are also varied. Table 9 shows the range of minimum and maximum price of both commodities. Although we cannot compare them due to commodity differences, we know that rubber price is more varied. It might be due to the quality of the slabs which are more varied than the quality of FFB.

Table 9. Rubber and Oil Palm Price (Rp 000/Kg)

Variable	Mean	Min	Max
Rubber	9.24	0.30	14.430
Oil Palm	0.82	0.30	1.360

Source: Own Calculation

As mentioned before, there are some seasonal factors in rubber and oil palm production, influencing the price. According to supply theory, the less production, the higher the price is. Despite of the insignificance in statistics, there are differences between rainy and dry season. From table 10, we can find that the average rubber price during rainy season is higher than those in the dry season because the trees can not be tapped in rainy season. In contrast, the average oil palm price during the dry season is higher than those in rainy season due to the lack of production in dry season.

Table 10. Average Price of Rubber and Oil Palm per Season(Rp 000/Kg)

Average Price	Dry Season	Rainy Season
Rubber	9.23	**9.26**
Oil Palm	**0.82**	0.81

Source: Own Calculation

The first revenue of rubber farms is generated in the fifth year while the first revenue of oil palm farms is generated in the fourth year. Table 11 shows the revenue comparison between rubber and oil palm in 5 percent discount rate. The result states that in the whole production period, oil palm farms can generate more revenue than rubber. This result is also consistent with the annual revenue. The high productivity or the price of oil palm might becomethe main reason of this result.

Table 11. Present Value and Equivalent Annual Anuity of Revenue per Ha (Rp 000/Ha)

Properties	PV of Revenue	EAA of Revenue
Rubber	161,217.98	9,846.91
Oil Palm	**170,588.22**	**11,301.77**

Note: DF 5%
Source: Own Calculation

5.2.2. Cost Analysis

In contrast with revenue, cost is issued since the first year of planting. This has become a challenge for farmers because they have to generate income from other sources to fund their living cost and crop planting until rubber and oil palm trees can be tapped and harvested. The variable cost is divided into two categories, labor and input cost. As mentioned before, rubber farms are more labor intensive than oil palm farms. This condition also can be seen from the fact that the labor cost of rubber farms per ha is higher than those of oil palm farms. The annual rubber labor cost is 4 times higher that of oil palm. This labor intensive condition can be also seen from the share of labor cost in all input costs, which are 78.52 percent for rubber labor cost and 12,27 percent for oil palm labor cost.

Table 12. Annual Value and Share of Variable Cost (Rp 000/Ha/year)

Variable Cost	Rubber		Oil Palm	
	EAA (DF=5%, Rp/Ha)	Share (%)	EAA (DF=5%, Rp/Ha)	Share (%)
Labor Cost	1464.65	78.52	420.27	12.27
Seedling	27.35	1.47	456.56	13.33
Replanting	6.35	0.34	19.30	0.56
Plant Menure	0.00	0.00	15.05	0.43
Animal Manure	0.00	0.00	0.13	0.003
Soil Amendments	2.09	0.11	33.27	0.97
Fertilizer	144.49	7.75	2007.21	58.61
Herbicide	127.34	6.83	274.01	8.00
Machinery	4.12	0.22	0.46	0.01
Input Transport	3.59	0.19	12.09	0.35
Output Transport	81.07	4.35	150.14	4.38
Other Cost	4.23	0.23	35.95	1.04
Total	1865.28	100.00	3424.45	100

Note: DF 5%
Source: Own Calculation

Even though labor cost of rubber is higher than that of oil palm, the total variable cost of oil palm is lessthan that of rubber. The reasons are:

1. The high needs of external material such as fertilizer, herbicide, and manure on oil palm farms.
2. The use of machinery which are more intense thanon oil palm farms.
3. The big purchases of input and the bulky of output lead to more spendingof transportation cost in oil palm farms.

The annual value and share of each input cost are shown in table 12. From this table, we find that the highest cost is cost of fertilizer in both commodities. Moreover, the cost of fertilizer in oil palm farms reach ten times more than that in rubber farms. Following fertilizer, seedling becomes the second highest cost in oil palm farms.

