STUDY ON DETERMINANTS AND IMPACT OF OIL PALM EXPANSION ON FARMERS' LIVELIHOOD IN INDONESIA

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STUDY ON DETERMINANTS AND IMPACT OF OIL PALM EXPANSION ON FARMERS' LIVELIHOOD IN INDONESIA

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STUDY ON DETERMINANTS AND IMPACT OF OIL PALM EXPANSION ON FARMERS' LIVELIHOOD IN INDONESIA

By

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A Dissertation

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Summary of Dissertation

The increasing yields of the oil palm have led to a rapidly expanding world industry with South East Asia, particularly Indonesia as the most productive country for its plantation. The aim of oil palm development in Indonesia is to reduce poverty in rural area by attracting its community to actively participate in agricultural sector as source of income. However, a significant challenge for the oil palm agricultural sector is the large productivity gap among the farmers that still exist. Despite of productivity gap, since rapid expansion of oil palm as one of government policy that play a significant roles rural income generator, the impact of oil palm expansion to farmers' livelihood is needed to be explored whether the expansion strategy improving its or not.

However, the study on evaluating impact of oil palm expansion on farmers' livelihood in Indonesia is very rare. As the first study on providing the impact analysis of oil palm expansion, it is expected to show the determinant and effect of oil palm land expansion particularly on productivity, agricultural adoption, poverty reduction and food security enhancement in Indonesia. Previous studies on livelihood analysis of oil palm cultivation mostly focus on comparing the oil palm grower with other crops. Hence, it may lead to undirected implication on how to enhance the future oil palm expansion program. It is important to understand whether the oil palm land expansion, which is one way of agricultural adoption on increasing farmers' income, have impacts on the welfare of households in the rural area. Based on the background, this study aim to 1) investigate the determinant that affect decision on expanding oil palm farmland based on performance analysis and to 2) evaluate the impact of oil palm expansion to the farmers' welfare.

Known as one of Indonesia's productive area for oil palm plantation, a total of 271 respondents from NES Trans and independent group in Riau Province were purposively selected on this study in 2013 and 2015. We set up several models to analyze various factors to achieve the purpose of the research. To estimate the efficient frontiers of farming productivity, a stochastic frontier analysis, SFA was utilized in Chapter 3. On the other hand, Chapter 4 investigated probability of farmers' decision on expanding oil palm farmland using Probit model. A propensity score matching approach (PSM) was applied in Chapter 5 to estimate the impact of expansion on farmer's income and poverty status. In order to understand the effect of land expansion and socio-economics background on household's food security status, OLS model and quantile regression were used in Chapter 6.

Based on the SFA analysis, technical efficiency indexes with average of 83 percent indicate that there was a scope for further increasing oil palm productivity by improving farmers' resources use efficiency and technology. Variance parameter results confirmed the effect of inefficiency exists. The coefficient of fertilizer was positive and highly significant to oil palm productivity. Negative and significant WPT (weighted of oil palm tree) coefficient suggested that ageing oil palm tree might reduce the output. The result was in line with the nature of oil palm tree, which its yield-peak periods were reported in between 9 – 19 years and decreased after 20 years of planting. Insignificant of labor coefficient arise from the effect of family labor that still actively involved on farming activity because oil palm was accounted as the main source of income. Analyzing the determinant factor affecting technical inefficiency indicated that the estimated coefficient of farmer group, education and diversification activity were negative to inefficiency. However, the variable of age of farmers and farm location were positive to inefficiency.

Furthermore, we examined factors underlying the probability of smallholder farmers expanding oil palm farm size over two decades. In order to analyze the reason behind farmers to expand their oil palm farmland, we divided the sample into two groups; expansion and non-expansion. The result pointed out that 73 percent of farmers in the study site expanded their oil palm farmland from 2 hectare to 4-16 hectare. It was found that the income, number of family member, land ownership status, farmer organization, extension program and soil type of oil palm farmland have positive impact on probability of farmers' decision on expanding oil palm farm size. Result of Probit model estimated income earned from oil palm as the most important factor relates to farmers' decisions to expand oil palm farmland.

With the aim to estimate the causal effect of oil palm expansion on farmers' livelihoods in Indonesia PSM was employed. In the first step of the model, logit estimation results indicated that number of family members actively involved in oil palm cultivation, farmers' financial assets, contract farming, and distance to the market were significantly associated with likelihood for expanding farm size. The average treatment effect represented that farm size had a positive and significant effect, increasing oil palm income per year for the expansion and non-expansion group, it was found that their income would increase if they expand their land. The results also show that the effect of poverty reduction, as proven by the higher percentage of farm households with per capita expenditures significantly above the poverty line. These results implied that expanding oil palm farmland was the right decision for both groups. Hence, positive and significant impacts of crop income from oil palm and per capita expenditures, confirmed that oil palm expansion help reducing the problem of job opportunity and poverty in Indonesia.

OLS and quantile regression models were applied to find the socioeconomic factors that influence farmers' food expenditure and calorie intake, and to examine whether the effect of oil palm expansion on food security differs across quantiles. The OLS result revealed that when farmers expanded oil palm farmland, income from oil palm, education, number of adult equivalent and food self-sufficiency program might lead to improve household food security status. Furthermore, the result indicated expanded farmland had a negative impact on food budget across quintiles due to the expenditure behavior. Household that fall into this category spends much of their budget on non-food expenditure, particularly on agricultural investment, child's education and luxury goods. On the other hand, food self-sufficiency exists as farmers produce food products from their own garden such as vegetables, poultry product, and livestock. The calorie consumption effects were positive and consistent across quantiles. This represented that land expansion and income earn from the oil palm may increase the total calorie from food and total calorie from nutritious food.

As the conclusion, result of this study highlighted that oil palm cultivation in the study area was experienced with the inefficient farming practice that lead farmers to expand their farmland. Furthermore, oil palm expansion was determined by economics motive, land ownership certification, financial assets, human capital, contract farming, and market access. The positive and significant impacts of oil palm expansion have been proven to generate income, per-capita expenditure and food security of farmers' household. Hence, it is important that government should provide accessible financial, land ownership scheme and market access, particularly for small-scale farmers to expand their oil palm farmland. In order to enhance the effect of oil palm expansion on farmers' welfare, government have to invest more on education, family planning program and food self-sufficiency program for rural household.

Keywords

Oil palm, smallholders, Indonesia, technical efficiency, stochastic frontier analysis, crop income, poverty reduction, propensity score matching, food security, quantile regression

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Widya Alwarritzi, Fukuoka, July 2017

Table of Contents

List of Abbreviations

AE	*Adult equivalent*
BPS	*Statistical Office Indonesia*
CPO	*Crude Palm Oil*
DKP	*Food Security Council Indonesia*
FAO	*Food and Agriculture Organization of the United Nations*
FAOSTAT	*Statistics Division of the Food and Agriculture Organization of the United Nations*
FFB	*Fresh Fruit Bunches*
GIS	*Geographic Information System*
IDR	*Indonesian Rupiah*
ISPOC	*Indonesian Sustainable Palm Oil System*
Kcal	*Kilo calorie*
NES	*Nucleus Estate and Smallholder scheme*
OECD	*Organization for Economic Co-operation and Development OLS Ordinary least squares*
PCE	*Per Capita Expenditure*
RSPO	*Roundtable on Sustainable Palm Oil*
USDA	*United Stated Department of Agriculture*

List of Figures

List of Tables

Chapter 1
Oil Palm Expansion: An Introduction

1.1 The oil palm expansion

Oil palm is one of the world's most rapidly increasing crops. Oil Palm production has boomed over the last decade, resulting in an expansion of the global oil palm planting area from 10 to 17 million hectares between 2000 and 2012. Palm oil has been used as a basic ingredient of most of human daily needs. Its product diversity can be found in almost daily products consumed in the world. Approximately 80 percent of global palm oil production is used for food purposes including as cooking oil, in margarines, noodles and baked goods. In addition, palm oil is used as an ingredient in non-edible products including in the production of bio-fuel, soaps, detergents and surfactants, cosmetics, pharmaceuticals and a wide variety of other household and industrial products (World Growth, 2011).

Originating in Africa, the oil palm was introduced into Malaysia and Indonesia in the colonial period. For communities in the tropical belt, palm oil has been a blessing. Current cultivation is concentrated in the tropical areas of the Americas, Africa and Southeast Asia. There are 43 known countries in the world that were listed as oil palm producer as can be seen from Figure 1.1. The Asian oil palm industry has thus developed at an astonishing rate, and now leads the world, whereas the African industry has gone backwards in most countries and the American oil palm industry has grown rather slowly.

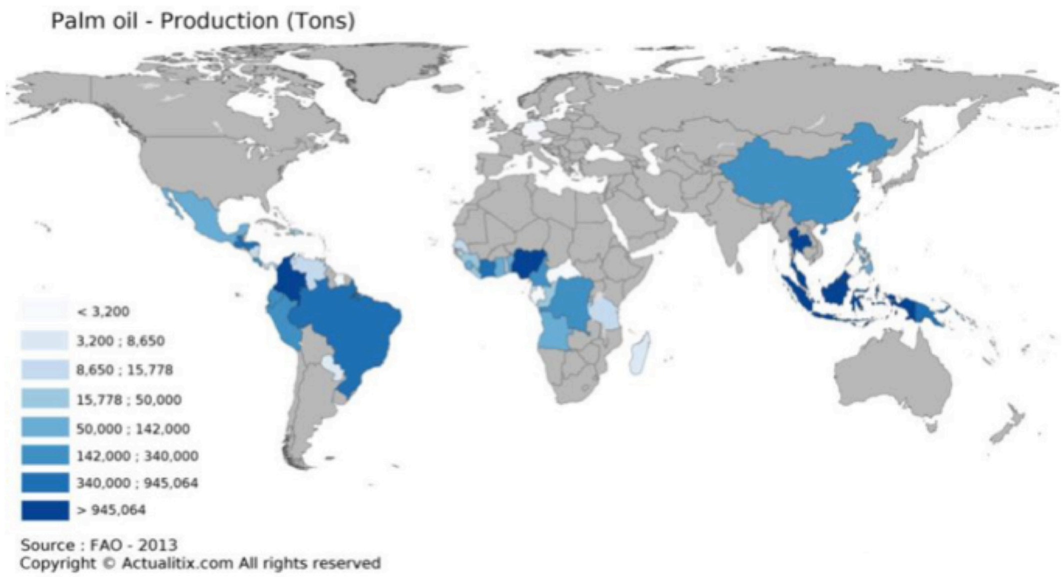


Figure 1.1 Oil palm producing countries in 2013

Source: FAO (2013)

Global palm oil production is dominated by Indonesia and Malaysia where the climatic growing conditions are ideally suited for palm oil trees. These two countries together accounted for around 85 to 90 percent of total global palm oil production. Indonesia is currently the largest producer and exporter of palm oil worldwide as can be seen in Table 1.1. During the period 1990–2005, oil palm in Malaysia and Indonesia expanded by a total of 1,874,000 ha and 3,017,000 ha respectively. Indonesia particularly has increased its area under oil palm plantations and annual CPO production more and in 2014 has become the world´s largest producer of palm oil (FAOSTAT 2014 , n.d.). The palm oil industry itself is a significant contributor to production in Indonesia. Palm oil is Indonesia’s second largest agricultural product. In 2008, Indonesia produced over 18 million tonnes of palm oil and grew to 33 million tonnes by 2014. Indonesian government had announced it targeting the palm oil production to reach 40 million tonnes by 2020. The majority of Indonesia's palm oil production is exported (Table 1.2). Important export destination countries are China, India, Malaysia, Singapore and the Netherlands.

Table 1.1 Global rank of palm oil production in 2014

Country	Palm oil production (metric tons)
1. Indonesia	33,000,000
2. Malaysia	19,800,000
3. Thailand	2,000,000
4. Colombia	1,108,000
5. Nigeria	930,000

Source: (Indonesia Investments, 2016)

Table 1.2 Indonesian palm oil production and export statistics

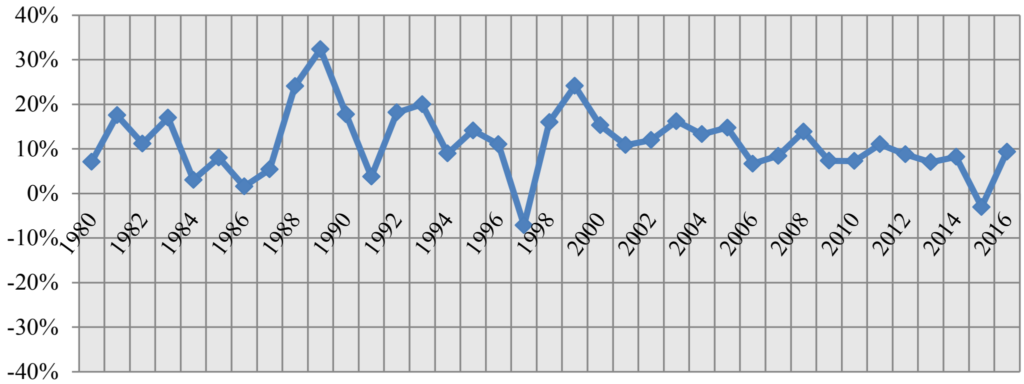
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016
Production (million tons)	19.2	19.4	21.8	23.5	26.5	30.0	31.5	32.5	32.0[1]
Export (million tons)	15.1	17.1	17.1	17.6	18.2	22.4	21.7	26.4	27.0[1]
Export (in USD billion)	15.6	10.0	16.4	20.2	21.6	20.6	21.1	18.6	18.6[1]

[1] indicates forecast
Source: (Indonesia Investments, 2016)

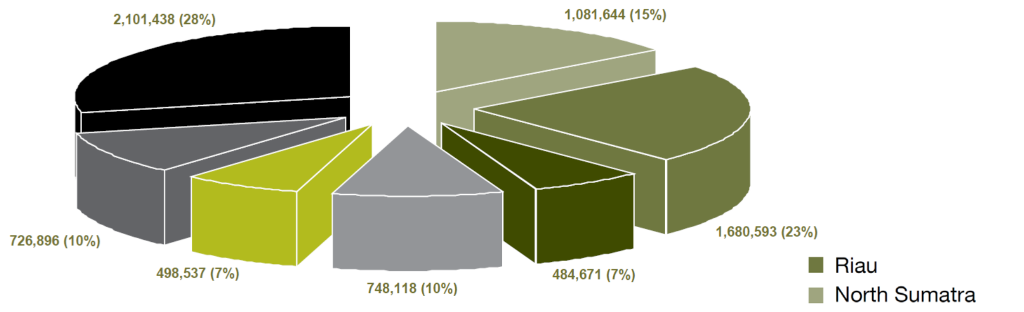
According to data from the Indonesian Ministry of Agriculture the total area of oil palm plantations in Indonesia is currently around eight million hectares. This number is expected to increase to 13 million hectare by 2020 (Indonesia Investments, 2016) that will continue to grow steadily with average growth rate of 11.18% as can be seen from Table 1.3. Increased land area of plantations in Indonesia is the result of government's efforts to make oil palm as a commodity to create jobs and improve the welfare of the community. The number of workers absorbed in upstream sector reached 1.95 million people in plantations, while 1.7 million farmers in people’s plantations (Duryat, et al., 2013).

The palm oil industry also contributes to regional development in Indonesia and is seen as a significant source of poverty alleviation through farm cultivation and downstream processing. World Growth (2011) suggesting that employment generated from palm oil production could potentially reach over 6 million lives and provides a reliable form of income for a large number of Indonesia's rural poor. Over 6.6 million tonnes of palm oil is produced by smallholders representing over 41 percent of total palm oil plantations. In 2006, it was found that around 1.7 to 2 million people worked in the palm oil industry. (World Growth, 2011).

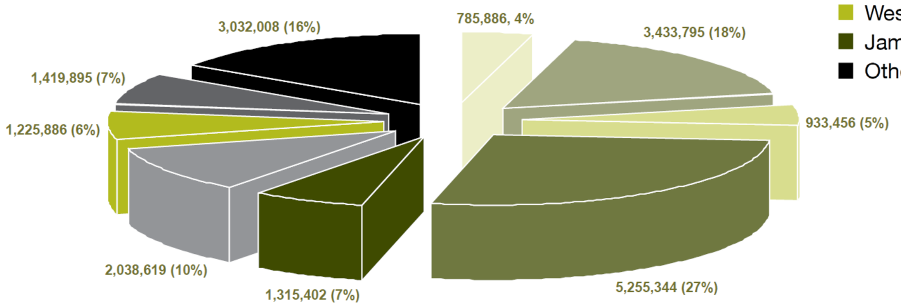
Table 1.3 Indonesia palm oil production annual growth rate



Source: (Index Mundi, 2016)



a) Location of oil palm plantation (ha)



a) CPO production by province (metric tons)

Figure 1.2 Location and production of oil palm plantation in Indonesia (2009)

(Price Water Coopers, 2010)

The 2009 data shown in Figure 1.2 depicted the location of plantations and its productivity as in 2009. Most of the plantations are located in Sumatera island (65% combined) where a significant portions of it located in Riau Province (23% from total), in which showing the great importance of oil palm industry in contributing regional income and absorbing labor force. As a main driver in fostering rural development and economic growth in Sumatra Island, an oil palm based agro-industry was seen as an important vehicle to transform Indonesia´s advantage in natural characteristic and human resources into a pillar of national economic development and a provider of foreign exchange earnings (Euler, 2015). The policy implication of this target was to transform rural areas into oil palm based production plantation and creates an opportunity that attracts locals as well as transmigrant into opening land and cultivates palm oil in the designated areas.

Given the importance of oil palm however, careless development of oil palm plantation is destroying forests, drying out peat-swamps, and wiping out endangered species and polluting air and waterways. This problem has been recognized by the industry and the Roundtable on Sustainable Palm Oil (RSPO) has been set up by which companies operating through approved methods can be assessed and certified. Most attention has focused on the two major palm oil exporting countries, Malaysia and Indonesia, which between them supply over 80% of the global market. Interestingly, oil palm farmland in these countries doesn't own by only big companies but some portion of it are owned by local farmers that cultivate the land themselves, often referred as smallholder farmers. These farmers share farming practices and information through local farming community and most of them operates in different scale of standard.

1.2 The emergence of oil palm smallholder farmers in Riau

The increasing yields of the oil palm have led to a rapidly expanding world industry with South East Asia, particularly Malaysia and Indonesia as the most productive country for its plantation (USDA, 2007). Indonesian government through Master Plan for Acceleration and Expansion of Indonesia's Economic Development (MP3EI), stated that oil palm as one of agricultural major sector with Sumatera Economic Corridor as its focus for production development, particularly, Riau Province. The trends of land utilization and oil palm production growing up until 2009, with smallholder plantation land area growing up by 24.2 per cent per year and targeted to be more than 3,800,000 Ha in 2020 (IPOC, 2008). This fact supported by the the growth in plantation ownership shown by Figure 1.3 that showing that there are significant change from domination of big major companies to smallholder plantation that emerged later and get a hold of about 43.76% of the plantation areas (Price Water Coopers, 2010).

In the last half-century, oil palm cultivation by smallholders has expanded and drastically changed livelihood strategies and the landscape of rural societies in the Indonesian outer islands (Koizumi, 2016). Based on the 2013 Census of Agriculture, smallholders cultivated 3,133,711 hectares with oil palms in Indonesia and the spreading area can be seen from Figure 1.4.

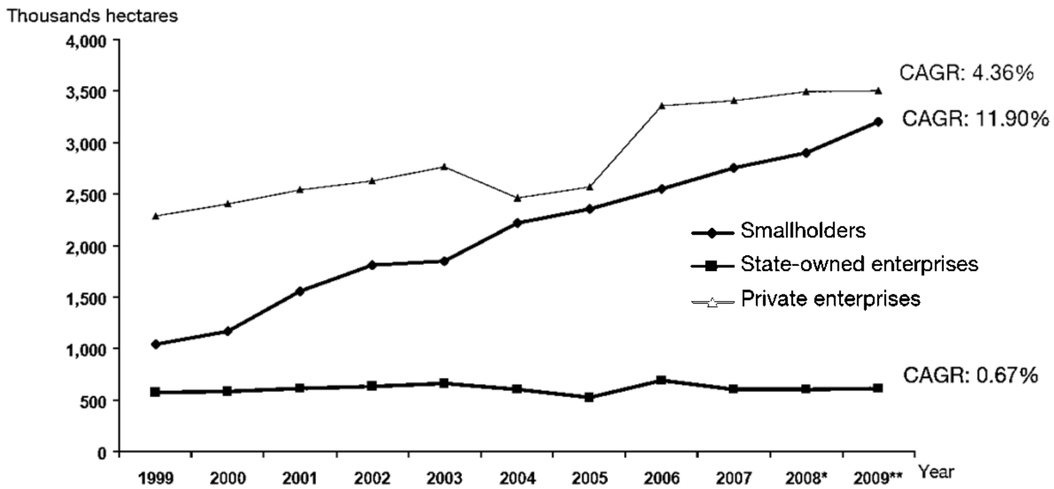


Figure 1.3 Development of oil palm plantations and ownership in Indonesia

(Price Water Coopers, 2010)

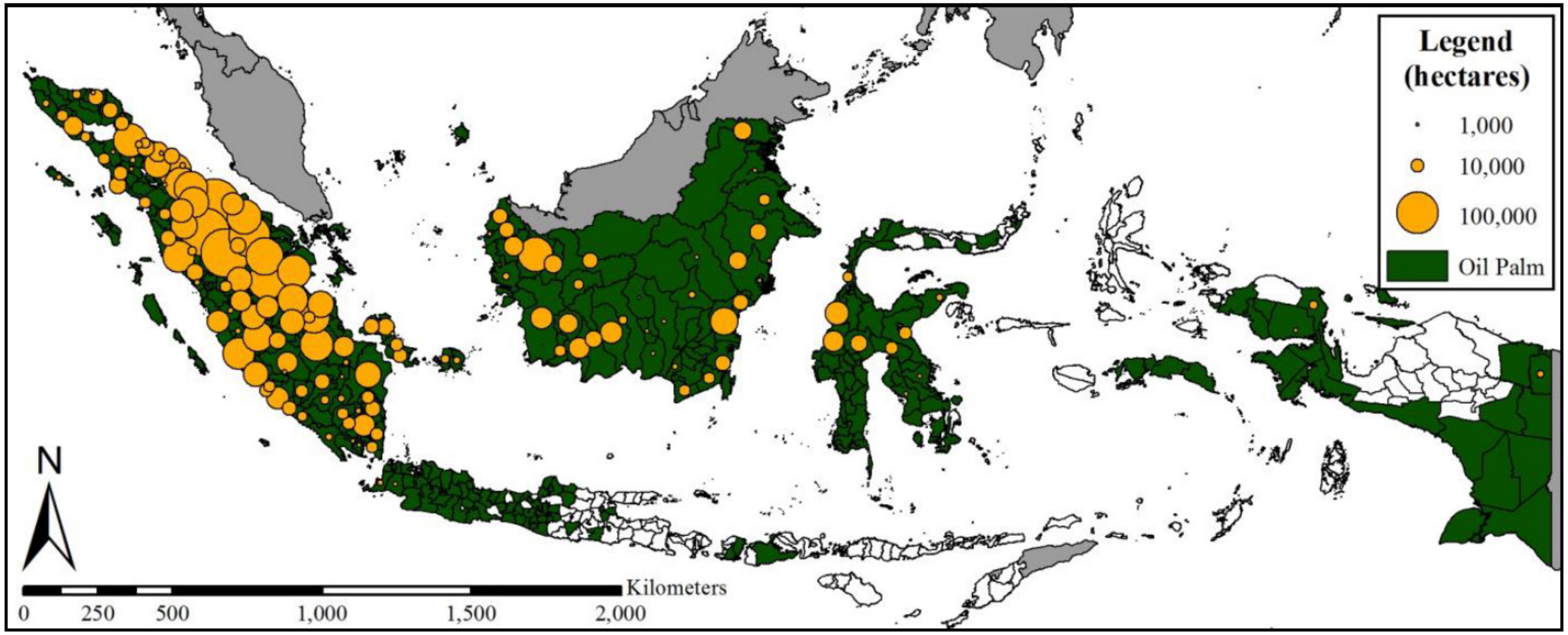


Figure 1.4 Areas of oil palm cultivation by smallholders in various districts

Source: (Koizumi, 2016)

Note: The figure divides Indonesia into districts. Districts where oil palms are cultivated by smallholders are shaded in dark green. Districts where smallholders cultivate more than 1,000 hectares of oil palms are indicated by orange circles corresponding in size to the total area cultivated in that district.

Table 1.4 Dynamic of oil palm plantation in Riau Province

No	Period	Year	Influence factors	Impact/Change
1.	Early development of oil palm	Early 1980	- Credits for Big Private National Plantation Company II - Policy of Riau provincial government to utilize idle land ex timber extraction	Development of oil Palm estate plantations in Riau Province
2.	Development of Independent Smallholding Plantation	1985 – now	- Development of estate plantation attract arrival of workers and immigrants who have knowledge background about oil palm cultivation - Availability of land sold by indigenous	Development of Independent smallholding oil palm plantation
3.	Development of plantation NES scheme	1988 – 1995	- The Policy of Government commissioned the private company to develop oil palm smallholdings	Development of PIR-Trans in forest area and PIR Plantation in area of ex public transmigration
4.	Development of plantation Cooperative scheme	1996 – Now	- Government policy regarding the credit scheme of planting for development of smallholding plantation	Development of smallholding plantation in the form cooperative scheme (KKPA)

Source: (Duryat, et al., 2013)

Oil palm was first introduced in Riau Province in the early 1980s by transmigration program from the government of Republic of Indonesia with aim to facilitate volunteers from over-populated islands to the less populated islands. Indonesian Government has previously implemented a series of rural and socio-economic improvement programs directed at small oil palm landholders. Until 2001, the use of palm oil ‘nucleus estates’ was suggested to raise the income of over 500,000 farmers. Oil palm plantations usually followed a Nucleus Estates and Smallholders (NES-trans) scheme in which a company holds a refinery and an estate surrounded by smallholdings. The NES-trans farmers were provided with technical assistance from the company through extension program and divided into several farmers group to disseminate technical information to enhance effectiveness of productivity.

Historically, smallholder plantations have been less productive than other palm oil plantations. In 2008, production per hectare for smallholders was estimated at 3.04 tonnes/ha as compared with 3.7 tonnes/ha for government plantations and private plantations. World Growth (2009) found that there is considerable potential for small holders in Indonesia to expand output on existing acreages through the use of fertilizer and new genetic stock

In 1988, the government has charged the national private plantation company (PBSN) to involve the communities in oil palm plantations ownership. For the development of new plantations, agro-industries are required to allocate 80% of their concession for smallholding plantations. The plantation companies were started to develop a partnership with the transmigrant communities to implant smallholding plantations on the ex-land of general transmigration program in early 1994. Each transmigrant received 1ha of agricultural land, previously were forest for growing food crops and oil palm, and 0.75 ha of reserve land still forested.

The major development of financial schemes for oil palm plantation was started in 1995, where “cooperative scheme” policy was introduced by the government in order to guarantee the implantation of smallholding plantations. The schemes main point is directing any bank to give planting credits to farmers’ cooperatives instead of directly to the farmers. The historical dynamic of palm oil plantation in Riau Province based on study by Duryat et.al (2013) can be seen in Table 1.4.

Due to its high benefit from oil palm cultivation, the wealth of Sumatran agriculture seemed promising in which oil palm attracts farmers and in line with it, the transmigration program attracted more migrants from Java Island. This program was further encouraged by district and provincial authorities eager to increase population density in their constituencies, especially since the passing of the regional autonomy laws in 1999. The trend of oil palm cultivation by NES-trans farmers was also followed by farmer from local people who are currently called as independent farmer. Independent farmer runs their farm quite different with the NES-trans farmers. They cultivate oil palm without contract farming system, and lack of extension guidance from any formal institution.

One of the problems regarding oil palm expansion is environmental degradation, particularly to the area of tropical peat forest, which has been changed to the oil palm cultivation (Figure 1.5). Remarkably need of oil palm both national and global resulted land expansion in Indonesia which peat land area was designated for oil palm cultivation. This trend may impact some environmental problem such as forest burning, regional fogging which also impacted to neighbor countries, lack of fresh water storage and natural forest degradation.

Forest burning has become major issue and adding the drawback of oil palm plantation in the Island of Sumatera, particularly in Riau Province. Man-made fires were used to prepare land for agriculture and to gain access to land cheaply. Absent controlled burning measures or sufficient law enforcement often make the fires grew out of control and this vast environmental crisis is repeated year after year. Most of the burning location is peatlands (*lahan gambut*) where some farmers utilized it to plant oil palm. It is a widespread issue that fire has long been a tool for agriculture in Indonesia. Informally, it also plays an important role in land acquisition.

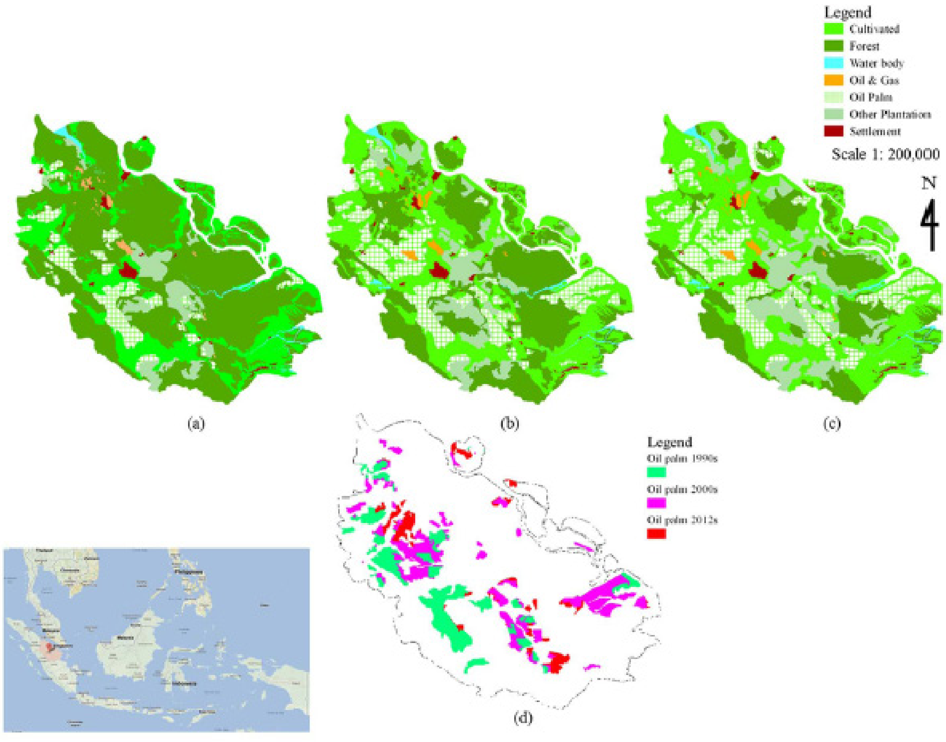


Figure 1.5 Trend of land use change detection for oil palm development in Study Area (a) 1990, (b) 2000s, (c) 2012, (d) oil palm plantation profile (Ramdhani, et.al..)

Analysis by the Center for International Forestry Research (CIFOR) provides an example of the role of fire in the lucrative palm oil industry. CIFOR concluded that using fire for land acquisition and clearing generates a cashflow of at least USD 3,077 per hectare of oil palm in just three years (Purnomo, et al., 2015). If every hectare burned in 2015 were converted to oil palm, the value would be about USD 8 billion, highlighting the scope for high profit in a short period of time. Poor land management and governance allow this ecologically destructive activity to continue. Peatlands are a target as they generally are uninhabited and relatively free of overlapping claims (World Bank, 2016). Nevertheless, forest burning happen due to lack of understanding in proper land acquisition techniques and not the main agricultural activity itself since oil palm were able to generate cash flows for farmer and support rural development in Riau Province.

The rural development itself is well contributed by the emergence of smallholder plantations that have the lowest agronomic performance on average but also more heterogeneous. In line with it, previous researches have outlined the importance to explain the yield spreads in smallholder's plantations to rethink technical advice for smallholder so that their current plantations and future display no factor limiting the yields (Duryat, et al., 2013). As the productivity of smallholdings plantation may vary from one farmer to another, it is necessary to observe the difference in terms of farmers group.

Since the growth of oil palm plantation in Riau Province undoubtedly were supported by the successful transmigration program, both general transmigration (before 1988) and PIR-Trans program (after 1988), therefore smallholding farmers can be categorized as immigrants and local farmers. Furthermore, following the NES trans scheme plantation policy and cooperation scheme policy delivered by the government of Indonesia in 1988 and 1996, farmers category that is expected to have significant difference in farming productivity can be distinguished as NES-Trans farmers and Independent Farmers.

1.2.1 NES-Trans Farmers

The nucleus estate and smallholder (NES) scheme is the pattern of development in the area estates people land new openings with a large estate as a core build and guide the people of the surrounding plantations as a plasma in a system of mutually beneficial cooperation, and sustainable. NES is often applied to the plantation core transmigration programs, such as in Indonesia for crop plantation such as oil palm, rubber and others under contract farming system. Construction of treatment facilities and public facilities such as roads, schools, houses of worship, clinics, and other projects are included in the NES scheme. One purpose of the pattern is to mobilize the people of the nucleus of excellence/technical and managerial skills possessed large estates to help develop plasma plantation for settlers who do not own land and are in the land suitable for plantation commodities.

Indonesia's program of Nucleus Estates and Smallholder (NES) development was designed to create productive employment at relatively low cost and raise the farm incomes of landless and near-landless families while increasing output and exports from important tree crops. The Bank supported the program through seven projects approved in quick succession in 1977-83. Of an expected cost of $1.3 billion for the seven, the Bank commitment was $655 million. The NES program took advantage of Indonesia's increased oil revenues. Later, however, as these revenues dried up, the Government was to face serious problems in providing counterpart funds. Based on OED report, on the whole, Indonesia's public sector NES strategy has not met its goals. It notes that a more gradual approach, on a smaller scale, might have left more sustainable benefits.

The projects overstretched the management capacity of the public sector estate companies that were responsible for implementation as well as for programs of their own. The estate companies received funds to clear land, build infrastructure and housing for settlers, provide employment, and establish and maintain the treecrops to maturity. Participants were to be employed as workers for the first three years after which, if judged suitable as settlers, they were to receive full title to their holdings.

1.2.2 Independent Farmers

Independent smallholders however are oil palm growers who are not tied to any government or company and therefore don't get any assistance from these parties. These independent smallholders sell their FFB's either to mills directly or through local buyers. This particular aspect can be seen as either a strong point or a weak point, as independent smallholders can choose to sell to the mill that offers the highest price for their FFB's, but this can also mean that in times of dwindling demands, mills can choose to only purchase from their plasma growers, leaving independent growers with no choice to sell their FFB's below market value (Sabrina, 2013).

Independent smallholders are particularly at risk from crop price fluctuations. However, monopsony purchases by mills and lack of bargaining power among smallholders exacerbate the problem. Nevertheless, ever since the late 1980s independent smallholders seem to be on the rise. Especially on the island of Sumatra and Kalimantan independent smallholders seem to grow significantly to meet the rising demand for palm oil (Papenfus, et al*.,* 2002). Primarily because independently owned oil palm smallholdings are considered to be highly profitable and which seems to be the main driver for farmers to choose for oil palm cultivation.

Other features which are considered positive are: the technical characteristics of the crop, including less labor and the high return on investment. Nonetheless beside the benefits, the independent smallholders still need to deal with some major disadvantages such as limited access to high-yielding trees, which means less output; (Zen, et al*.,* 2008) limited financial resources, lack of technical knowledge (and the high level of inputs, such as fertilization.

In the future independent smallholders are likely to become a much larger group (IPOC, 2008), mostly depending upon the amount of available land. But more importantly this group also bears the greatest opportunity to increase yields by improving soil health or by replacing low yielding with high yielding trees. Over-all investment in yield intensification for independent oil palm smallholders could therefore have large sustainability benefits for the future, most of all related to counteract further oil palm expansion into existing forests (Brandi, et al., 2012). To bring back deforestation andit is related to the environmental and social ef-fects.

1.3 Problem statement and study objectives

1.3.1 Problem statement

To ensure sustainable development of oil palm plantations, the simultaneous con-sideration of agronomic, socio-economic and environmental is inevitable. In the context of increasing demand for palm oil and land scarcity concern about oil palm expansion, there is a demand for knowledge on how to increase the small-holdings palm oil yield per hectare in a sustainable way. A significant challenge for the palm oil industry is the large productivity gap between actual and achieva-ble yields of palm oil plantations. In Indonesia, palm oil yields averaged 3-4 tonnes/ha, however, various estimates of potential yields are up to 8.6 tonnes/ha.

Achieving higher yield of oil palm requires more attention, particularly on how farmers decide to adopt farming methods that meet their skill and available re-sources. Farmers' choices to grow oil palm rely on social, cultural, economic and technical factors, and in order to stimulate agricultural practices to be successful, these factors must be understood. Many study have proved that oil palm cultiva-tion in Indonesia rapidly expand in recent year, however, there is little information available on farmers' decisions about expanding the oil palm holding size and attitudes which influence their decision-making. Furthermore, given growing worldwide demand for palm oil for both food and fuel, the availability of land for conversion to oil palm estates may pose a significant challenge to the growth of the Indonesian palm oil industry (World Growth, 2011).

The outcome of oil palm expansion on farmers' livelihoods is a widely debated topic. Some study found that threats include an increasing vulnerability and economic marginalization of the rural population. Like many others agricultural practice adoption, as well as unequally distributed benefits among oil palm adopters. In contrast, other study suggested that oil palm expansion raises the opportunities entail livelihood improvements through increased incomes, rural development and poverty reduction.

Farmers' specialization in non-food cash crops like oil palm has been criticized for decreasing on farm production diversity, declining significance of subsistence food crops, and increased livelihood vulnerability to food security and price on international commodity markets (Pellegrini and Tasciotti, 2014; Jones, et al., 2014). Moreover, in a widespread situation on malnutrition and undernourishment, it is crucial to assess the implications of the recent expansion of oil palm plantations on household nutrition and the prevalence of food security.

1.3.2 Objective of the study

The main objective of this study is to evaluate the oil palm expansion in Indonesia weather it is improving farmers' household livelihood or not, which can be breakdown to two approaches.

1. To investigate the determinant that affect decision on expanding oil palm farmland based on performance analysis.
2. To evaluate the impact of oil palm expansion to the farmers' welfare.

In addition, specific themes will be analyzed in order to grasp essential information that relates to the main objective as follows:

1. Analysis of the factors influencing technical efficiency among oil palm smallholder farmers in Indonesia.
2. Factors determining household level farmers' decision to expand oil palm farmland in Indonesia

3. Impact of oil palm expansion on farmers' crop income and poverty reduction in Indonesia
4. The Effect of Oil Palm Expansion on Food Security in Indonesia

1.4 Data collection and study region

The selected study sites are under the Pelalawan Regency administration, Riau Province, Indonesia (Figure 1.6). Pelalawan Regency is located in the East Coastal Sumatra between 1.25' north latitude to 0.20' south latitude and between 100.42' east longitude to 103.28' east longitude, with total area of 12,647.29 km^2. Topographically, Pelalawan Regency consists of hilly area 30-35 meter above sea level. The annual precipitation ranged between 62 mm/year to 300.2 mm/year in 2011. Pelalawan Regency has population density of 12 persons per km^2 (Statistics, 2012). Since this area was considered as transmigration destination, it has resulted ethnic variation including *Malay, Minangkabau, Java, Batak and* Chinese group. Along with the development of oil palm plantation and other natural resources industries, Pelalawan Regency becomes one of representative regency for its' best natural resources management in Indonesia.