5.2.3. Profit Analysis

As stated before, profit in this research is calculated in gross margin form. Table 13 represents the profit of rubber and oil palm in three discount factor levels. In all discount factor levels, NPV of rubber farms are more than that of oil palm farms. It can occur because rubber farms have longer production period than that of oil palm, since the production period of rubber is 30 years while oil palm is only 25 years. On the other side, the EAA value of profit states thatrubber farms are less profitable than oil palm farms annually. This result confirms that even if oil palm farms spend more variable cost, they still can generate more income. Furthermore, it is consistent with the research hypothesis and other previous studies, which stated that oil palm was more profitable than rubber (Papenfus, 2008; Feintrenie, Chong, and Levang, 2009; Belcher et al, 2004).

Furthermore, table 14 also states that oil palm profits, described by NPV and EAA, are more sensitive to discount factor changes than rubber profit. It can be seen in the differences of oil palm profit in between discount factors is higher than that of rubber profit. It can occur due to the high losses of oil palm in pre-production period. Belcher et. al (2004) mentioned that the effect of discount factor is depending on timing. Thus, the commodity with higher capital expenditure in the early period will be more profitable at lower discount rate and insensitive to changes than that with lower capital expenditure.

Table 13. Present Value and Equivalent Annual Annuity of Profit (Rp 000/ Ha)

Discount Factor	GM Rubber		GM Oil Palm	
	NPV (Rp/Ha)	EAA (Rp/Ha)	NPV (Rp/Ha)	EAA (Rp/Ha)
5%	133,933.52	9,156.25	133,240.98	12,217.16
10%	68,679.38	3,338.31	67,054.73	4,211.20
15%	38,673.70	1,650.32	35,547.87	1,917.79

Source: Own Calculation

5.3. Determinant Profit Factors

5.3.1. Comparative Determinant Profit Factors between Rubber and Oil Palm Farms

The determinant profit factor analysis was conducted by OLS method. The variables consist of farm characteristics, resource uses and farmer characteristics. OLS is not valid in the presence of heteroscedasticity and multicolinearity. To estimate the valid OLS estimator without heteroscedasticity, the heteroscedasticity-robust procedure by stata 11 is used. At the same time, the model has no multicolinearity since all variance inflation factors (VIF) provided by stata are less than 5.

The results of multiple regression analysis using the OLS method are shown in table 15. Ruber profit model has adjusted $R^2$of 41.7 percent which means that 41.7 percent of data variation are explained by this model and the remaining 58.3 percent are explained by error. On the other side, the oil palm profit model has adjusted R^2 of 64.1 percent which also has the same meaning to the previous description. In the case of multiple hypothesis, both models stated that all variables jointly affect the rubber and oil palm profit. This is reflected by the p-value of F-test which is significant at the 0.05 level.

For eachcommodity, the number of determining factors significantly affect profit is different based on t-test analysis. For rubber farms, there are 8 significant determinants i.e. plot size, tree age, number of productive trees, herbicide use, farmer age, household member involved in agriculture, certificate and *sporadik* ownership and cooperative involvement. On the other side, oil palm have 7 significant determinants, i.e number of productive trees, district (Maro Sebo Ilir), herbicide use, NPK fertilizer use, farmer education, HH member involved in agriculture, and ethnicity (Javanese).

Farm characteristic consist of 4 variables. The plot size significantly influences rubber profit but it is not influencing oil palm profit. Increasing of plot size leads to decreasing profit of rubber and oil palm farms. The increasing plot size per Ha will decrease rubber profit until Rp 1,159,642, ceteris paribus. This result is in line with Ellis (2006) which stated that there is an inverse relationship between farm size and productivity. Usually, farmers with larger plot size will tend to do extensification, then they will use less input or labor per Ha. Besides, the larger plot size does not mean it has the more fertile soil. It might be caused by the less fertile soil in the large plot size per Ha than that in the small plot size. Based on the magnitude, plot size effect on rubber's profit is more than that in oil palm's profit..

Tree age also significantly determines rubber profit but it is not determining oil palm profit. The increasing 1 year of tree age will increase rubber profit by Rp 127,101, ceteris paribus. Even though we know that after certain years there is declining period. The positive impact shows that most rubber trees in Batanghari are still in productive period. It is in line with the data in which about 71 percent of rubber trees are in a production period (6-30 years) and 70 percent of them are in early of productive tree (6-18 years).

A number of productive trees significantly affect both commodities. The large number of trees per Ha does not guarantee that the farms have the large number of productive trees since plant diseases, old tree, or immature tree cause tree cannot be tapped or harvested. Based on value, the effect of this determinant of oil palm profit is higher than that to rubber profit.