Known as one of productive area for oil palm in Indonesia, four villages were purposively-selected on this research; two villages are under the NES-trans program located in "Makmur (MR)" and "Mekar Jaya (MJ)"and two villages are classified as non transmigration village for independent farmers; named "Kiyap Jaya (KJ)"and "LubukOgung (LO)". This research was formed by primary data through the 271 household level oil palm farmers in 2013 by structured questionnaire (Appendices 1). Respondent was purposely selected using the proportion of population size in each village. The number of sample size in each villages namely "MR", "MJ", "KJ", and "LO" are 86, 56, 103, and 26 respectively.

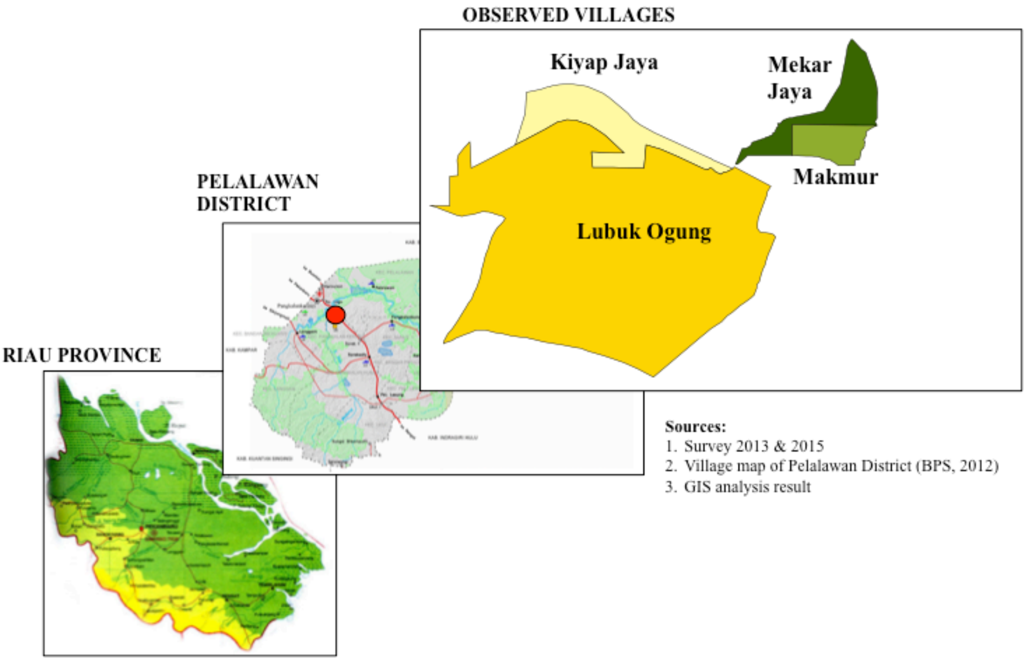


Figure 1.6 Map of Study Site
Note: Author's courtesy

1.5 Dissertation structure

This dissertation consisted of seven chapters and their relationship was presented in Figure 1.7. **Chapter 1** covered the introduction of the study including background, information regarding the study site, sample selection, problem statement and objective of the study. **Chapter 2** captured the literature review on the livelihood concept and practice. Furthermore, the main part (result) of this dissertation was written in chapter 3, 4, 5, and 6. Chapter 3 and 4 represented the objective 1, thus chapter 5 and 6 were under the objective 2. The detail of each chapter is as follow:

Chapter 3 analyzed the technical efficiency of oil palm productivity in the study site. A SFA was applied to analyze the technical efficiency score and the existence of inefficiency among the farmers. The result found that the average technical efficiency index was less than 100% implying that still have significant productivity gap among farmers. The result indicated that the coefficient of fertilizer was positive and highly significant to oil palm productivity. The result also confirmed that inefficiency exists influencing by several socio-economics factors, such as: farmer group, education and diversification activity (negative to inefficiency). However, the variable of age of farmers and farm location were positive to inefficiency.

Previous chapter has identified that oil palm sector in Indonesia still face a significant challenge called productivity gap among the farmers due to improper and uniformity farming practice. In order to deal with this problem, farmers in the study area has considered to expand their land size as one of adoption to increase the benefit from oil palm. **Chapter 4** discussed the reason behind farmers to expand oil palm farmland. Using the sample of expansion and non-expansion group, the result shows that 73 percent of farmers in the study site expanded their oil palm farmland from 2 hectare to 4-16 hectares. Probit model estimated that the income, number of family member, land ownership status, farmer organization, extension program and soil type of oil palm farmland had positive impact on probability of farmers' decision on expanding oil palm farm size. Furthermore, in **Chapter 5**, we found several socio-economics background influencing farmers to expand oil palm farmland such as number of family members, farmers' financial assets, contract farming, and distance to the market are significantly associated with likelihood for expanding farm size

In line with the objective 2, we did impact analysis of expansion with several key indicators. **Chapter 5** tackled the evaluation of impact due to farm size expansion by quantifying household income and per-capita expenditure. In the second step of PSM analysis, the average treatment effect indicated that expanding oil palm farmland was the right decision for both groups. Hence, positive and significant impacts of crop income from oil palm and per capita expenditures, confirmed that oil palm expansion help reducing the poverty in Indonesia. Besides the income and per-capita expenditure, impact indicator that used in this study was food security status of household. We investigated oil palm expansion impact on food budget and nutritional status of household in **Chapter 6**. The OLS result suggested that when farmers expanded oil palm farmland, increasing income from oil palm, education, number of adult equivalent and food self-sufficiency program have lead to improve household food security status. The calorie consumption effects were positive and consistent across quantiles. This indicated that land expansion and income earn from the oil palm increased the total calorie from food and total calorie from nutritious food.

Finally, **Chapter 7** summarized the major findings of the study and derived policy implications. It further proposes some directions for future research.

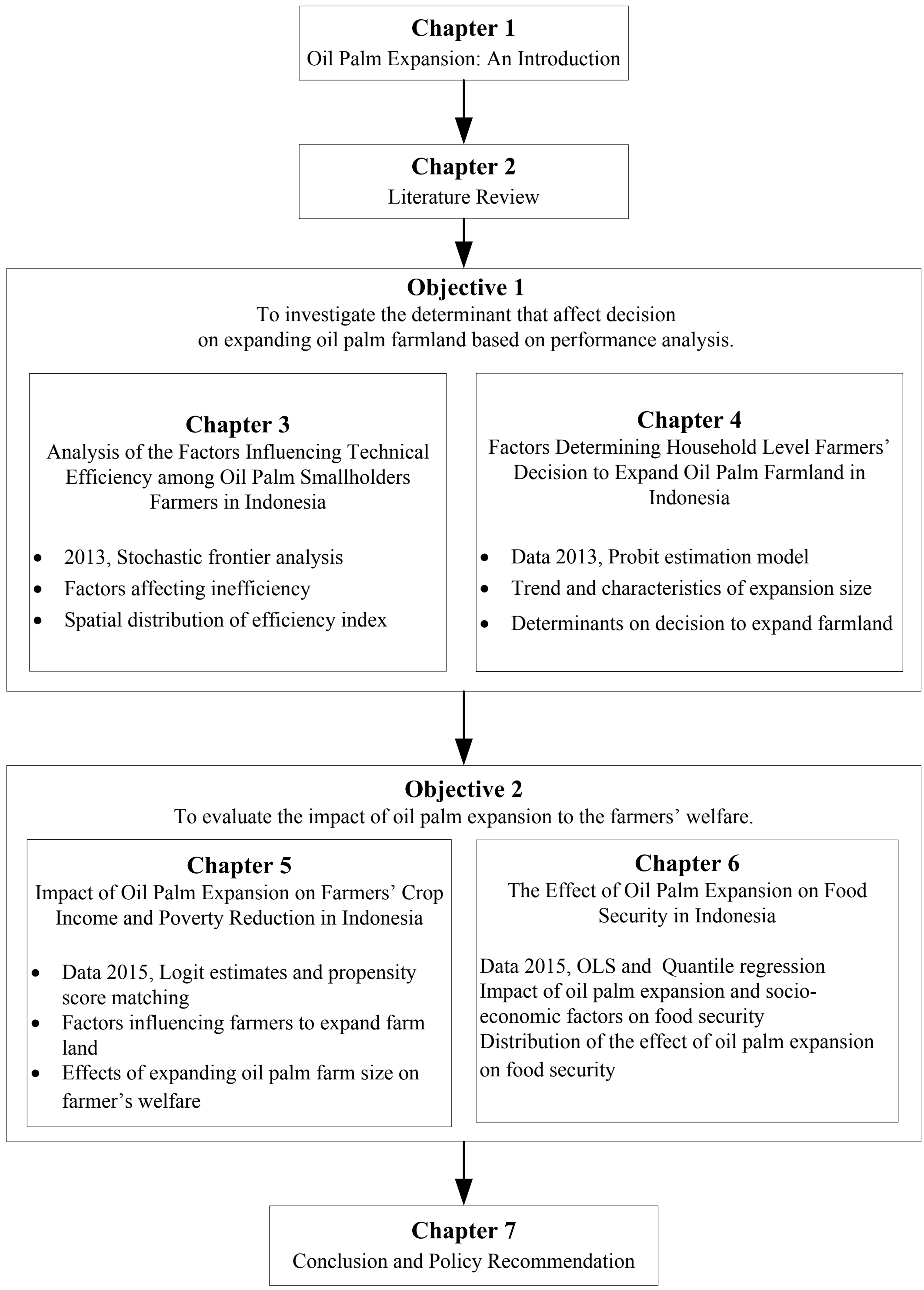


Figure 1.7 Flow of dissertation

Chapter 2
Literature Review

2.1 Livelihood definition

Livelihood can be defined as a means of securing the necessities of life (oxforddictionaries.com). Various definition of livelihood has emerged from the extensive learning and practice that attempt to represent the complex nature of a livelihood. Chambers and Conway (1991) suggested that a livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base.

2.2 Livelihood aspect

Livelihood consists of four important factors, such as assets, vulnerability, strategy, and interdependence. Livelihood assets or capitals can be categorized as tangible and intangible. Tangible assets include food stores and cash savings, as well as trees, land, livestock, tools, and other resources. Intangible assets are supporting tools to achieve something such as one that can make food, work, and assistance as well as access to materials, information, education, health services and employment opportunities. There is another way to understand the assets or capitals that categorized as human capital (skill, health, knowledge, and ability to work), social capital (membership of formalized groups and relationship of trust that facilitate cooperation and economics opportunities), natural capital (land, soil, water, forest and fisheries), physical capital or basic infrastructure (road, ICT, tools, equipment, water and sanitation) and financial capital (saving, credit, trade, income and remittance.

In order to access and use the asset for a favorable outcome, livelihoods are formed within social, economic and political contexts. Institutions, processes and policies, such as markets, social norms, and land ownership policies. Livelihood contexts includes social relations: The way in which gender, ethnicity, culture, history, religion and kinship affect the livelihoods of different groups within a community Social and political organization: Decision-making processes, civic bodies, social rules and norms, democracy, leadership, power and authority, rent-seeking behavior Governance: The form and quality of government systems including structure, power, efficiency and effectiveness, rights and representation Service delivery: The effectiveness and responsiveness of state and private sector agencies engaged in delivery of services such as education, health, water and sanitation Resource access institutions: The social norms, customs and behaviors (or 'rules of the game') that define people's access to resources.

Livelihood strategies are the way of people to access and use these assets, within the aforementioned social, economic, political and environmental contexts, form a livelihood strategy. The livelihood strategy has enormous range and diversity. An individual may take on several activities to meet his/her needs. For example, people may engage in activities that contribute to a collective livelihood strategy; within households, individuals often take on different responsibilities to enable the sustenance and growth of the family. In some cultures, this grouping may expand to a small community, in which individuals work together to meet the needs of the entire group.

Livelihood vulnerability is defined, as the strength of a given livelihood that measured not only by the productive outcomes but also the equally of its resilience to shocks, seasonal changes and trends. Shocks may be including natural disasters, regional stability and economic shock. Availability of resources, income-generating opportunities, and demand for certain products and services may fluctuate seasonally. More gradual and often predictable, trends in politics and governance, technology use, economics, and availability of natural resources, can pose serious obstacles to the future of many livelihoods. These changes impact the availability of assets and the opportunities to transform those assets into a “living”. Under such conditions, people must adapt existing strategies or develop new strategies in order to survive.

One final important characteristic of livelihoods is their interdependence. Very few livelihoods exist in isolation. A given livelihood may rely on other livelihoods to access and exchange assets. Traders rely on farmers to produce goods, processors to prepare them, and consumers to buy them. Livelihoods also compete with each other for access to assets and markets. Thus positive and negative impacts on any given livelihood will, in turn, impact others. This is a particularly important consideration when planning livelihood assistance.

2.3 Livelihood approach: Lesson learnt from International NGOs

The idea of this brief review is to understand the fundamental principles behind the approach of livelihood that has been implemented by any international NGOs such as the United Kingdom Department for International Development (DFID), Cooperative for Assistance and Relief (CARE), Oxford Committee for Famine Relief (Oxfam) and the United Nations Development Program (UNDP). Even though there are some variations of livelihood approach applied by each NGO, review may be elucidating the direction in which these might move in the future (Carney, et al., 1999).

CARE highlighted the shifted from "food first" or food production to a wider focus on the ability of households to secure the food that they required. This led to a widening of the scope and recognition that food was just one of the ranges of factors that determined poor people's decisions. Thus the evolution of the concepts and issues related to household food and nutritional security led to the development of the concept of household livelihood security and then, more broadly, to livelihoods. This focus on the household does not mean that the household is the only unit of analysis, nor does it mean that all CARE's interventions must take place at the household level. The various perspectives brought to livelihoods analysis contribute to the generation of a range of strategic choices that are reviewed more fully during detailed project design.

DFID stresses the importance to livelihoods of capital assets, which distinguishes in five categories of such assets: natural, social, physical, human and financial. It also point out the need to maintain an outcome; how development activity affects people's livelihoods and not only about immediate project outputs (DFID's outcomes are seen as categories of things that people might want to achieve, but there is no assumption that they should be achieved This is one of the most significant changes associated with the livelihood approach. It means that projects will be planned and evaluated according to the contribution they make toward achieving beneficial livelihood outcomes for their target beneficiaries.

Oxfam Great Britain adopted a sustainable livelihoods approach in the early 1990s that focus on accommodating the issues of environmental change together with concerns about globalizing markets, deteriorating economic rights, gender and wider social inequality and the need to strengthen deprived people's participation in the development process. Oxfam's desired outcomes are that people living in poverty will: achieve food and income security; have access to secure paid employment, labor rights and improved working conditions.

Unlike the other agencies covered in this review, UNDP explicitly focuses on the importance of technology as a means to help people rise out of poverty. One of the five stages in its five-stage livelihoods approach is to conduct a participatory assessment of technological options that could help improve the productivity of assets. UNDP has employed the livelihood approach largely within its agriculture and natural resources work agriculture, environment, infrastructure, enterprise). In order to do this, and to understand how assets are utilized, it takes as its entry point the adaptive/coping strategies that people employ in their livelihoods. Focusing on these issues highlights the multidimensionality of poverty and the range of actions that can be taken to reduce different forms of poverty.

2.4 Livelihood approach in this study

This study aims to apply the sustainable livelihood approach in order to evaluate the use of resources (asset) by rural household and its impact on their welfare. The stress of this study is resources use, strategy and outcome. Resources use is based on the performance of farmers managing their asset. However, to improve the performance farmers should adopt the appropriate strategy to achieve it and determine the factors behind this. Lastly, it is important to evaluate the outcome, whether or not it bring welfare effect including income and per-capita expenditure enhancement as well as food security (nutritional effect: food intake and food expenditure). Overall explanation on the association of livelihood approach in this study is as follows.

Land expansion and resources conversion for the agricultural purposes is occurring in the developing country mainly due to the high degree of integration of rural areas with the national and international economics and population pressures (Barbier, 2004). Besides that, agricultural expansion in the tropical country was exuberated by the improper of intensification as well as mismanagement of the farm (Food and Agricultural Organization of the United Nation (FAO), 2014). (Alwarritzi, et al., 2015) found that the higher yield gap among oil palm farmers in Indonesia is significantly influenced by poor application of the input use and unobserved factors such as human resources availability. The socio-economic factor determining smallholder farmers' decision on expanding their oil palm farmland ware captured. The recent study by (Alwarritzi, et al., 2015) found that the likelihood to expand oil palm farmland determined by higher income earned from oil palm and the role of land tenure system in Indonesia that allow smallholder farmers to own the certification of their farm. Geographical attribute often contribute the probability of farmers' decision to expand oil palm farmland; the availability of peat land in Riau Province, Indonesia was found increasing the likelihood to expand farmland (Alwarritzi, et al., 2015). Previous studies have indicated that oil palm expansion is positively influence by village and regional characteristics (Budidarsono, et al., 2013, Gatto, et al., 2014). The prevailing evidence suggests that there are several determinant inducing oil palm farmland expansions such as human capital, socio-economic motivation, and geographical variables.

After being implemented during two decades, the wellbeing effect from the impact oil palm cultivation deserves special attention, especially since the recent land expansion for oil palm are largely driven by smallholder farmers. As explained in the previous sub-section, smallholder farmers account for nearly 50% of the total oil palm area and for 36% of the total fresh fruit bunch (FFB) production in Indonesia, the world´s leading oil palm producer (Ditjenbun, 2015). The government expects that, if smallholder farmers sustainably expand the oil palm farmland, the lacking of job opportunity and poverty problems may be reduced. (Finan, et al., 2005) highlight the role of the land as an instrument to reduce the poverty in Mexico; using semi-parametric estimation, an additional hectare of land increases welfare on average depends on the controlled variable of household. However, the outcome of oil palm adoption on farmers' livelihoods is becoming a debated topic globally. (Cahyadi & Waibel, 2013) found that oil palm play important role on improving farmers' livelihood through increased incomes, poverty reduction and rural development. In contrast, in the several practice of oil palm adoption by smallholder farmers affected to an increasing vulnerability and economic marginalization of rural community (McCarthy, 2010; Rist, et al., 2010).

Further, in a broad sense, farmer specialization in non-food cash crops like oil palm has been criticized for decreasing on farm production diversity, declining significance of subsistence food crops, greater farmer dependency on trade and markets to satisfy nutritional needs, and increased livelihood vulnerability to price shocks on international commodity markets (Pellegrini and Tasciotti, 2014; Jones et al., 2014). (Krishna, et al., 2015) employ endogenous switching regressions to model the impacts of oil palm adoption using total annual consumption expenditures as a proxy for household welfare.

Chapter 3
Analysis of the Factors Influencing Technical Efficiency among Oil Palm Smallholders in Indonesia

3.1 Introduction

The increasing demand of oil palm has led to a rapid expansion of agro industry, with South East Asia, particularly Indonesia as the most productive country for its plantation (USDA, 2007). Master Plan for Acceleration and Expansion of Indonesia Economic Development (MP3EI) stated that oil palm is one of agricultural major sector on focus to be developed, with Sumatera as center for production. The aim of oil palm development is to reduce poverty in rural area by attracting its community to actively participate in agricultural sector as source of income. Given the importance of oil palm for piling up the national income and increase standard of living in rural community, more attention should be given to downstream level that called as smallholder farmers.

Accentuation of oil palm cultivation in MP3EI policy brings opportunity for smallholder farmers. It was reported that smallholder farmers have occupied about 52% of total plantation area (Dinas Perkebunan Provinsi Riau, 2010). However, along with the tremendous trend of oil palm cultivation by smallholders, unequal agricultural practice still remains as an actual problem. Furthermore, significant gap of oil palm productivity among farmers convey inconsistent result to government expectation on reducing inequality of rural livelihood.

Oil palm cultivation was introduced in Riau Province in the 1980s by transmigration program, with aim to control over-populated islands by relocating inhabitants to less populated islands. Oil palm plantations have been designated through Nucleus Estates and Smallholders (NES-scheme) in which a company operates a refinery and an estate supported by smallholding owned by trans-migrant or known as NES-Trans farmers. However, NES-Trans farmers were provided with technical assistance from company and divided into several group to ease dissemination of technical information. Having learnt from NES-Trans farmers on successfully practicing oil palm plantation, local people who are called as independent farmers also followed the trend of oil palm cultivation. In contrary to NES-Trans farmers, Independent farmers run their farm without contract farming system, thus lack of guidance from formal institutions. Consequently, farmers in this study area experienced productivity gap that may arise from farmers' characteristic in applying farming practice. Nevertheless, there was less attention on investigating oil palm technical efficiency with the case of both NES-Trans and Independent farmers before the gap problem was boomed in recent years. One notable study by (Hasnah, et al., 2004), took the case of NES-Trans farmers in West Sumatera, Indonesia.

Based on the background, this research has hypotheses that the non-uniform farming practice existing may affect to the productivity performance. Furthermore, discussion on socio-economics characteristics of farmers will provide better explanation on how to improve farming practice. Hence, this chapter is focus on investigating the oil palm productivity performance by technical efficiency analysis and to determine socio-economics characteristics of farmers that have substantial impact to technical efficiency. The results are expected to provide evidence on the important role of extension service and formal education to enhance oil palm productivity. Thus, the implication may force government to increase investment on education facility, research and development as well as extension service, which is likely to accelerate productivity of oil palm in smallholder's level. Other important issues are concerning specific farm location and farm diversification option that may sustain the future agricultural practice of smallholder farmers.

3.2 Data and analysis model

3.2.1 Study region and household survey

The analysis data used for this chapter was formed by primary data through 271 oil palm smallholder farmers gathered by structured questionnaire in 2013. The selected study sites are under Pelalawan Regency administration, Riau Province, western part of Sumatera, Indonesia. Hence, for this study, two villages are under the NES-Trans program located in “Makmur (MR)” and “Mekar Jaya (MJ)” and two villages are classified as non-transmigration village for independent farmers; named “Kiyap Jaya (KJ)”and “Lubuk Ogung (LO)”. The background of choosing the study area was based on variation of socio-economics characteristic of farmers and these 4 villages were attributed with geographical variation, particularly the characteristic of soil. Referring to the Reproduction Soil Map (Kementerian Kehutanan Republik Indonesia (KEMENHUT), 1989), Mineral soil is covering 3 selected villages (MR, MJ and KJ) and peat land is existed in the southern part of LO village. Therefore, farm location was introduced as one of unobserved variable in technical efficiency and incorporated to individual technical efficiency index of oil palm farmers.

3.2.2 Stochastics frontier approach

Technical efficiency of oil palm farming practice has been widely applied by several studies, particularly to investigate performance level and inefficiency factors. Hasnah, et al. (2004) found that mean of technical efficiency index of NES-Trans farmers using translog model was 0.66, implying that farmers can increase oil palm output through better extension service than use more input. This author highlighted that since the progressive farmers has not been successful on disseminating farming guidance, the selection of progressive farmers is very important for future scheme.

Stochastic frontier approach was also applied to investigate efficiency among oil palm farmers in Nigeria (Iwala, et al., 2006). The findings implied that technical efficiencies index varied among oil palm farmers, ranging between 0.463 and

0.999. Results indicated that age of palm tree, cost of fertilizers and agrochemicals, and cost of harvesting and processing were positive to the output. In the other hand, the use of labor had negative contribution to oil palm production due to farmers excessive manual labor employment in the farming practice. Farmers' education level negatively contributed to efficiency because farmers tend to have off-farm job and delegated hired labor to operate their farm.

To estimate the efficient frontiers, a popular parametric method; the stochastic frontier analysis, SFA was utilized. It has the main strength to be able to deal with statistical noise in the data and also permits statistical testing of both the hypotheses pertaining to the production structure and the degree of inefficiency (Coelli, et al., 2005). This function contains a disturbance term comprising of statistical noise and technical efficiency term (eq. 1 and 2). Technical efficiency will consist if the ratio of observed output and maximum feasible output is equal to 1. Therefore, inefficiency affects the model when technical efficiency score for each firm is less than 1.

$$Y = \left(\beta_0 + \sum_{n=1}^{N} \beta_0 \ln X_n + \frac{1}{2} \sum_{n=1}^{N} \sum_{m=1}^{M} \beta_{nm} \ln X_n \ln X_{nm} + (V_i - U_i) \right) \quad (3.1)$$

$$U = \boldsymbol{\delta}_0 + \boldsymbol{\delta}_1 \boldsymbol{Z}_{1i} + \cdots + \boldsymbol{\delta}_n \boldsymbol{Z}_{ni} \quad (3.2)$$

Y	=	Production per hectare
$\beta_0 - \beta_{nm}$	=	Regression coefficient including constant (β0)
$X_0 - X_{nm}$	=	Production input per hectare
V_i	=	Random error term
U_i	=	Non-negative random variables which assumed to account for technical inefficiency
δ_0 - δ_n	=	Inefficient parameters
Z_{1i} - Z_{ni}	=	Socio-economic variables

Table 3.1 Descriptive statistics of technical efficiency variables

Variable Code		Definition	Unit	Mean	Std. Dev.	Min.	Max.
Y	Yield	Oil palm fresh fruit bunch (FFB) yield	Ton/ha	19.59	6.0	4.8	46,64
<u>*Production input*</u>							
X_1	Fertilizer	Total of chemical fertilizer applied	Ton/ha	1.18	0.34	0.20	2.68
X_2	Herbicide	Total of herbicide applied	Liter/ha	3.94	1.12	1.5	7.5
X_3	Labor	Working day of hired & family labor	Man-day/ha	43.11	11.91	21	60
X_4	WPT	Weighted oil palm tree	Number/ha	0.84	0.13	0.56	1
<u>*Inefficiency variable*</u>							
Z_1	Group	1 = NES-Trans farmers; 0 = independent farmers	Dummy	0.60	-	0	1
Z_2	Education	Years of farmer education	Years	9.09	2.93	6	16
Z_3	Age	Head of households age	Years	49.15	7.44	31	84
Z_4	Divers	1 = have farm diversifica-tion; 0 = otherwise	Dummy	0.27	-	0	1
Z_5	Credit	1 = get access to credit; 0 = otherwise	Dummy	0.75	-	0	1
Z_6	Farm Location	1 = peat soil; 0 = mineral soil	Dummy	0.10	-	0	1

Note: Farm Location was recorded using GPS

3.3 Result and discussion

3.3.1 Descriptive statistics

Table 3.1 shows descriptive statistics of household characteristic. There are two categories of variables; given input of production with regard to oil palm productivity, and unobserved variables such as socio-economic and spatial heterogeneity range for explaining inefficiency effect. Farm location was gathered from GPS point's records integrated with soil map (KEMENHUT, 1989). Decision to introduce farm location based on geographical variation (soil type) into unobserved variable, which explained the spatial heterogeneity in technical efficiency by introducing into dummy variable, was referred to (Areal, et al., 2012).

There was high variability in yield with an average of 19.6 ton per hectare during 2012-2013. Amount of aggregated chemical fertilizer was about 1.18 ton per hectare, including urea, rock phosphate, potassium chloride, and dolomite. Farmers used herbicide 3.94 liter per hectare in order to anticipate spreading of Imperta cylindrica, the most serious source of oil palm enemy (Hasnah, et al., 2004). 43 man-days were needed for labor input, consist of hired and family labors, to operate oil palm farm per hectare (1 days is equal to 6 hours). The total of working days ware accumulated from total activities such as weeding, crop maintenance, fertilizing, and harvesting.

To emphasize the age of tree effect to productivity, variable of weighted oil palm tree (WPT) was introduced. WPT was calculated by dividing the average output of oil palm fruit for each age profile with the maximum output at its' yield peak period. Based on yield profile, oil palm tree ages were grouped into 3 categories such as w1= 3 – 8 years, w2 = 9 – 19 years (considered as yield peak period), and w3= over 20 years [19]. Thus, WPT value in each age profile were determined as: w1PT1 = 70/125, w2PT2 = 125/125, and w3PT3 = 100/125. This way has been applied by several researches to capture the effect of tree age in Cocoa in Ghana (Ofori-Bah & Ashafu-Adjaye, 2011) and Vietnam's Rubber Plantation (Hung, et al., 1993).

As for farmer group, 60% of NES-Trans farmer were selected. The age range of respondents was between 31 and 84 years old, with the mean age is 49 years old, implying that farmers in study area are relatively ageing. Majority of farmers gained formal education with average of 9 years or similar with primary school level. Around 30% of farmers had farm diversification such as crops plantation and livestock. As for credit access, 75% of oil palm farmers were facilitated by low rate interest of credit from bank. Lastly, 10% of farmers cultivated oil palm in

Table 3.2 Maximum likelihood estimate of inefficiency effect for oil palm farmers

Variable	Parameter	Coefficients	Std. Error	z
Stochastic frontier				
Constant	β_0	0.20	0.06	3.30
ln(Fertilizer)	β_1	0.17**	0.08	2.18
ln(Herbicide)	β_2	-0.03	0.08	-0.35
ln(Labor)	β_3	0.14	0.11	1.23
ln(WPT)	β_4	-1.66***	0.15	-5.16
0.5([ln Fertilizer]^2)	β_{11}	-0.28	0.17	-1.62
0.5([ln Herbicide]^2)	β_{22}	-0.52	0.23	-2.25
0.5([ln Labor]^2)	β_{33}	0.94	0.62	1.52
0.5([ln WPT]^2)	β_{44}	-4.87	1.15	-4.25
[ln Fertilizer][ln Herbicide]	β_{12}	0.01	0.16	0.34
[ln Fertilizer][ln Labor]	β_{13}	0.05	0.18	0.25
[ln Fertilizer][ln WPT]	β_{14}	0.23	0.23	1.00
[ln Herbicide][ln Labor]	β_{23}	-0.07	0.18	-0.41
[ln Herbicide][ln WPT]	β_{24}	0.08	0.32	0.24
[ln Labor][ln WPT]	β_{34}	-0.05	0.38	-0.14
Variance Parameter				
Sigma-v	σ_v	0.23	0.02	
Sigma-u	σ_u	0.23	0.07	
Lamda	λ	1.01	0.09	
Log Likelihood Function		-30.33		

Note: (a) *** and ** are significant at 1% and 5% levels, respectively (b) the log-likelihood function of a stochastic frontier model is maximized by the Newton–Raphson method, and the estimated variance matrix is calculated as the inverse of the negative Hessian (STATA, n.d.)

the large size of peat soil due to the land availability in this area, particularly in the southern part of study area.

3.3.2 Stochastic frontier analysis

Stochastic frontier approach, which deals with the stochastic frontier production, was applied with assumption that all deviations from frontier were associated with disturbance terms. Since oil palm farmers in the study area were smallholding-family based operation, farmers tend to pay less attention to farming record system, and production record might be inaccurate. Thus, the availability of data on productivity was likely to be subject on measurement error (Coelli, et al., 2005). The main point of this section was to gain the evidence that inefficiency effect existing among oil palm smallholder farmers. As the simultaneously estimation result, analysis of production input was discussed.

Coefficient of fertilizer was positive and highly significant to oil palm output, indicates that farmers need to consider the quality and quantity of each fertilizer used in order to achieve higher yield. Negative and significant of WPT coefficient means that ageing tree reduced the output. This finding in line with nature of oil palm tree, which has yield-peak periods are between 9 – 19 years and will be reduced after 20 years of planting (USDA, 2012). Insignificant of labor coefficient was far from the expectation. It arise from the effect of family labor that still actively involved on farming activity because oil palm was accounted as the main source of income. Furthermore, coefficient of herbicide variable, which was found negative and not significant, was consistent with the fact that chemical herbicide application should be carefully applied to the target pest, weed or disease. Inappropriate amount decreased productivity due to its negative effect to the tree and soil condition (RSPO, 2007). Thus, RSPO suggested that farmers have to consider integrated pest management by using physical methods to minimize chemicals application.

As the main point of discussion in this chapter, inefficiency effect in oil palm productivity could be shown through examining the value of estimated lambda (λ). The result implied that value of λ was larger than one; mean that inefficiency term contributed significantly in oil palm productivity analysis. Thus, the analysis of socio-economics aspect of smallholder farmers might be more pronounce to explain the existing productivity gap. Result of likelihood ratio (LR) test was 52.92, which larger than critical value in 5% significant level with 11 degrees of freedom taken from Table 3.2 of results of Kodde and Palm (Kodde & Palm,

1986) then null hypothesis of no inefficiency effect was rejected. Therefore, LR test confirmed that inefficiency effect due to socio-economics background of farmers strongly influence the technical efficiency among oil palm smallholder farmers in the study area. The explanation of socio-economics factors influencing technical efficiency was described in the next part, as the result of maximum likelihood estimate of inefficiency effect.

3.3.3 Factors affecting inefficiency

The result of technical inefficiency effect is presented in Table 3.3. This study found that group of oil palm farmers was negative and highly significant, indicates that NES-Trans farmers were more efficient than independent farmers. The reasons behind this evidence are that NES-Trans farmers have adequate guidance from their contract company, which the guidance was also refer to farming practice standard of RSPO and the way how to disseminate extension program through farmers group in this study area seems obtained higher efficiency which was contrary with finding of (Hasnah, et al., 2004). NES-Trans farmers in this study area, through farmers group, tend to maintain best management farming practice given by extension service. In contrast with independent farmers, the role of farmer groups and extension services for oil palm farming practices were having less attention.

Negative sign of education and significant was consistent with expectation, implying that education level of oil palm farmers may improve technical efficiency. Educated farmers tend to be more responsive in technology adoption and utilization. (Coelli & Battese, 1996) found that higher year of schooling farmers achieved less inefficiency. Dummy variable of farm diversification had negative sign and significant, assumed that if farmers had various sources of production beside oil palm cultivation (e.g., crop cultivation in different plots and livestock), it was likely to generate positive impact to efficiency.

Table 3.3 Descriptive statistics of technical efficiency variables

Variable	Parameter	Coefficients	Std. error	z
Constant	δ_0	-6.69	13.88	-0.48
Group	δ_1	-1.69 ***	0.76	-2.23
Education	δ_2	-7.44 *	4.73	-1.57
Age	δ_3	4.66 **	2.30	2.03
Divers	δ_4	-2.00 *	1.08	-1.85
Credit	δ_5	-0.48	0.80	-0.60
Farm location	δ_6	1.55	1.04	1.49

Note: ***, ** and * are significant at 1%, 5%, 10% levels, respectively

(Coelli & Fleming, 2003) argued that farm diversification activities seem to increase efficiency because farmers may have opportunity to select several farming activities which complement the given input each other resources. Furthermore, this result is interesting to be investigated in the further research. The analysis of multi output and input of production may be required to provide which combination of products result higher efficiency.

Negative of credit access, but not significant, implying that access of credit may not have substantial effect to increase efficiency in this study area. One of specific reason was because of inappropriate utilization of credit. Farmers in the study area tend to use credit facility for expanding oil palm farmland to increase production or buying daily expenditure rather than for improving productivity for its current farmland. Challenge on paradigm is needed to optimize the advantage from credit access. In line with (Binam, et al., 2004), if farmers can appropriately use credit facility, it was likely to enhance farmers adopting farming technology and improve productivity, a crucial factor for agricultural sector, as have been studied in Nigeria. Farmer age had positive sign with the inefficiency and it was significant at 5%, younger farmers are shown to be more technically efficient than older farmers. This was due to younger farmers tend to be more activity in present agricultural activity and willing to improve farming knowledge, which agreed with (Coelli & Battese, 1996).

Positive of farm location, but not significant, indicated that farmer who cultivates oil palm in peat soil area may be less efficient. Based on Funakawa, et al. (1996), peat soil in tropical area was generally low in nutrient supplying capacity which limiting its potential. This condition may lead to higher effort from oil palm farmers to invest more in production input as well as specific maintenance in order to meet targeted yield. However, farmers in peat soil area or called as LO might be difficult to achieve efficiency due to the fact that farmers were lack of guidance from formal institution on maintaining their farmland under peat soil condition.

3.3.4 Spatial distribution of efficiency index

Technical efficiency index for farmers in each villages are presented in Figure 3.1. Mean of individual technical efficiency of oil palm farmers in study area was 83%, indicated that there was plenty of section should be improved to get the maximum efficiency. Spatial heterogeneity was considered since this variable may affect to the differences in efficiency level among farmers (Areal, et al., 2012). This therefore suggested that farmers should apply appropriate farming practice based on their farm location characteristic to maintain its productivity.

Referring to individual technical efficiency score for each location in study area, it was concluded that lowest average of technical efficiency score was 74%, which experienced by the independent farmers in peat land area. The result implied that farmers in this study area could not achieve optimum level of productivity was due to lack of knowledge on how to cultivate oil palm in peat land. Current farming guidance only supports farmers who cultivate oil palm in mineral land. However, the interaction between geographical characteristic and farmer’s ability to apply farming activity in particular area should be taken into account in the policy allocation.