The last farm characteristic is district which significantly affect the oil palm farmer but not the rubber farmers, eventhough only Maro Sebo Ilir district is significantly influencing profit. From the coefficient, Maro Sebo Ilir is known as the most productive district, where the oil palm farm in this district can generate the biggest profit. In every Ha, oil palm farmer in this district will get Rp 5,710,931 more than Bathin XXIV as basis district. This condition is also in line with the BPS Batanghari data (2013) stating that Maro Sebo Ilir is the district with the second largest of production.

Resource variables consist of three variables which are the most used and give large impact to profit due to the large contribution to the total cost. The herbicide usesignificantly influences both commodities but with different effects. This determinant gives a negative impact to oil palm profit. Controlling for all other factors, in every Rp 64,338 of additional herbicide cost, farmer can lose profit of Rp 258,646. This suggests that there has been ineffective herbicide use since its use which is too much is not followed by the high increasing of production even it decrease the production of oil palm. Moreover, the high herbicide price is not followed by the high quality of it. In other side, this input has positive effect to rubber profit. This result shows that weed reduction is effective to improve rubber production. Controlling other factors, in every Rp 64,338 of additional herbicide cost, rubber farmer can get Rp 195,394 as additional profit.

Another important input is fertilizer where in this research location, farmers use various fertilizers such as Borate, NPK, KCl, sulfur, TSP, Urea, Za, NPK Foska, NPK+Foska and SP36+Foska. The main fertilizer used by rubber and oil palm farmers are urea and NPK which have different function. Even though only NPK variable in oil palm profit is significant, the relationship between these fertilizers is interesting to explain due to the different sign. For rubber, urea has a positive effect and NPK has a negative effect, while for oil palm both of the fertilizers have the opposite effect. These results mean that in rubber urea is responsive to increase latex production, while in palm oil, NPK is responsive to increase FFB production. It is in line with the need of rubber and oil palm tree. Rubber tree use more single fertilizer, such as urea (Ikapi, 2008), while oil palm tree use more compound fertilizer, such as NPK (Jannah, Fatah, and Marhannudin, 2012) since urea is functioning for trunk and root growth whereas NPK is functioning for leaves, fruit, root and trunk growth. Based on value, in every Rp 4,725 of increasing NPK cost, oil palm profit will increase Rp 2,978, ceteris paribus.

Farmer characteristic variables consist of seven variables. The farmer age significantly influences rubber profit but not oil palm profit. The increasing of farmer age will lead the increasing of rubber profit. This suggest that the older the farmer, the more experience they have. Then, the experience gives them more knowledge about how to manage the crop well and get better production and profit. This result is in line with Olujenyo and Olayiwola (2008) stating that age and experience have positive impact to production.

Oil palm profit are significantly determined by ethnicity of farmer particularly Javanese, while rubber profit is not. The reason is transmigration especially in the 1988 Nucleus Estate Settlement program which gave land away to grow the oil palm farm (Fearnside, 1997). Like the other transmigration program, many Javanese people also took part of this program. Table 15 states that Javanese farmers earn Rp 5,150,252 more profit than Melayu farmer.

The number of household members involved in agriculture is significantly affecting rubber and oil palm profit. This determinant gives a negative impact to profit. It is a bit surprising since this variable was expected as an unpaid labor source, then they will increase production without additional cost. In the research area, the most family labor work on harvesting or tapping activities where these activities are directly determined output. They could be not working as proper as hired labor, then they produce less output than the hired labor. Beside that, the poor farm management and soil fertility also can cause the lack of production (Olujenyo and Olayiwola, 2008).

Sharecropping is an activity that is mostly applied in rubber farms. The labor payment is certain percent of production. The statistic result shows that this determinant significantly influences rubber profit with negative effect. In every percent of increasing the production used for sharecropping wage, the profit will decline until Rp 56,303, ceteris paribus. This result has been expected because wage is a part of cost which can reduce profit.

The legal status of land ownership can be seen from the certificate and *sporadik* ownership, even if the custom law is also applied. From credit utilization side, the farmer having this document prefer to use credit from formal institution because it does not bind the farmer, while informal institution usually set high interest rate or low output price. The result states that this determinant is only significantly influencing the rubber profit since credit institutions used by rubber farmer are more differ than that by oil palm farmers. The magnitude means that the farmer with a certificate or *sporadik* can get Rp 2,580,627 more than the farmer without it.