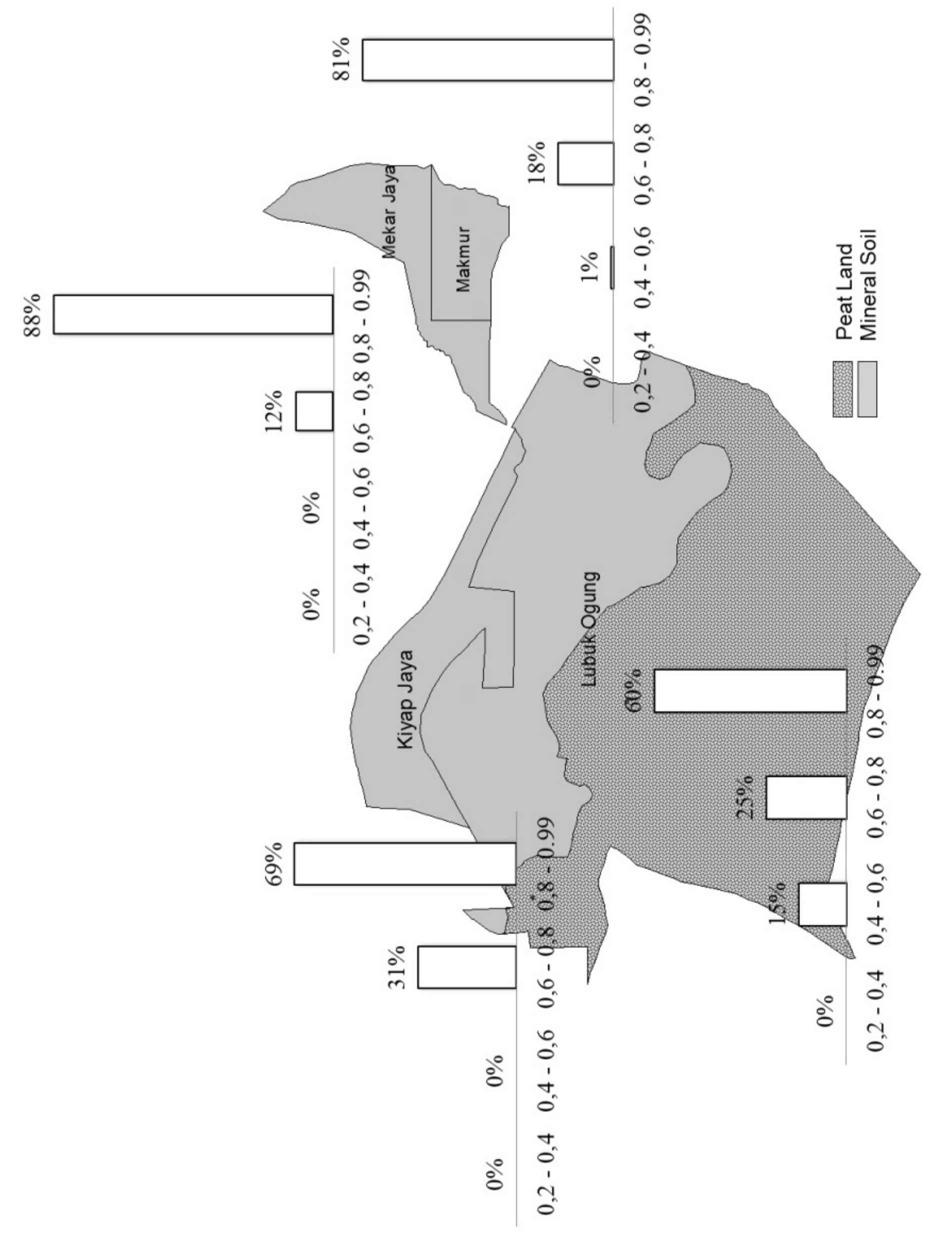


Figure 3.1 Technical efficiency index of oil palm farmers in study area

Sources: (a) Self survey of farmers` plot investigation, Riau, Indonesia, 2013 (b) (Kementrian Perhutanan Republik Indonesia (KEMENHUT), 1989) (c) (Central Bureau of Statistics (BPS), 2012)

3.4 Conclusion and recommendation

This chapter investigates and shows the existence of inefficiency effect on oil palm cultivation practice among smallholder farmers in Riau Province and then determines unobserved variable may affect technical efficiency. It was clearly known from the analysis that technical efficiency index discrepancy was relatively high (41%), reflecting that farmers in study area experienced farming practice without uniformity production input. There were several socio-economics factors that should be paid more attention which may increase of the efficiency, such as:

1. Role of technical assistance from formal institution on farming practice and farmers group. As experienced by NES-Trans farmers, disseminating extension material through farmer group enhanced effectiveness of productivity. Therefore, this example of best practice farming can be applied to the independent farmers as well.

2. Education improved oil palm productivity because farmers with higher level of education were likely to be more responsive in technology adoption and utilization. In addition, level of education influenced farmer decision for efficient farming practice. Thus, particularly young generation for those wish to work in agricultural sector should be facilitated to actively involve on formal education that related to agriculture

3. Credit facility for agriculture sector was given by government to support smallholder farmers to enhance their productivity. However, evaluation is necessary to investing whether credit facility has been used for improving oil palm cultivation or has been consumed for other purposes.

4. Farm diversification activities gave opportunity of farmers to select those activities which complement given input resources and have positive impact to efficiency.

5. It was found that technical efficiency score of oil palm farmers who cultivated in peat soil tend to have lower index compare that of with farmland in

mineral soil. This result indicated that farmers in peat soil area have no particular guidance on how to maintain farmland under peat soil condition.

Investigation on technical efficiency pointed out the opportunity for improving oil palm productivity performance by improving socio-economics aspect of smallholder farmers. Thus, some evidences were provided in support to rural livelihood or in advance to the human security notion that improvement in socio-economics aspect of farmers can enhance oil palm productivity.

In relation to income generation, since the ageing of oil palm tree decreases productivity over the time, farmers need to consider diversification activities that are generating alternative income. However, appropriate combination of agricultural activities that will result in better output should be furtherly investigated. Other interesting finding was about farmers cultivating on peat land area that had lower technical efficiency index might be a contribution to Indonesia government that continuing of the expansion of peat land for oil palm by smallholders without appropriate management affected not only less productivity performance but also environmental degradation.

Chapter 4
Factors Determining Household Level Farmers' Decision to Expand Oil Palm Farmland in Indonesia

4.1 Introduction

Many study have proved that oil palm cultivation in Indonesia has rapidly expand in recent year, however, there is little information available on related factors and attitudes which influence their decision to expand their plantation. Furthermore, given growing worldwide demand for palm oil for both food and fuel, the availability of land for conversion to oil palm estates may pose a significant challenge to the growth of the Indonesian palm oil industry (World Growth, 2011).

This chapter mainly focuses on investigating the factors associated with recent expansion of oil palm plantation in Indonesia. First, briefly analysis of land holding size trend will be employed by using latest land ownership information from farmers. Second, econometric model will used to investigate the factors behind farmers` decision to expand farm size during several years of planting. The study was expected to reveal the economics motivation and other social and physical characteristics of farmers contributed to future projected expansion.

4.2 Data and model specification

4.2.1 Study region and household survey

Similar to the previous chapter, the primary data was gathered by structured questionnaire to 271 household level farmers in 2013 as a continuation of the first survey in 2012 where the data were used in the previous chapter. The 2013 survey took places in four selected villages in Pelalawan Regency administration, Riau Province, western part of Sumatera, Indonesia. Two villages were representing NES-Scheme program, namely "Makmur (MR)" and "Mekar Jaya (MJ)", and other two villages were classified as non-transmigration village for independent farmers; namely "Kiyap Jaya (KJ)" and "Lubuk Ogung (LO)". In addition, when the second survey was conducted in 2013, it was found that the number of farmers joining the association has increased from 58% in 2012 to 65% in 2013, thus updating the information regarding the percentage of farmer joining the group into the analysis of this study.

4.2.2 Probit estimation

Farmers` decision on expanding oil palm farm size was presented in dichotomous dependent variables. Assuming the Y dependent variables was decision of farmers to expand their oil palm farmland after several years when they first time cultivate, then it took value of one if the farmers expanded the farm size and zero for otherwise. In Probit model, the probability that an individual farmers expanded their farmland, notated as *P(EX)*, given the socio-economics factors and geographical characteristic *(Z)* can be expressed as follows

$$P(EX = 1|Z) = \int_{-\infty}^{Z'\beta} \phi(t)dt = \Phi(Z'\beta) \qquad (4.1)$$

with the marginal effect for the normal distribution.

$$\partial P / \partial Z = \phi(Z'\beta)\beta \qquad (4.2)$$

Where $\phi(t)$ is the standard normal density. In addition, the goodness-of-fit measure for linear probability model can be reported as the percent correctly predicted. Referring to Wooldridge (2013) for each *i,* the predicted probability can be computed as $EX_i = 1$, given the variables, Z_i. If $(\Phi(\hat{\beta}_0 + \hat{\beta}_1 Z_i) > 0.5]$, EX_i is predicted to be unity; if $(\Phi(\hat{\beta}_0 + \hat{\beta}_1 Z_i) \leq 0.5]$ $(\Phi(\hat{\beta}_0 + \hat{\beta}_1 Z_i) \leq 0.5]$, EX_i is predicted to be zero. The percentage of times the predicted EX_i matches the actual EX_i is the percent correctly predicted.

4.2.3 Empirical model

A Probit model was applied to investigate the underlying factors of farmers` decision on expanding oil palm farmland. The dependent variable was whether farmers decided to expand oil palm farm size after several years of oil palm cultivating and farmers haven't decided to expand the farm size. The selected variables for this study included farmers` household head level of education (EDUC), number of family size of farmers` household (FSIZE), oil palm farming experiences (EXPR), annual income from oil palm production (INCM), land ownership status (LOWN), availability of off-farm income (OFFI), participation in training or contact with extension agent (EXT), and membership of farmers organization (GROUP). Implementation of the model also account for variety of geographical condition (e.g. soil type) among 4 villages selected in this study. Therefore, the regional of dummy variable for soil type were also incorporated into the model (SOIL). A complete description of variables specified, measurement unit and expected outcome sign is presented in Table 4.1.

The availability of human capital which indicated by farmers` education and number of family member involved in oil palm cultivation. Many study reveal that decision making in farming activities was depend on education of farmers. (Mital & Kumar, 2000) found significant impact of educated farmers on their decision to adopt seed variety. Furthermore, referring to the Chayonivian theory of peasant economy (Rahman, 2008), higher subsistence pressure increase the decision to adopt new agricultural innovation was increased. Subsistence pressure, measured by number of family member in a farmers` household, was incorporated in the model. Both human capital variables were expected to be positive in the decision to expand oil palm cultivation.

The impact of farming experience on making decision is still unclear. (Herath & Takeya, 2003) argued that as experience increase (and therefore farmers age increase), the ability of farmers` to adopt new innovation was decreased, while risk aversion and learning with current management practice may increase. On the other hand, farmers experience may lead to greater knowledge in farming. Concerning the previous argument, farming experience in oil palm plantation is expected to be positive.

Table 4.1 Description of the variables specified in the model

Notation	Variable acronym	Measurement Unit	Variable definition	Expected Sign
Dependent variable				
EX	EXPANSION	Dummy	Farmers' decision to expand the size of their oil palm farmland 1 = if farmers expand the land size after several years of planting the oil palm, 0 = Otherwise	
Independent variables				
Z_1	EDUC	Category	Farmers' education level; 1 = Elementary School, 2 = Secondary School, 3 = High School, 4 = University	+
Z_2	FSIZE	Number	Number of family member	+
Z_3	EXPR	Years	Years of oil palm farming experience	+/-
Z_4	INCM	'000 USD/year	Annual income from oil palm cultivation	+
Z_5	LOWN	Dummy	Land legislation or certification for oil palm farmland issued by National Land Agency of Indonesia 1 = Having land certifications, 0 = Otherwise	+
Z_6	OFFI	Dummy	Whether farmers have off farm income 1 = Having off farm income, 0 = Otherwise	+/-
Z_7	EXT	Dummy	Farmers' activity on accessing the extension or training program 1 = Had accessed 0 = Otherwise	+
Z_8	GROUP	Dummy	Membership in a farmers association 1 = Joined farmer group, 0 = Otherwise	+
Z_9	SOIL	Dummy	Soil type of oil palm plot 1 = Cultivate oil palm in peat soil, 0 = Otherwise	+/-

The amount of annual income earned from oil palm was included to reflect the importance of oil palm cultivation as the major income sources of the farmers` household. The higher income earned the higher financial leverage to undertake risk associated to the farmers` decision to expand oil palm farmland. This expected to be positive to prove that one of the farmers decision was motivated by the benefit from the oil palm production.

The evidence of land ownership status was varying in several cases. One case from (Herath & Takeya, 2003) found that land ownership was negative and signify to farmers' decision on intercropping in Sri Lanka. It was indicated that mostly farmers in Sri Lanka are operate farming in rented land. Furthermore, Land ownership certification variable was considered in this model because it is very important for farmers in the study area if the decide to expand their oil palm farmland, particularly as collateral of credit to the finance institution. Hence, it was assigned as positive in this model.

Dummy variable of off farm income also was taken into account because of the relative importance of non-agricultural activity in supporting the expansion of oil palm of each household. However, the role of off-farm income to the decision of farmers is still not clear. According to (Dimara & Skuras, 1998), an increase of off-farm annual work units' decreased the probability of decision of farmers to enhance their farming technology, but the relationship was not significantly different. Based on previous study, it was difficult to assign the sign of this variable.

The effects of extension agent contact and farmers group were expected to be positive and significant. The existence of both formal institution increase knowledge hence farmers were motivated to expand and develop oil palm farmland. The trend of oil palm expansion has increased in recent year and farmers tend to occupy peat land area. The availability of peat land in study area attracted the oil palm farmers to expand their farmland. This variable is introduced to have positive signed to influence farmers` decision.

Table 4.2 Land size of oil palm owned by household level farmers from 1990 to 2012

Land area (ha)	Percentage of farmers			
	Kiyap Jaya (KJ) (N = 106)	Lubuk Ogung (LO) (N = 28)	Mekar Jaya (MJ) (N = 36)	Makmur (MR) (N = 101)
Before expansion				
<4	82%	95%	100%	100%
4-8	17%	5%	0%	0%
>8	1%	0%	0%	0%
After expansion				
<4	35%	80%	32%	28%
4-8	49%	15%	68%	55%
>8	16%	5%	0%	17%

Note: Survey conducted by author in 2012

4.3 Result and discussion

4.3.1 Trend of oil expansion size of smallholders

Table 4.2 shows the information about oil palm land size when farmers started to cultivate oil palm farm size in year 1990 until the author conducted the survey in 2012. It was found that 75% of farmers expanded the oil palm farm size. As shown in Table 2, 100% of farmers in village under the NES-Scheme program "MJ" and "MR" cultivated oil palm was less than 4 hectares. In fact, NES-Scheme farmers started the oil cultivation since 1990's and each person received 2 hectares of land from government since they joined the transmigration program on that era (Alwarritzi, et al., 2015).

Based on survey data, more than 50% of NES-Scheme farmers have expanded oil palm farmland to the medium scale and 17% to the large scale. In contrast with NES-Scheme farmers, around 80-95% of independent farmers in "KJ" and "LO" had started cultivation with various size, but still categorized as small scale farm. Successful independent farmers have expanded to medium and large-scale farm until 2013. This trend shows that smallholder farmers rapidly expanded their farmland because of the ability to maintain their asset and their dependency to oil palm product as main source of income in the study area.

Table 4.3 Summary of factors used in the model

Variable	Average	std.dev	Min.	Max.
EDUC	2.02	0.95	1	4
FSIZE	4.90	1.16	2	9
EXPR	18.38	5.79	5	25
INCM	5.85	2.31	0.98	15.83
LOWN	0.94	0.24	0	1
OFFI	0.24	0.43	0	1
EXT	0.42	0.49	0	1
GROUP	0.65	0.48	0	1
SOIL	0.10	0.30	0	1

Note: Combined data from survey conducted in 2012 and 2014

4.3.2 Characteristics of oil palm farmers

The summary of factors associated with farmers' decision to expand oil palm farmland from 271 samples population is presented in Table 4.3. 75% of farmers in this study area have expanded oil palm farmland and 25% of farmers have not expanded their farmland. In average, farmers in the study area gained primary school education, implying that farmers only have basic education and possess minimum knowledge related to agriculture. The study revealed that, most farmers learn the how-to based on their experiences, which enhanced with contribution from sharing knowledge of farmer group and extension agent.

Farmers earned, annual income around 6,000 USD in average, but the gap is very far between the highest and the lowest, revealing that farming practice and scale might be difference among farmers. Only 25% farmers had income from their off-farm activity, shows that oil palm was the main of income in the study area. Status of oil palm farmland was an important variable in order to expand oil palm farm-land. It is useful as collateral when farmers need to borrow money from finance institution. However, It was found that 94% of farmers own the land certificate issued by The National Land Agency (BPN). Lastly, 10% of farmers cultivated oil palm in peat soil area, which can be found in "LO" area (Alwarritzi, et al., 2015).

Table 4.4 Probit estimation result

Expansion	Coef.	Std. Err.	z	P>z	
EDUC	0.043	0.104	0.410	0.682	
FSIZE	0.235	0.083	2.830	0.005	***
EXPR	0.007	0.025	0.290	0.776	
INCM	0.398	0.124	3.210	0.001	***
LOWN	0.798	0.361	2.210	0.027	**
OFFI	-0.131	0.226	-0.580	0.563	
EXT	0.472	0.248	1.900	0.057	**
GROUP	0.594	0.324	1.830	0.067	*
SOIL	0.732	0.427	1.710	0.087	
cons.	-2.581	0.725	-3.560	0.000	

Note: ***,**,* are significant at 1%, 5% and 10% level respectively
Self-surveyed in 2012 and 2014
Number of observation = 271
LR $chi^2(9)$ = 61.02 Prob > chi^2 = 0.0000
Log likelihood = -123.24232 Pseudo R^2 = 0.1984
Correctly predicted value = 0.79

Table 4.5 Marginal effect of factors associated with oil palm expansion

Variable	*dy/dx*	Std. Err.	z	P>z	
EDUC	0.011	0.037	0.410	0.682	
FSIZE	0.060	0.020	2.940	0.003	***
EXPR	0.002	0.016	0.290	0.775	
INCM	0.102	0.030	3.340	0.001	***
LOWN	0.204	0.090	2.270	0.023	**
OFFI	-0.033	0.058	-0.580	0.562	
EXT	0.121	0.063	1.930	0.054	*
GROUP	0.152	0.082	1.860	0.062	*
SOIL	0.187	0.108	1.740	0.082	*

Note: ***,**,* are significant at 1%, 5% and 10% level respectively
Self-surveyed in 2012 and 2014
Number of observation = 271

4.3.3 Determinants on decision to expand oil palm farmland

This section explains the result of estimating the model with cross sectional data of 271 respondents in the study area. The empirical Probit model (Table 4.4 and Table 4.5) was calculated using STATA 13. A goodness-of-fit measure can be computed in the Probit model as percent correctly predicted. The model correctly predicts that 79% of the response of farmers' decision on expanding the oil palm farmland. Furthermore, in order to examine the estimated coefficient, the marginal effects of probability of farmers' decision on expanding are presented. The marginal effects can be interpreted as dependent on the unit of measurement of the independent variables (Greene, 2013).

Based on probability specification estimate (Table 4.4), it was found that number of family member, income, land status, extension program, farmer group and soil type were shown more likely to expand oil palm farmland. Regarding the off-farm income, it was shown as not significant but farmers were less likely to expand their farmland when they have off-farm income.

Table 4.5 shows the result of marginal effect calculation from the mean of variable on farmers` decision on expanding oil palm farmland. It is observed that for an increasing 1% of annual income earned from oil palm per year, the probability of farmers to expand their farmland increases by 0.001%. This implies highly elastic response of 3.34 when calculated at the mean values of independent variables. However, it is proved that when farmers get enough money from oil palm production, the probability to invest their income on expanding oil palm farmland might be higher.

As for the family member variable, with 1% increased of farmers' household member, the probability of expanding farmland increased by 0.003%, implying that 2.94 highly elasticity response. Based on the local people tradition, the parents expect to inherit valuable asset for their children. On the other side, the active number of family member also important to increase productivity and reducing cost of hired labor.

The dummy variable representing land ownership status was significant and positive to farmers' decision to expand farmland. This indicated when there was land certificate for oil palm cultivation, the probability of farmers to expand farm size tend to be higher. According to household survey, financial institution easily gave credit access when farmers had land certificate. This finding in-line with Indonesia Land Tenure Profile report (USAID, 2010) where was Indonesian Government should facilitate local people, who depend on natural resources as their main income, a land tenure property right in order to protect their livelihood.

As reported earlier, farmers in the study area gained farming education from extension contact and social interaction through farmers group. It was found that dummy variable of extension contact and farmers group appeared to be positive and significantly impacted to farmers' likelihood on expanding oil palm farm size. An increase of 10% in the dummy of farmer's access to extension service program and farmers group membership increased the probability of expanding oil palm farmland by 1.93% and 1.86% respectively.

The dummy variable representing the soil type implied that farmers who were cultivated in peat soil area had a significant positive impact to the probability to increase their farm size. Based on the previous study (Alwarritzi, et al., 2015), it was found that the availability of mineral land to be cultivated has been limited since strict regulation regarding environmental issue was published and also the current oil palm cultivation. Based the field survey and the official map (KEMENHUT, 1989), the availability of land for an agricultural purpose was large and the price of land was relatively cheap compare to mineral land. Even though it was difficult to cultivate oil palm under peat soil condition, farmers may expand their oil palm farmland in order to sustain their sources of main income and future generation needs.

4.4 Conclusion and recommendation

4.4.1 Conclusion

This study revealed that most of oil palm farmers in this study area have expanded their farm size to medium scale category during the period of 1990 to 2012. The reason behind farmers' decision was taken into account in this study to investigate the probability of future oil palm expansion in Indonesia, particularly for small-holders operated oil palm farm.

Based on the Probit analysis, it was found that the income earned from oil palm, number of family member, land ownership status, farmer organization, extension program and soil type of oil palm farmland have positive impact on probability of farmers' decision on expanding oil palm farm size. Furthermore, this study has proven that economics motive had dominant factors to oil palm expansion. This finding implied that farmers in the study area have dependency on oil palm cultivation as their main source of income. Further investigation is necessary to examine the relationship of individual probability of expansion to the farm size, income, and other livelihood indicators.

4.4.2 Recommendation

It was found that oil palm as one of the most potential sources of income both local and national level, then government need to consider several elements to guarantee the sustainability of oil palm expansion in the future. Based on the empirical result, several factors must be improved are:

1. Since oil palm farming require wide area of cultivation and high cost, it is necessary if farmers enriched with farming practice skills to prevent production risk and environmental problems. Furthermore, government has to pay attention on strengthening technical knowledge through extension program for oil palm farmers to produce oil palm in good quality product and high productivity.

2. Promoting the accessibility of farmers to certify their agricultural land which in line with Indonesian government purpose on establishing MP3EI program on promoting agricultural sector, particularly oil palm cultivation as main income in rural area.

3. Giving more attention on the role of farmer organization in maintaining market networking. Under the farmer organization, farmers may have higher bargaining position when they sale oil palm product to the company compare to farmers without any organization assistance. Hence, when farmers expand their land, they will not worry to sale their product and receive other technical assistance.

Chapter 5

Impact of Oil Palm Expansion on Farmers' Crop Income and Poverty Reduction in Indonesia

5.1 Introduction

5.1.1 The Importance of the Oil Palm Sector

The demand for oil palm, a main source of biofuel and used for human and livestock consumption as well as in the pharmaceutical industry, has risen dramatically and led to rapid expansion of its cultivation in Indonesia. Indonesia has become the top oil palm producer since 2008; total oil palm plantation area expanded from 0.7 million ha in 1990 to 10.45 million ha in 2013, with a growth rate of approximately 500 thousand hectares per year over the past ten years (Food and Agricultural Organization of the United Nation (FAO), 2014). Government support has been provided through the Master Plan for Acceleration and Expansion of Indonesia's Economic Development (MP3EI), which focuses on developing oil palm plantations, with Sumatra Island as the center of production. The major goal of oil palm development is to provide job opportunities and reduce poverty in rural areas. Consistent with World Bank (2008), developing countries escaping from poverty and job opportunity problems often depend on the agricultural sector; indeed, the realization of this master plan should widen opportunities for smallholder farmers to participate actively in the oil palm sector in Indonesia.

However, oil palm is not only cultivated through large-scale operations, it is also produced by local smallholder farmers. It has been reported previously that Indonesian smallholders occupied 46% (4.6 million hectares) of the total national oil palm plantation area (Ditjenbun, 2015). Despite the majority of smallholders lacking adequate guidance or training, farmers have continued to expand oil palm over recent decades. This trend raises several questions in terms of what makes an individual likely to expand their oil palm farm and the causal effects that might arise. Several studies have investigated spatial and demographic factors associated with the expansion of land used for oil palm in Indonesia. (Gatto, et al., 2015) found that distance from oil palm farms to roads and access to capital for buying inputs or raw materials contributed positively to driving oil palm expansion in Indonesia. Additionally, the high financial returns generated by oil palm plantations compared to rubber or rice cultivation were found to motivate farmers to expand oil palm land in Jambi Province (Rist, et al., 2010). However, oil palm not only generates high returns on investment; it also has other advantages, such as requiring less labor and enabling partnerships with banks and palm oil refinery companies.

Like the adoption of many other agricultural practices, oil palm land expansion can be seen as an attempt to reduce rural poverty, provide household income, and foster economic development. Since many of Indonesia's oil palm-farming smallholders use inadequate inputs and improper management techniques, oil palm production levels per hectare remain relatively low (Alwarritzi, et al., 2015). However, it is quite difficult to evaluate the wellbeing effects of adopting new agricultural practices. Most studies of incomes and poverty have relied on macroeconomic approaches and analysis at regional scales. Despite oil palm expansion occurring widely among smallholder farmers in Indonesia, few studies have investigated the household-level factors driving farmers to expand farm sizes. This makes it difficult to project the future of oil palm expansion or to evaluate its impact on farm households.

As such, the present study aims to contribute to the literature on evaluating the causal effects of farmers' agricultural activities in Indonesia (and particularly oil palm land expansion) by analyzing the factors associated with farmers' decisions to expand oil palm farm size. In the first step of the analysis, we examine the probability that a farmer will expand his or her oil palm farm using a probability model. In the second step, we analyze the effect of oil palm expansion on farmers' wellbeing by using propensity score matching (PSM) to account for self-selection bias (e.g., the fact that the decision to expand oil palm cultivation is not random. The effects of oil palm expansion are investigated in terms of whether expansion increases farmers' wellbeing, as indicated by farm incomes and poverty status. The resulting better understanding of the expansion decision and its impact on farmers' welfare can help policymakers understand how policy interventions can contribute to reducing rural poverty among farm households.

The rest of the sub-chapter is organized as follows. The next sub-chapter presents trends in oil palm expansion by smallholder farmers in Indonesia over the past two decades. In sub-chapter 5.2, we describe the data, the PSM approach, and the treatment effect model used and explains how each variable may be associated with the decision to expand oil palm farm size. Sub-chapter 5.3 presents the empirical results for the propensity to expand oil palm farm size and the average treatment effects of oil palm expansion. Finally, the last sub-chapter concludes and briefly implicates the findings from overall chapter.

5.1.2 Oil Palm Land Expansion and Certification Schemes in Indonesia

The rapid expansion of agricultural land in developing countries is mainly due to the high degree of integration between rural areas and national or international economic systems as well as population pressures. Despite economic forces, oil palm land expansion in Indonesia is also triggered by a lack of agricultural intensification, as demonstrated by the productivity gap among smallholders.

Oil palm cultivation in Indonesia began to increase dramatically in the 1990's when the government supported massive plantations for tree crops (e.g., oil palm, coffee, and cocoa) in order to generate domestic economic growth, increase export revenue, and facilitate the employment of people in remote areas. Sumatra Island was the original location for cultivation of oil palm during the period of Dutch colonialism and has the best overall environment for oil palm cultivation. Over more than two decades of oil palm development, Sumatra remains the largest and most productive area, housing 70% of the national mature oil palm area and 75% of oil palm production. In recent decades, oil palm expansion in Indonesia has spread widely to outer Sumatra. The second major area for expansion and production is Kalimantan, where oil palm land has increased dramatically to 1.4 million hectares in the last five years.

The Indonesian Government predicts that oil palm plantations will increase in area by 500,000 hectares each year while production by smallholder will reach almost 31 million tons in 2015. Thus, concerning national trends in oil palm development, the Indonesian government established the official Platform for Sustainable Oil Palm Plantations as a national certification scheme in order to improve smallholder farmers' capacity to increase oil palm productivity and mitigate the environmental impacts of plantations (UNDP (United Nations Development Program), 2015). To support the rapid expansion of oil palm plantations in Indonesia, the scheme offers certification to smallholders at the village level in order to support their access to markets by: 1) collaborating with the national oil company to promote oil palm as the main source of biodiesel, 2) establishing a fair international market price, 3) working in partnership with the private sector, and 4) creating an industry that promotes sustainable Indonesian oil palm products.

5.2 Data and model specification

5.2.1 Data and sampling procedures

We carried out household-level interviews in four neighboring villages in Riau Province that have undertaken oil palm cultivation over the last few decades, from 1990 to the survey period in April to June 2015. A total of 271 sample households from four major villages in Riau were purposively selected based on the characteristics of the plantation scheme. Two villages (Mekar Jaya and Makmur) are under Nucleus Estate Smallholders (NES schemes that were established in the 1990's, and two villages are independently cultivating oil palm. We then randomly selected farmers involved with each scheme, whether they had expanded their oil palm or not, from a list provided by leaders of farmers' organizations and villages. For the purpose of this study, treated group are classified as farmers who expanded their farm size over two decades named as "expansion" group, while untreated group are the farmers who did not expand oil palm farm size notated as the "non-expansion" group.

A structured questionnaire was designed to gather detailed information regarding farm characteristics (e.g., farm size, year of expansion, number of trees, yield, and income), household and farmers' characteristics such as education, age, number of family members actively involved with the plantation, social capital including extension visits, farmers' association membership, and contract farming scheme participation, capital assets which cover the information about vehicle ownership, total land area, land certificate ownership, and credit access), and geographic factors (e.g., distance to the market and soil conditions). Survey on household expenditures for food and non-food consumption was gathered in order to gain information on farmers' per-capita expenditure as well as their consumption behavior. Furthermore, in order to confirm important information on oil palm farming practices in the study area, group discussions were conducted with the leaders of farmers' groups.

5.2.2 Logit estimates and empirical models

Farmers' decisions to expand oil palm farm size were presented in dichotomous dependent variables. The *Y* dependent variables comprise the decisions of farmers to expand their oil palm farmland several years after they first cultivate; *Y* took a value of one if farmers expanded farm size, and zero otherwise. In our logit model, the probability of an individual farmer expanding farmland, notated as $\text{Prob}\,(\text{Y} = 1|\text{x})$, given socioeconomics factors and geographical characteristic $\mathbf{x}'$ and β was impact of the change in $\mathbf{x}'$ on the probability. $\Lambda\,(\mathbf{x}'\beta)$ was the value of the logistic cumulative density function associated with each possible value of the underlying index. The model can be expressed as follows.

$$\text{Prob}(\text{Y} = 1|\text{x}) = \Lambda(\mathbf{x}'\beta) = \frac{e^{x'\beta}}{\left(1 + e^{x'\beta}\right)^2}\,\beta_j \;=\; \frac{\exp(\mathbf{x}'\beta)}{1 + \exp(\mathbf{x}'\beta)} \qquad (5.1)$$

with marginal effect for normal distribution.

$$\partial p / \partial \mathrm{x_j} = \Lambda(\mathbf{x}'\beta)[1 - \Lambda(\mathbf{x}'\beta]\beta_j = \frac{e^{x'\beta}}{(1 + e^{x'\beta})^2}\,\beta_j \qquad (5.2)$$

In addition, the coefficients in the logit analysis were estimated using maximum likelihood estimation and serve to indicate the direction of influence on the probability. The marginal effect of each independent variable was calculated and indicated by the calculated changes in probability.

We thus used a logit model to investigate the factors influencing farmers' decisions to expand oil palm cultivation. A complete description of the variables, measurement units, and expected coefficient signs is presented in Table 5.1. The explanatory variables included in the vector X relate to human capital (household head's age (AGE) and level of education (EDUCATION), number of family members in the household (FSIZE), total family labor hours worked on the oil plantation (FAMLAB)), financial capital and assets (availability of non-farm income (NONFI), availability of other farm income (OTHFI), access to agricultural credit (CREDIT), land ownership status (LOWN), number of vehicles such as motorbikes owned (MOTORBIKE)), social capital (contact with extension services (EXTENSION), membership in a farmers' association (GROUP)), market access (contract farming system (CONTRACT), distance to the nearest refinery company (DISTANCE)). The model also controlled for a variety of geographical conditions (e.g., soil type) that vary among the four villages by incorporating a regional dummy variable for soil type (SOIL).

This study measured the availability of human capital using farmers' education and the number of family members involved in oil palm cultivation. Many studies have found that agricultural decision-making depends on farmers' education levels. One of the arguments was stated by Mital and Kumar (2000) which found significant impact of education on farmers' decisions to adopt certain seed varieties.

Table 5.1 Variables used and definitions

Variable	Unit	Definition	Expected Sign
Dependent variable			
Expand decision	Dummy	1 if farmer decided to expand farm size, 0 otherwise	
Independent Variable			
Human Capital			
AGE	Ordered	1 = 30-40 Years	+/-
		2 = 41-60	
		3 = >60	
EDUC	Ordered	1 = Elementary school	+
		2 = Junior high school	
		3 = High school	
		4 = Academy/university	
FAMSIZE	Person	Number of family members	+
FAMLAB	Hours	Total hours of family labor working in oil palm farm	+
Financial and Asset			
NONFI	Dummy	1 if the farmer has non-agricultural income, 0 otherwise	+/-
OTHFI	Dummy	1 if the farmer has other farm income sources besides oil palm, 0 otherwise	+/-
CREDIT	Dummy	1 if the farmer receives agricultural credit from a bank, 0 otherwise	+
LOWN	Dummy	1 if the farmer has a land certificate, 0 otherwise	+
MOTORBIKE	Number	Number of motorbikes owned by the household	
Social Capital			
EXTENSION	Times	Number of visits of extension agent each year	+
GROUP	Dummy	1 if the farmer is a member of a farmers' group, 0 otherwise	+
Market Access			
CONTRACT	Dummy	1 if the farmer is in a contract farming scheme, 0 otherwise	+
DISTANCE	Km	Distance from the oil palm plot to the nearest market	-
Regional Dummy			
SOIL	Dummy	1 if soil type of farmers' plot is peat, 0 otherwise	+

Referring to the Chayanovian theory of the peasant economy (Rahman, 2008), subsistence pressure (measured by the number of family members in a farm household) was incorporated into our model. In addition, farmers with more family members involved in farming were found to be more likely to undertake agricultural diversification in the Netherlands (Hassink et al., 2015). Human capital was generally expected to have positive effects on the land expansion decision. The impact of the farmer's age, however, was unclear. Herath and Takeya (2003) argued that as age and experience increases, the ability of a farmer to adopt a new innovation decrease, while risk aversion and learning from current management practices may increase. On the other hand, farmers' experience may increase farming knowledge. The impact of farmers' ages on oil palm expansion thus cannot be predicted based on previous findings.

The evidence on the impact of land ownership status was varies. Herath and Takeya (2003) found that land ownership had a significantly negative effect on farmers' decisions to intercrop in Sri Lanka and showed that most farmers used rented land. In the present study, an indicator for having a land ownership certificate was included in the model because this was an important factor for farmers in the study area when deciding whether to expand oil palm cultivation, particularly as such a certificate can be used as collateral for credit from formal or informal financial institutions. Hence, the impact of this variable was expected to be positive.

In addition, dummy variables for off-farm income were included because of the relative importance of non-agricultural activities in supporting the expansion of oil palm. However, the role of off-farm income in farmers' decisions remains unclear. According to Dimara and Skuras (1998), an increase in off-farm annual work units decreased the probability of Greek farmers deciding to enhance their farming technology, but this effect was not significant. Based on previous studies, it was thus difficult to ascertain the sign of this variable. In contrast, the effects of extension agent contact and membership in a farmers' association were expected to be positive and significant: extension access and farmers' group participation should increase the efficiency of oil palm production in the study area. Moreover, interactions with these formal institutions increase farmers' knowledge, making them more motivated to expand and develop oil palm farmland. Previous studies implied that contract farming is an institutional innovation that has a positive effect on farm productivity (Verhofstadt & Maertens, 2015). The Contract farming for oil palm plantations has been in existence in Indonesia since the 1990's, when NES scheme farmers started to cultivate oil palm. Contract farming provides technical guidance and market access. Currently, contract farming can be found not only among NES scheme farmers; independent farmers have also developed contracts with the nearest refinery company in order to sell their products. Overall, contract farming was expected to positively influence expansion.

The distance between farmers' oil palm plot to the market was an important variable influencing farmers' decisions to expand oil palm land. Since the limitation of infrastructure facility in the study site and transporting cost is relatively expansive, oil palm farmers prefer to sell their product to the nearest refinery mills. This result was in line with Verhofstadt & Mertens (2014), when farmers can easily access markets, the probability of increasing cultivation area will also be higher. Based on this assumption, market distance was expected to have a negative effect. Similarly, the nearer the plot to the refinery, the greater we expected the likelihood of expanding farm size to be higher. Lastly, the trend of oil palm expansion has increased in recent years, mostly on peat land, and the availability of peat land in the study area encourages oil palm farmers to expand their farmland (Gatto, et al., 2015). This variable was expected to positively influence farmers' decisions.

5.2.3 Propensity score matching

The PSM approach develops a statistical comparison group by matching every individual from the adopter group with a non-adopter with similar characteristics. In essence, matching models attempt to create the conditions of an experiment in which adopters and non-adopters are randomly assigned, allowing one to identify a causal link between choices and outcome variables. We use crop income from oil palm and wellbeing status (indicated by a dummy variable based on per capita expenditure (PCE)) as the outcome variable: one if farmers are living above the food poverty line and zero otherwise. Household PCE was calculated based on household purchasing power, as obtained from the survey. The food poverty line was constructed based on the standard commonly used in Indonesia in which one day of per capita expenditures is equivalent to 13.000 IDR (1 USD).

PSM is a two-step procedure. First, a probability model is calculated for the decision to expand farm size via probability estimation; this provides a decision propensity score for each observation. In the second step, each observation in the treated group (expansion) is matched to one in the untreated group (non-expansion) with a similar propensity score value in order to estimate the average treatment effect for the treated (ATT), denoted as

$$ATT = E\,(Y_1 - Y_0|\mathbf{x}, D = 1) = E\,(Y_1|\mathbf{x}, D = 1) - E\,(Y_0|\mathbf{x}, D = 1) \qquad (5.3)$$

where D is an indicator variable equal to one if the farmer expanded oil palm farm size and zero otherwise. Y_1 is the outcome for the expansion observation, Y_0 is that for the non-expansion observation, and $\mathbf{x}$ is a vector of control variables. When farm size expansion is randomly adopted, we can replace $E\,(Y_0|\mathbf{x}, D = 1)$ with $E\,(Y_0|\mathbf{x}, D = 0)$. However, as mentioned above, the groups are not randomly distributed, and $E\,(Y_0|\mathbf{x}, D = 1)$ is unobservable. Therefore, we employ two methods to match the expansion and non-expansion observations: nearest neighbor matching (NNM) and kernel-based matching (KBM).

After matching, one must run a balancing test to ascertain whether the differences in the covariates between the two groups have been eliminated, in which case the matched comparison group can be a considered a plausible counterfactual (Ali & Abdulai, 2010). Although several versions of balancing procedure exist, the most widely used is the mean absolute standardized bias (MASB) approach. Thus, we employed the MASB method suggested by Rosenbaum and Rubin (1985) in which the standardized difference should be less than 20% to confirm success in the matching process. Additionally, Sinsesi (2004) proposed comparing the pseudo R^2 and p-values of the likelihood ratio test for the joint insignificance of all regressors after matching: the pseudo R^2 should be lower, and the joint significance of covariates should be rejected (i.e., there should be an insignificant *p*-value for the likelihood ratio). Many studies have analyzed the effects of farmers' decisions to adopt alternative technologies or farming practices in terms of farmers' wellbeing. This study estimates the impact of oil palm farm expansion on two outcome variables: net oil palm income and the poverty headcount ratio using the international standard of purchasing power or PCE (not less than 1 USD per person per day (Deaton, 2003)).

5.3 Result and discussion

Table 5.2 and Table 5.3 summarize the variables used in the model as well as farm information, including input costs, net oil palm income, yields, household per capita expenditures, and trends in farm size expansion. On average, farmers in the study area were in the less productive life phase, with an average age of 50 years and insignificant differences between the groups. In both groups, farmers generally had only a secondary education, implying that oil palm farmers are running plantations without any educational background.