The last variable is cooperative involvement where this determinant significantly influences both rubber and oil palm profit with different effect. For oil palm case, if farmers or their family is involved in cooperative, they will get Rp 2,903,833 more profit than the other. Some cooperative role such as financial support and information source enable oil palm farmer to use proper input, thus it can encourage more profit. This advantage is taken by most oil palm farms (65.35%) in which 84 percent of them are productive oil palm farms (7-24 years). At the same time, for rubber case, if farmers or their family is involved in cooperative, they will get Rp 3,704,633 less profit than the others. This result is a bit contradictive with a cooperative function which explained before. It is due to the low number of rubber farm which use this opportunity in which 55 percent of them are productive farms.

Table 14. The OLS Model Result: Comparing Determinant Profit Factor of Rubber and Oil Palm (Dependent Variable: Profit per Ha (Rp 000))

Variables	Rubber		Oil Palm	
	coef	Se	coef	se
Farm Characteristics				
Plot size (Ha)	-1,159.642***	290.081	-41.399	165.607
Tree Age (Year)	127.101**	60.801	101.993	140.565
No. Of Productive Tree (Unit/Ha)	26.943***	3.044	96.487***	16.616
District (Dummy)				
Bathin XXIV	Basis			
Muara Bulian	882.988	1,439.668	-1,546.148	2,314.295
Bajubang	-740.586	1,694.317	-2,365.034	2,286.410
Maro Sebo Ilir	-1,320.383	4,398.079	5,710.931***	2,166.474
Pamayung	1,549.091	2,726.438	4,735.705	3,008.710
Resource Use				
Hired Labor (Work Day/Ha)	-19.367	31.279	-6.692	18.861
Herbicide (Liter/Ha)	195.394**	96.431	-258.646***	93.023
Urea Fertilizer (Kg/Ha)	2.076	1.474	-2.084	2.034
NPK Fertilizer (Kg/Ha)	-1.020	1.467	2.978***	1.069
Farmer Characteristic				
Farmer Age (Year)	96.271*	49.721	78.560	66.871
Farmer Education (Year)	139.185	155.235	381.627*	223.400
HH Member Involved in Agriculture (People)	-974.987*	526.705	-2,217.059***	743.153
Percentage of Production Used as Wage (%)	-56.303*	32.241		
Ethnic (Dummy)				
Melayu	Basis			
Javanese	1,399.237	1,284.190	5,150.252***	1,894.995
Others	-118.774	1,648.863	2,909.596	2,386.844
Certificate and Sporadik Ownership (Dummy)	2,580.627***	959.046	-239.066	1,437.323
Cooperative Involvement (Dummy)	-3,869.165**	1,853.044	1,890.065	1,619.754
Cons	-2,834.080	3,351.692	-10,293.495**	4,958.226
Number of observations	234		126	
R2	0.465		0.693	
Adjusted R2	0.417		0.641	
Prob > F	0.000		0.000	
VIF	1.550		2.390	

Note: ***, **, * Significant at 1%, 5%, and 10% respectively

Source: Own Calculation

5.3.2. The Effect of Crop Selection on Profit

After explaining the determinant factor of rubber and oil palm profit, it is also important to know whether crop selection influences the profit. Table 16 shows that plot size, tree age, number of productive trees, farmer age, district (Maro Sebo Ilir), certificate and *sporadik* ownership, and crop selection are determinant of profit. In general, the additional plot size has negative impact to profit, while the additional tree age, number of productive trees, and farmer age will increase the profit. Farmer holding certificate or *sporadik* ownership will get more profit than farmer without it. From district side, Maro Sebo Ilir is proved as the district with the highest profit. It can also be seen from table 16 stating that Maro Sebo Ilir is district with the highest of oil palm profit and the second highest of rubber profit. The rest variable such as hired labor, herbicide use, urea use, NPK use, farmer education, HH member involved in agriculture, ethnicity, cooperative involvement are not significant determining commodity profit in Batanghari.

Crop selection is the important determinant for this model. The significance of this determinant proves that rubber or oil palm generates a different amount of profit. Furthermore, the crop selection determines the direction of land use change, whether it goes to oil palm or rubber farms.

The result states that oil palm farms are more profitable than rubber farms. Oil palm profit from 1 Ha farms is Rp 2,084,486 more than rubber farms, this result is in line with profit analysis by EAA, even though we cannot compare the profit differences between EAA and this OLS model. Some previous literatures also obtained the same result where return to land and return to labor of oil palm farms are more than those of rubber farms (Papenfus, 2008; Feintrenie, Chong, and Levang, 2009; Belcher et al, 2004). Moreover, this can be a foundation of land use change direction in which the existing land will be used for build up oil palm farms more. Then, if it is continued to occur, the rubber farms will be converted to oil palm farms.