The data revealed that most farmers learned farming practices from experience, enhanced by knowledge sharing among farmers. The average family size was five, implying that a typical farm household has at least two children who can be potential successors in running the future oil palm operation. Regarding family members involved with oil palm farming activities, we found that farmers in the expansion group allocated more hours working on the farm than the non-expansion farmers did. Based on our observations during the survey, expansions farmers applied fertilizer by themselves in order to ensure proper input use and directly check farm conditions.

Table 5.2 Descriptive statistics for the variables used and farm information

Variable	All (N=271)		Expansion (N=199)		Non-expansion (N=72)		Difference
	Mean	SD	Mean	SD	Mean	SD	
Human Capital							
AGE	1.94	0.30	1.94	0.25	1.92	0.40	0.03
EDUC	2.02	0.95	2.04	0.99	1.96	0.84	0.08
FAMSIZE	4.90	1.16	4.95	1.18	4.74	1.12	0.21
FAMLAB	41.78	4.32	41.86	4.30	41.55	4.41	0.32
Financial Capital and Assets							
NONFI	0.41	0.49	0.38	0.49	0.49	0.50	-0.11*
OTHFI	0.24	0.43	0.26	0.44	0.18	0.39	0.08
CREDIT	0.75	0.43	0.88	0.31	0.35	0.48	0.53***
LOWN	0.79	0.41	0.79	0.41	0.32	0.47	0.65***
MOTORBIKE	1.94	0.88	1.89	0.79	2.05	1.08	-0.16*
Social Capital							
EXTENSION	2.42	2.61	2.57	2.69	2.03	2.34	0.54*
GROUP	0.65	0.48	0.69	0.46	0.55	0.50	0.14**
Market Access							
CONTRACT	0.85	0.36	0.99	0.10	0.45	0.50	0.54***
DISTANCE	6.41	3.47	6.24	3.30	6.87	3.87	0.63*
Regional Dummy							
Soil	0.10	0.30	0.09	0.28	0.12	0.33	-0.04
Oil palm farm size (Ha)	4.65	2.59	5.62	2.39	2.02	0.23	3.59***
Oil palm income (Million IDR)	89.55	62.46	108.82	61.73	37.29	20.34	71.53***
Per-capita expenditure ('000 IDR)	14.32	67.36	14.33	65.97	14.26	71.47	0.07
Wellbeing status	0.58	0.52	0.62	0.49	0.51	0.51	0.11*

Table 5.3 Farm characteristics and household information by land size

	Small scale	Medium Scale	Large Scale
Oil palm farm size (Ha)	**<4**	**4 – 8**	**>8**
Number of farmers (%)	26.57	68.27	5.17
Input use (Million IDR)	8.91	21.05	50.08
Revenue (Million IDR)	45.15	123.44	244.20
Oil palm income (Million IDR)	36.25	102.39	194.12
Total income (Million IDR)	37.44	103.26	196.30
Yield (Ton/Ha)	19.21	19.79	18.80
Family size	4.75	4.93	5.21
Per capita expenditure ('000 IDR)	14.15	14.48	12.04
Wellbeing status (%)	51	59.89	28.9

Table 5.1 presents that average values of financial and asset variables differ significantly between the groups. Interestingly, a significantly higher percentage of non-expansion farmers had non-farm income sources. For example, they were government employees, run small businesses at home, and were oil palm middlemen, transported oil palm fruit to refineries, and worked as farm laborers. As explained in the previous section, the Indonesian government supported oil palm expansion by facilitating farmers' access to bank loans and providing them with land certificates. Indeed, the average values for the credit use and land certificate ownership variables differ significantly between groups, suggesting that farmers who expanded oil palm land were aided by credit and used land certificates as collateral to help obtain it. Farmers' group membership and extension agents' visits differed significantly between the two groups, implying that farmers gained knowledge mostly from social interactions within farmers' groups and with extension staff. This aligned with the fact that farmers have only limited educational backgrounds in farming.

Thus, the role of farmers' groups and extension services were very important for transferring farming knowledge, particularly for farmers with more than two hectares of farmland. Furthermore, the distance to the market was less than 7 km on average, implying that farmers tend to select areas close to refinery mills to cultivate oil palm. A long distance from the plot to the mill may increase the cost of transportation and the risk of damage to the oil palm fruit. Lastly, 12% of non-expansion farmers cultivated oil palm in peat soil, suggesting that farmers' operating with peaty soil conditions face technical constraints.

A surprising result was also seen in household PCE: the difference between groups was not statistically significant, implying that farmers who expanded oil palm production spent their income on agricultural investments, buying luxury goods, or paying off credit. Many farmers had expanded the size of their oil palm farm compared to the area they cultivated in the 1990s (Table 5.3). Indeed, 73% of farmers had expanded their oil palm farms to be on a medium or large scale. Farmers in the NES program started oil palm cultivation in the 1990s, and each received 2 ha of land from the government. Based on aggregate calculations, input costs, oil palm revenues, oil palm income, and total income were statistically different between the two groups. However, production per hectare was not, implying that in terms of yield, the groups had similar outcomes.

5.3.1 Logit estimation results

The results of estimating the empirical logit model are presented in Table 5.4; they were obtained using Stata 13 and analyzing cross-sectional data on 271 respondents in the study area. The McFadden pseudo R2 was 0.68, indicating that 68% of the variation in the probability of a farmer expanding oil palm cultivation is explained by the variables included in the model. A goodness-of-fit measure for the logit model can be computed using the percentage correctly predicted; our model correctly predicted that 92% of farmers' decisions to expand oil palm farmland. Since the coefficient of logit estimation result could not be directly interpreted, the average marginal effects of the explanatory variables on the probability of deciding to expand were presented in Table 5.4; note that marginal effects were dependent on the units of measurement for the independent variables (Greene, 2013).

Based on the probability specification estimates, it was found that hours worked by family members in oil palm farming, access to credit, land ownership status, number of extension visits per year, farmers' group membership, and distance to the refinery were positively associated with the likelihood of a farmer expanding oil palm land. Non-agricultural income was shown to have an insignificant effect. Since the coefficient of logit estimation result cannot be directly interpreted, we also provide the marginal effects of independent variables.

The results of calculating marginal effects on the decision to expand oil palm revealed that a change in the dummy variable for having credit from a financial institution for agricultural purposes increased the probability of a farmer expanding his or her farmland by 0.44 (holding all other variables constant). Although the Indonesian government supported the agricultural sector by providing small loans with low interest rates and long-term installment plans, we still found a significant role of land certificate ownership in increasing the probability of a farmer expanding his or her oil palm farm size (effect size about 0.44, keeping other variables constant). This finding was consistent with a report by USAID (2010), which encouraged the Indonesian government to implement land tenure rights to protect the livelihoods of local people dependent on natural resources for their main income.

As for the family labor variable, a one-hour increased in the total family working time increased the likelihood of expanding farmland by 0.02. Having more family members actively involved in the plantation is important to increase productivity and reduce the cost of hiring labor when expanding plots size. Our observations during the survey suggested that farmers' groups disseminate farming guidance from refineries under contract schemes. Thus, we concluded that farmers generally expanded their oil palm farm was because of their personal preferences (socio-economics background).

Table 5.4 Logit estimation of factors influencing farmers' decisions to expand oil palm farm size

Variable	Logit estimates		Marginal effect	
	Coef.	Std. Err.	Dy/dx	Std. Err.
Human Capital				
AGE	-0.69	1.05	-0.08	0.12
EDUC	0.14	0.31	0.02	0.04
FAMSIZE	-0.12	0.26	-0.01	0.03
FAMLAB	0.18*	0.07	0.02*	0.01
Financial Capital and Assets				
NONFI	-0.64	0.59	-0.07	0.07
OTHFI	0.43	0.63	0.05	0.07
CREDIT	3.63***	0.72	0.41***	0.11
LOWN	3.88***	0.80	0.44***	0.12
MOTORBIKE	-0.33	0.33	-0.04	0.04
Social Capital				
EXTENSION	-0.08	0.10	-0.01	0.01
GROUP	-2.86**	1.03	-0.32***	0.11
Market Access				
CONTRACT	6.18***	1.37	0.70***	0.21
DISTANCE	0.17	0.13	0.02*	0.01
Regional Dummy				
Soil	-0.23	1.00	-0.03	0.11
Constant	-13.11***	4.79		
Log likelihood	-50.93			
LR Chi^2	213.93***			
Pseudo R^2	0.68			
Percent corrected value	92%			

Table 5.5 Matching quality indicator

Matching Method	Pseudo R^2 Before	Pseudo R^2 After	LR chi^2 (p-value) Before	LR chi^2 (p-value) After	Mean standardized bias after matching
NNM[a]	0.68	0.11	213.93***	63.83	15.3
NNM[b]	0.68	0.16	213.93***	89.06	18
KBM[c]	0.68	0.12	213.93***	67.47	18.2
KBM[d]	0.68	0.12	213.93***	67.01	16.3

Notes: Outcome Data from author's survey in 2015, *** p<0.01, ** p<0.05, * p<0.1, NNM[a] = single NNM with replacement and common support; NNM[b] = five NNM with replacement and common support; KBM[c] = KBM[c] with band width 0.06 and common support; KBM[d] = KBM with band width 0.03 and common support

Table 5.6 Average treatment effect of expanding oil palm farm size

	Matching Method	ATT Exp.	ATT Non-Exp.	ATT Dif.	ATU Exp.	ATU Non-Exp.	ATU Dif.
Crop Income (Million IDR)	NNM[a]	108.82	45.32	63.49***	83.58	46.29	37.29***
	NNM[b]	108.82	46.53	62.28***	105.27	37.29	67.98***
	KBM[c]	108.82	48.01	60.80***	98.30	48.45	49.85***
	KBM[d]	109.57	46.32	63.25***	96.30	49.30	46.99***
Wellbeing status (%)	NNM[a]	0.7	0.56	0.14	0.57	0.21	0.36***
	NNM[b]	0.81	0.56	0.25**	0.6	0.57	0.03
	KBM[c]	0.72	0.56	0.16*	0.71	0.39	0.32***
	KBM[d]	0.69	0.56	0.13	0.71	0.38	0.33***

Notes: Abbreviations as in Table 17. Exp. is Expansion Group, Non-Exp. is Non-Expansion Group, and Dif. is Difference

These findings represented an interesting area for future research. As explained earlier, farmers in the study area obtained agricultural education through extension contact or social interactions within farmers' organizations. Contrary to our prediction, extension visits had a negative but statistically insignificant impact on the likelihood that a farmer would expand his or her oil palm farm. In addition, we also found that farmers were less likely to expand their oil palm farms if they were members of a farmers' association, with the marginal effect is -0.32. These findings implied that extension services and farmers' organizations in the study area do not serve to encourage farmers to expand farmland.

Market access variables were shown to have positive and significant impacts on likelihood of expansion. The marginal effect of the variable indicating contract farming implied that if farmers have agreements with refineries, they were more likely to expand their farmland by a factor of 0.70, other variables held constant. Marketing agreement can ensure that oil palm farmers were able to sell their products right after harvesting. Thus, it was likelier that the price of oil palm fruit will approach the global market price. Market distance also contributed (effect size of 0.02) to raising the probability that a farmer will choose to expand his or her farmland. Since oil palm fruit degrade if stored for a long time, selling the fruit quickly after harvesting has advantages, even if it means that the farmer might face the price prevailing on a given day. On the other hand, some remote areas was still lack of roads connecting facility from oil palm plots to refineries; farmers thus faced unexpected situations such as road blockages, traffic jams, and accidents when transporting oil palm fruit.

5.3.2 Effects of expanding oil palm farm size on farmer's welfare

The relationship between agricultural adoptions, particularly land expansion and poverty reduction was theoretically complex and further analysis regarding impact is necessary. Before analyzing the causal effect of oil palm we did test the indicators of matching quality before and after matching using the Covariate balancing test. (Table 5.5). Table 5.6 reported the estimates for the average farm size expansion effect estimated by the NNM and KBM methods (based on single and five nearest neighbor approaches) and the Epanechnikov kernel estimator with two different bandwidths (0.06 and 0.03). The standardized mean difference for overall covariates used in the propensity score was reduced to 15.3-18.2 after matching. The *p*-values for the likelihood ratio tests indicate that the joint significance of covariates could always be rejected after matching, whereas it was never rejected before matching. The pseudo R^2 dropped significantly, from 68% before to 11-16% after matching. The low mean standardized bias and the insignificant *p*-values in the likelihood ratio test after matching suggest that the proposed propensity score specification was fairly successful at balancing the distribution of covariates between the two groups.

All the causal effect analysis was based on the common support implementation; thus the distributions from the expansion and non-expansion groups were located in the same domain. The outcome variables were net oil palm income per unit of landholding size and the household poverty headcount ratio based on daily consumption. Results indicate that farm size has a positive and significant effect, increasing oil palm income by from 60.80 to 63.49 million IDR per year. This suggested that expanding farmers made the right decision to expand their farms. For the non-expansion group, it was found that their income would increase from 37.29 to 67.98 million IDR per year were they to expand their land. These results implied that expanding oil palm land was the right decision for both groups.

The results also showed some poverty reduction, as proven by the higher percentage of farm households with *per capita* expenditures was significantly above the poverty line, ranging by 16 to 25%, implying again that the expansion farmers made the right decision in terms of expanding oil palm farm land. Considering the ATU results, non-expansion farmers would see a 32 to 36% decreases in poverty were they to shift to the expansion group. Overall, these findings aligned with previous studies in which oil palm expansion was found to have a positive impact on improving farmers' household welfare and providing a source of income, particularly in Indonesia and other developing countries.

In addition, Obidzinski, et al. (2010), who studied the social impact of oil palm plantations in three other plantation regions in Indonesia (West Papua, West Kalimantan, and Papua), reported that most smallholder farmers improved their livelihood conditions thanks to higher incomes, better housing, broader social networks, and improved access to infrastructure. However, studies have also found indirect impacts of oil palm expansion on the environment, such as declining forest area at the village level (Gatto, et al., 2015).

5.4 Conclusion and recommendation

This chapter estimated the causal effect of expanding oil palm farm size on income and poverty reduction in Pelalawan Regency, Riau Province of Indonesia. Propensity score matching was used to examine the outcomes of the expansion process, with a model accounting for selection bias based on observable differences between the treated and untreated groups. The empirical analysis indicated that expanding oil palm farm size raised farmers' oil palm incomes and thereby helped reduce poverty. Specifically, farmers in both the expansion and non-expansion groups were shown to be able obtain higher incomes than if the other farmers that had not expanded farm sizes. However, both groups seemed to have made the right decisions in terms of expanding oil palm farm size. On average, expanding oil palm farms has a positive effect on poverty alleviation; with the results suggesting that farm size expansion increases the percentage of households living above the poverty line.

The overall conclusion of the analysis is that oil palm farm expansion can be an important strategy for smallholder farmers to increase their incomes and improve their welfare. Oil palm expansion, however, was driven by human capital availability, particularly the availability of family members who can be actively involved in farming practices; financial assets such as credit support from financial institutions land ownership certification, and market variables (including participation in a contract farming scheme and market access). On the other hand, oil palm expansion experienced to be constrained by a lack of technical guidance. As such, extension service programs and the effectiveness of farmers' groups should be considered as future topics for government policy to address.

The factors driving oil palm expansion should be taken into account when trying to improve Indonesia's oil palm expansion program. Three important supporting factors were discovered that can help to sustain future expansion i.e. human resources availability, Connection between smallholders and refineries and infrastructure facilities. Human resources availability particularly related to the farm's successor inside the farmer's family because of most of the current household heads in the sample population were relatively old. Links between smallholders and refineries should be enhanced for selling oil palm products without an intermediate seller which can reduce transaction cost and give more direct profit to the farmers. Lastly, building sufficient infrastructure facilities will allow oil palm farmers to transport oil palm products to refineries effectively and provide access to buy agricultural material in another town. To understand the full potential of oil palm expansion for improving farm households' livelihoods, however, additional research must quantify the food security status of oil palm farmers, analyze technical efficiency levels, and determine how the effects of expansion vary with farm size.

Chapter 6
The Effect of Oil Palm Expansion on Food Security in Indonesia

6.1 Introduction

Since oil palm plantation boomed dramatically and its crop area almost tripled over the last two decades, the Indonesian government had focused on developing for smallholder's oil plantation in order to create job opportunities and reduce poverty in rural areas (Sheil, et al., 2009). The oil palm area expansion and production was highly encouraged with counseling as it had significant impacts in increasing farmers' income and consumption expenditure (Alwarritzi, et al., 2015). Furthermore, it is important to understand the policy implication from such government policies that affect smallholder farmer production, so that they can earn better income. The crucial aspect to be analyzed for recent oil palm expansion is the farmers' access to sufficient, safe, and nutritious food as their basic need, popularly known as food security.

Oil palm expansion in Indonesia was quite a challenging program, which is expected to eradicate hunger, considering that there is a widespread malnutrition among children, and about 11.4% of the population lives below the poverty line (FAO, 2014. Since oil palm is a non-food cash crop, the impact of oil palm expansion to farmers' food security is uncertain. Similar to the situation in India, where genetically modified (GM) cotton was promoted by the government to induce rural income, oil palm has been seen as a pathway to influence the farmers' socio-economic condition, particularly in improving or worsening farmers access to food (Qaim & Kouser, 2013).

The ex-post effect of oil palm expansion was a widely debated topic (Baker, 2010; Alwarritzi, et al., 2016; Krishna, et al., 2015), but there were very few studies that focused on its impact on farmers' food security. The heterogeneous effects of oil palm expansion on food expenditure and calorie intake might be pronounced because the income elasticity of oil palm farmers' demand was different. Oil palm farmers with large farm area may have positive effect on calorie consumption, but the opposite is true for food expenditures. The expansion might positively affect nutritious food intake, particularly at the mid to upper tail of total expenditure distribution, implying that households in this category spend their income to not only fulfil their basic calorie needs, but also consider the nutrient intake quality in their daily diets (Euler, 2015). However, previous studies on livelihood analysis of oil palm cultivation mostly focused on comparing the oil palm grower with other crops (rubber plantation). Hence, it may lead to undirected implication on how to enhance the future oil palm expansion program. Investigation of the oil palm expansion impact on food security among farmers with different income distribution and farm size expansion is important in order to highlight in which level farmers household may receive significant impact.

This chapter is mainly focused on analysis of the impact of oil palm expansion on farm household food intake in Indonesia, including food expenditure, calorie intake, and dietary quality. As the first study to examine the impact of oil palm expansion on food security using micro-level data, a comprehensive household survey were carried out in 2015. The focus of analysis referred to the definition of food security by the FAO: "a situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preference for an active and healthy life." This definition consists of four key components of food supply: availability, stability, accessibility, and utilization. A food system is vulnerable when one or more of these four components are uncertain or insecure (FAO, 2008).

6.2 Data and methods

6.2.1 Study region and household survey

Data for analysis were obtained from the comprehensive survey conducted in 2015 as also utilized in the previous chapter. A total of 271 sample households from four major villages in Riau were purposefully selected to represent the characteristics of the plantation scheme. Two villages (Mekar Jaya and Makmur) are under Nucleus Estate Smallholders (NES) schemes or transmigration villages that were established in the 1990s, while the other two villages independently cultivate oil palm. Within each village, we selected farm households depending on whether they had experienced oil palm farmland expansion vis-à-vis their farm size exceeding two-hectare area over two decades. Then, the farmers as "expansion farmer" if they had expanded oil palm farm size and "non-expansion farmer" if otherwise were (Alwarritzi, et al., 2016).