Table 15. The OLS Model Result: Determinant Profit Factor of All Commodities (Dependent Variable: Profit per Ha (Rp 000))

Variables	coef	Se
Farm Characteristics		
Plot size (Ha)	-490.143**	207.743
Tree Age (Year)	177.828***	53.019
No. Of Productive Tree (Unit/Ha)	28.383***	2.942
District (Dummy)		
Bathin XXIV		
Muara Bulian	1,316.776	1,326.754
Bajubang	-1,350.285	1,424.585

Maro Sebo Ilir	5,539.920**	2,186.424
Pamayung	1,088.056	2,482.800
Resource Use		
Hired Labor (Work Day/Ha)	15.834	21.025
Herbicide (liter/Ha)	-47.666	70.102
Urea Fertilizer (Kg/Ha)	-0.572	1.318
NPK Fertilizer (Kg/Ha)	1.973	1.491
Farmer Characteristic		
Farmer Age (Year)	74.846*	44.004
Farmer Education (Year)	48.233	149.854
HH Member Involved in Agriculture (People)	-634.979	400.957
Ethnic (Dummy)		
Melayu	1,630.753	1,142.153
Javanese	570.465	1,384.652
Others		
Certificate and Sporadik Ownership (Dummy)	1,839.263**	848.154
Cooperative Involvement (Dummy)	801.396	1,600.000
Crop dummy (0=Rubber, 1=Oil Palm)	2,084.486*	1,086.971
Cons	-4,496.585	2,980.630
Number of observations	362	
R2	0.427	
Adjusted R2	0.395	
F	24.142	
VIF	1.730	

Note: ***, **, * Significant at 1%, 5%, and 10% respectively

Source: Own Calculation

5.4. Policy Implication

These research findings expect that crop selection affect the land use change where oil palm farms are more profitable than rubber farms. Thus, the bare land will be used for the oil palm farming; even rubber farm could be converted to oil palm farms. In governmental policy side, it is not simply implies that all of the land should be allocated for oil palm farming, but another important issues have to be considered as well. To prevent the land use exploitation that can cause deforestation, the development of oil palm should be focus on intensification rather than extensification. Intensification of oil palm can be done by increasing number of productivity tree, increasing NPK fertilizer up to optimal level, optimize the herbicide use, and optimize the family labor.

Although rubber farms are less profitable than oil palm farms, this commodity can be improved by considering some factors influencing rubber profit. In farms, replanting unproductive trees and optimizing land use can improve rubber profit. In resource use, the weed reduction will give higher production, thus it give higher profit. In labor use, the family labor use has to be optimized in order to avoid the decline of rubber production. Sharecropping activities also have to be optimized because sharecropping will reduce profit. To increase the access of formal loan, farmer should have certification or *sporadik*.

VI. CONCLUSIONS

The result of characteristic comparison shows that tree age, farmer education, share of productive tree, and number of household member involved in agriculture are significantly different between both commodities. Oil palm farms are mostly in Maro Sebo Ilir district, while rubber farms are mostly in Muara Bulian district. Although Melayu is the main indigenous people in Jambi, surprisingly rubber and oil palm farms are mostly owned by Javanese people. Oil palm and rubber farms are the main income source for most farmers because only a few farmers have other income source. The cooperation has not improved, since the percentage of cooperation involvement are still low in both commodities.

Profitability analysis states that annually oil palm farmsare more profitable than rubber, although variables costs of oil palms farm are higher than rubber. This result is caused by the high of oil palm revenue. In both commodities, fertilizer cost is the highest cost because of the high fertilizer requirement.

Based on OLS model, there are some different determinant profit factors between rubber and oil palm farms. For rubber farms, tree age, number of productive tree, herbicide use, farmer age, and certificate and *sporadik* ownership give positive impact to profit, while plot size, number of household member involved in agriculture, and cooperation involvement give negative impact to profit. In other side, for oil palm farms, number of productive tree, NPK fertilizer use, farmer education, and ethnicity (Javanese) have positive impact to profit, whereas herbicide use and household member involved in agriculture have negative impact to profit. Based on another model, crop selection is also determining the amount of profit, then it influences land use changes. This determinant state that oil palm farm is more profitable than rubber farm.

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