A structured questionnaire was designed to gather detailed information regarding various agricultural and socioeconomic information, including input-output of oil palm production, household characteristics, income sources, and technical assistance related to food security. Furthermore, the survey on annual household expenditure on food consumption was conducted to obtain information on farmers' per capita expenditure and their consumption behavior. In a survey questionnaire with a 7-day recall period covering 12 food group items, households were asked about the quantity of different food items consumed and their corresponding monetary value. Food consumed by farm households included market purchases, home production, and meals taken or given from outside home. Meals taken or given from outside were converted using average market prices as paid by other households living in the same village.

The current chapter analysis covers the energy content and nutritional composition of all food items that were converted from national food composition tables as developed by the Sustainable Micronutrient Intervention to Control Deficiencies and Improve Nutritional Status and General Health in Asia, known as SMIL-

ING project (SMILLING, 2013). The total consumption of calories from highly nutritious food included seafood, animal products, fruits, and vegetables. The daily household calorie consumption was divided by the number of adult equivalent (AE) in a household to obtain the calories consumed per AE per day using AE conversion factors for estimated calorie requirements according to age and gender (Claro, et al., 2010).

6.2.2 Model specification

The OLS model was specified to investigate the impact of oil palm expansion and other socioeconomic factors on food expenditure and calorie intake, which is as follows:

$$Y_i = \alpha + \gamma EP_i + \sum_{h=1}^{H} \beta_h X_i + \rho V_i + \varepsilon_i \tag{6.1}$$

where the dependent variable Y for ith household included annual expenditure for food, daily calorie consumption, and calorie from nutritious food. The dummy variable indicating whether farmers expanded their oil palm farm size during two decades (from 1990s until the survey period) was specified as EP_i where vector γ provides the conditional mean effect of EP_i. The socioeconomic factors in vector X_i contain household head's age, years of education, number of family members, total annual income, and some dummy variables. Since farmers are categorized as NES scheme and independently reside in different villages. Then V_i is specified as dummy variable of village, either under the transmigration scheme or non-transmigration village. Furthermore, γ, β_h and ρ are the parameter vectors to be estimated, and ε_i is the random error term with zero mean and constant variance. The analysis on the effect of oil palm expansion on food expenditure and calorie consumption might lead to heterogeneity among expansion and non-expansion farmers due to different motivation and socioeconomic background. The alternative solution for investigating the effect under heterogeneous effect is to apply quantile regression specification (Eq. 6.2), which was introduced by Koenker and Bassett (1978) as the median regression generalization to other quantiles. The quantile regression allows estimating the effect in the condition that changes the conditional distribution of the dependent variable (Roger & Hallock, 2011). Previous studies have applied the quantile regression to model the heterogeneous effect from wheat price (D'Souza & Jolliffe, 2012), oil palm adoption (Euler, 2015), and farming technology adoption (Sanglestwai *et al*., 2014). The conditional quantile regression of Y_i for any given value of xi can be expressed as

$$Q_{\tau}(y_i|x_i) = X_i\beta_{\tau} \qquad (6.2)$$

where $Q_{\tau}(y_i|x_i)$ is the conditional quantile function at τ quantile with 0 < τ < 1, and β_{τ} is the respective unknown parameter vector that can be estimated at any point of conditional distribution of dependent variable by asymmetrical weighing of absolute residual values. This study estimated three different quantile levels of the conditional distribution of respective dependent variable (τ= 0.25, 0.50, 0.75). We apply the same vectors of household socioeconomic and farm attributes as in the OLS regression analysis.

Table 6.1 presents the summary statistics of dependent and independent variables used in this study. The dependent variables covered the ability of households to achieve food security on their access to and control over certain "assets" or "capitals," which may be categorized as human capital, financial capital, natural capital, and social capital (World Food Programme (WFP), 2012). The independent variables represent households' annual budget on food, daily calorie intake, and daily intake from nutritious food. The explanatory variables were related to households' farm assets and demographics including dummy for whether farmers expand oil palm farm size, annual income from oil palm, household head's age, years of education, number of family members, dummy for whether household have other farm income, and access to agricultural credit. Furthermore, several social capital and market access variables were considered, including dummy variables for contact with food program extension services and the contract farming system. The model was also controlled for diverse village attributes that vary among the four sample villages by incorporating a regional dummy variable of independent village where transmigration village is a reference.

Table 6.1 Descriptive Statistic of Expansion and Non-expansion Farmers

Variable and unit	All (N=271)	Expansion (N=199)	Non-expansion (N=72)	Difference
Calorie expenditure and consumption				
Total annual food expenditure	5.20	5.21	4.16	1.05**
(Million IDR/AE)	(2.46)	(2.41)	(0.30)	
Daily calorie consumption	3033.14	3123.22	2784.18	339.04**
(kcal/AE)	(258.60)	(201.91)	(234.56)	
Daily calorie from nutritious food	1107.22	1207.28	830.67	376.61***
(kcal/AE)	(301.40)	(287.17)	(99.41)	
Farm and socio-economic characteristics				
Income from oil palm	89.55	108.82	37.29	71.53***
(Million IDR)	(62.46)	(61.73)	(20.34)	
Age of household head	51.15	51.24	50.80	0.44
(years)	(7.44)	(6.61)	(9.36)	
Education of household head	9.09	9.17	8.87	0.3
(years)	(2.93)	(3.06)	(2.53)	
Household size	4.23	4.20	4.54	-0.34
(number of AE)	(1.02)	(0.96)	(1.19)	
Having other farm income (dummy)	24 (0.43)	26 (0.44)	18 (0.39	8
Having credit (dummy)	75 (0.44)	88 (0.31)	35 (0.48)	53***
Extension for food program (dummy)	76 (0.43)	78 (0.42)	75 (0.43)	3
Contract farming (dummy)	85 (0.36)	99 (0.10)	45 (50)	54***
Village (dummy)	39 (0.49)	37 (0.48)	46 (0.51)	-9

Original field survey, 2014. Mean values are presented with standard deviation respectively. IDR is Indonesian Rupiah, 1 US$ = 13.000 IDR (Indonesian Rupiah). ***, **, * are significant at $P < 0.01$; $P < 0.05$; $P < 0.1$ respectively

Table 6.2 OLS Estimation Result for Rood Expenditure and Calorie Consumption

Variable and unit	Total annual food expenditure (Million IDR/AE)	Daily calorie consumption (kcal/AE)	Daily calorie from nutritious food (kcal/AE)
Expansion (dummy)	-0.893*** (-0.301)	225.895*** (27.171)	121.015*** (23.122)
Income from oil palm (Million IDR)	0.012*** (0.002)	1.054*** (0.186)	3.477182*** (0.158)
Age of household head (years)	-0.008 (-0.014)	-1.985 (1.282)	0.391 (1.091)
Education of household head (years)	0.021 (-0.037)	6.039* (3.344)	6.678** (2.846)
Household size (number of AE)	-0.969*** (-0.097)	-1.484 (8.803)	-4.463 (7.491)
Having other farm income (dummy)	0.284 (0.238)	-19.808 (21.456)	-16.892 (18.259)
Having credit (dummy)	-0.311 (0.263)	-7.456 (23.742)	15.473 (20.204)
Extension for food program (dummy)	0.679*** (-0.239)	86.775*** (21.598)	20.482 (18.380)
Contract farming (dummy)	0.002** (0.346)	55.836* (31.251)	-30.967 (26.594)
Village (dummy)	-1.942*** (0.251)	-209.529*** (22.707)	-107.9297*** (19.324)
Constant	9.551*** (1.019)	2806.896*** (91.952)	767.3551*** (78.252)
Observation Number	271	271	271
Adj. R-squared	0.59	0.69	0.83
F	37.60	56.7	134.76

Estimates Standard errors are shown in parenthesis. ***, **, * are significant at $P < 0.01$; $P < 0.05$; $P < 0.1$ respectively

6.3 Result and discussion

6.3.1 Characteristics of oil palm farmers

Table 6.2 shows the descriptive analysis of dependent and independent variables. The average expanded farm household spends significantly higher on annual food than the non-expansion household does. Generally, the daily calorie consumption for both groups was higher compared to the national average, which was around 1,900 kcal per capita in 2012 (Central Bureau of Statistics (BPS), 2015). As for the daily food intake, expansion farmers consumed more calorie than the non-expansion farmers, and the expansion farmers consumed nutritious food more than the non-expansion farmers. This implied that the expansion farm household might need higher energy for operating oil palm farmland, which is larger than that of the non-expansion farmers. Furthermore, the expansion group not only increased their daily calorie consumption, but also improved the diet quality by adding more nutritious and assorted foods.

The oil palm farm size was found significantly different between both groups. In our sample, from 271 total respondents, around 74% of the farmers expanded their oil palm farmland from small scale to medium and large scale (more than three hectares) during 1990 to 2014. On average, the expansion farmers grow oil palm under six hectares of farmland, implying that farmers had the ability to operate medium scale even though most of them are smallholders and conventional farmers. Both groups had significant difference in income levels, suggesting that besides having higher production, the wider cultivation area drives economies of scale and could lead to operating cost efficiency (Alwarritzi, et al., 2015). The study revealed that oil palm farmers were in the less productive life phase with an average age of 51 years. In both groups, farmers generally had at least nine years of educational experience or similar secondary education, implying that oil palm farmers were running plantations without adequate farming-related background. Based on field observation, most farmers learned farming practices from experience, enhanced by knowledge sharing among farmers. Regarding the number of family members in adult equivalent, the data represented insignificant difference between expansion and non-expansion farm households.

6.3.2 Impact of oil palm expansion and socio-economic factors on food security

Since the Indonesian government supports oil palm expansion by facilitating farmers' access to bank loans, the average values for the credit use variables differ significantly between groups. Farm households engaged in the extension class for the food self-sufficiency program was insignificantly different between the two groups, implying that this program was well disseminated and had attracted farm households in the study area. Thus, farm households might gain more knowledge about the know-how to enhance their dietary quality as well as maintain their available land to produce nutritious food such as vegetables and fruits. Lastly, we found that higher percentages of non-expansion farm households were residing in non-transmigration villages rather than in transmigration villages. This implied that oil palm expansion is closely related to the knowledge transfer among neighboring farmers, and the NES trans scheme was a good example, as they have good farmers' associations (Alwarritzi, et al., 2015).

As explained in the previous section, the OLS applied model to further analyze the impact of oil palm expansion on food security among oil palm farm households in the study site (see Table 6.2). The result revealed that the dummy variable of farmers expanding farmlands might lead households to consume more daily calorie and nutritious food, implying that a larger oil palm cultivation area requires more productive labor to operate farming activities. Similarly, previous study has shown that oil palm farm households consume more calories from daily consumption of nutritious food (Euler, 2015). However, the budget on food decreased by IDR 0.89 million as the farmers tend to expand oil palm farmland, which was consistent with Engel's law, suggesting that larger oil palm area leads to lower proportion of household income being spent on food. The tendency for decreased amount of food budget was found among non-food cash crops in India as well (Qaim & Kouser, 2013).

Interestingly, the result suggested that the effect of an increase income significantly enhances the total annual food expenditure, daily calorie intake, and nutritious food consumption by around IDR 12,000, 1.05 kcal/AE, and 3.48 kcal/AE, respectively. Previous studies have shown that income significantly influenced food expenditure mainly through labor productivity (Rist, et al., 2010), and increased healthy food diversity index (Larissa, et al., 2009); however, it has relatively small or negative impact on daily calorie intake and dietary quality among low income households (Doan, 2014).

Furthermore, other socioeconomic factors also influenced food expenditure and calorie intake of oil palm farm households. Farmers' years of education were positively associated with daily calorie intake and nutritious food consumption (increased by 6.04 and 6.68 kcal/AE, respectively), suggesting that better education might be correlated with farm income through better agronomic management practice. The coefficient of household size (AE) was negative and significantly different from zero for food expenditure, implying that the food budget decline with the increasing household size. This was probably because a larger household has a higher number of children who eat less than adults (Abdullai & Aubert, 2004).

The Indonesian government had established food security program to improve food self-sufficiency in rural areas. Based on this fact, the analysis results implied that a household where the housewife joined the program had significantly increased the daily food expenditure and calorie intake (by IDR0.68 million and 86.78 kcal/AE, respectively). The Indonesian government expected farm households might strengthen the sustainability of their food security through extension service staff providing knowledge on food diversity and optimization of land use, including nursery group progression and nutritious food processing (Kementerian Pertanian Republik Indonesia (KEMENTAN), 2015). Previous study by Diansari and Nanseki (2015) suggested that counselling and community assistance programs were essential to upgrade household members' food nutrition knowledge, preferably in small groups to ensure that the program message was effectively delivered.

Lastly, there was a significant effect of village variation, implying those farm households living in non-transmigration village negatively affected their budget on food and calorie intake. This was probably due to relatively lower farming performance compared to transmigration village (Alwarritzi, et al., 2015), which might lead to lower income earning and purchasing power, particularly on food.

6.3.3 Distribution of the effect of oil palm expansion on food security

Table 6.3 presents the results for the quantile regression. As explained in previous section, more comprehensive picture of the predictor variables' effect on the response variables were obtainable using quantile regression. Quantile regression models the relation between a set of predictor variables and specific percentiles (or quantiles) of the response variable and allows comparing how some percentiles of farm household's food security indicators were more affected by certain farmers' characteristics than other percentiles.

According to the OLS model, the average budget spent on food by a farm household that expanded its oil palm farmland was IDR 890,000 lower than that of a farm household that had not expanded its oil palm farmland. The quantile regression results indicated that the effect of expanded farmland had a larger negative impact on the medium to higher quantiles of food expenditure. This lower food budget was probably because the expansion farm household spent much of their budget on non-food expenditure, particularly on the oil palm farmland, while food self-sufficiency existed as farmers produce food products from their available gardens. (Koenker & Hallock, 2001) highlighted the tendency of the food budget increase along with the household income increased as depicted in spacing of the quantile regression lines, which revealed that the conditional distribution of food expenditure was skewed to the left.

The calorie consumption effects of expansion farm household and income were positive and consistent across quantiles. This study suggested that positive income

Table 6.3 Quantile Regression Analysis Result

Variables and unit		Quantile Regression		
	OLS	**25th**	**50th**	**75th**
	Annual Food Expenditure (Million IDR/AE)			
	(N=271)	(N=91)	(N=90)	(N=90)
Expansion (dummy)	-0.89***	-0.88***	-1.14***	-0.93**
	(-0.301)	(-0.25)	(0.27)	(0.46)
Income (Million IDR/Year)	0.012***	0.01***	0.015***	0.016***
	(0.002)	(0.002)	(0.001)	(0.003)
Constant	9.55***	7.68***	8.24***	9.11***
	(1.019)	(0.94)	(-0.91)	(1.57)
	Daily calorie consumption (kcal/AE)			
	(N=271)	(N=93)	(N=88)	(N=90)
Expansion (dummy)	225.89***	66.28***	137.81***	207.39***
	(27.17)	(14.52)	(0.19)	(52.34)
Income (Million IDR/Year)	1.05***	1.105***	2.40***	3.43***
	(0.19)	(0.36)	(0.19)	(0.1)
Constant	2806.89***	2708.35***	2694.66***	2760.26***
	(91.95)	(177.12)	(97.19)	(49.17)
	Daily calorie from nutritious food (kcal/AE)			
	(N=271)	(N=91)	(N=90)	(N=90)
Expansion (dummy)	121.01***	8.53	11.34	34.35*
	(23.12)	(7.99)	(16.66)	(18.66)
Income (Million IDR/Year)	3.48***	4.21***	5.48***	6.12***
	(0.160)	(0.13)	(0.11)	(0.06)
Constant	767.36***	678.90***	621.59	610.18***
	(-78.25)	(63.14)	(56.36)	(27.07)

Estimates Standard errors are shown in parenthesis. ***, **, * are significant at $P < 0.01$; $P < 0.05$; $P < 0.1$ respectively elasticity and land size increased daily calorie and nutrition intake. Previous studies found that income enhancement resulted in increases in total calorie intake, but this may not coincide with a diet richer in nutrients (Brinkman, et. al., 2010; Skoufias, 2009).

Within the scope of calorie intake, nutrition food has attracted considerable interest; numerous research studies have emphasized the importance of nutrition intake on health, such as vegetables, seafood, and other micronutrient food components. Low vegetable consumption was a major factor causing micronutrient deficiencies, and several widespread nutritional disorders including birth defects, weakened immune systems, mental and physical retardation, blindness, and even death were caused by diets lacking such micronutrients (FAO, 2003). Uusiku, et al. (2010) review the nutrition and food consumption in sub-Saharan Africa, and emphasize the role of dietary fibers, particularly from vegetables, in the prevention of chronic and lifestyle diseases. By consuming adequate nutrients, it is expected that oil palm farm households might become more productive and continue with oil expansion program, as they will benefit their mental and physical health.

6.4 Conclusion and implication

This chapter suggested that oil palm expansion enhances farm households' food security through better income and farmland expansion. Although oil palm is not a food cash crop, but the evidence implied that oil palm may be an important pathway to reduce the poverty problem such as hunger and malnutrition in Indonesia. However, note that the extent to which food expenditure and dietary quality change with increase in income will depend on the household consumption behavior as well as socioeconomic background. Thus, appropriate policy and regulatory frameworks are required to ensure to meet the farm households' needs to improve their food security status.

The key findings of this chapter suggested several implications. First, policymakers will need to focus on the calorie intake change that results from the income earning and farm size expansion of the oil palm cultivation; so that lower income and non-expansion farm households do not decrease their daily calorie consumption and nutritious food intake. Since oil palm plantation is the major income source, it is necessary to improve farming production facilities and technologies so that farmers will become more productive. The other initiative is to facilitate farmers with direct marketing through contract farming system in order to ensure a fair price for their products and provide advisory support.

Second, since food expenditure was relatively higher in lower quantile group of farmers, this indicated that farmers with smaller farm size spend more of their income on food due to limited resources to meet their food needs, particularly to produce nutritious food products. Since only own small scale of land, non-expansion farmers do possess adequate land to cultivate home vegetables or raise livestock, and thus they have to allocate more budgets on food products. Educating farm households on food self-sufficiency might have a significant effect on disseminating required knowledge to produce their own nutritious food products and maintain dietary intake levels. Besides, this program can alleviate the negative effects of low formal education levels of most Indonesian farmers.

Chapter 7
Conclusion and Policy Recommendation

The main purpose of study was to 1) investigate the determinant that affect decision on expanding oil palm farmland based on performance analysis, and 2) evaluate the impact of oil palm expansion to the farmers' welfare. The findings of study indicated that economics motivation, human resources, market access have driven oil palm expansion, and financial capital, which means that those are important sectors of farmers' main income. Oil palm expansion has improved welfare of farmers' household by increasing farmers' income and per-capita expenditure. The expansion of oil palm was sensitively affected to household consumption expenditure, calorie consumption and dietary quality of farmers' household.

Sustainable development of oil palm agriculture implies maximizing its socio-economic benefits. In order to design adequate policies, it is important to acquire knowledge on oil palm's persisting agronomic performance, adoption process and its welfare implications in a smallholder context. The present study has contributed to the existing literature by empirically analyzing smallholder oil palm cultivation in Riau province, Sumatera Island of the Republic of Indonesia with regard to these aspects.

7.1 Research findings

The main findings are summarized based on the main objectives of the study. In order to tackle the **objective 1**; to investigate the determinants that affect decision on expanding oil palm farmland based on performance analysis, we highlighted the important point from Chapter 3 and Chapter 4. **Chapter 3** has shown the evidences that mean of individual technical efficiency of oil palm farmers in study area of 83% indicates that there is unobserved variable that should be improved to maximize yield of oil palm. From the SFA, we found that inefficiency effect existed where farmers in study area experienced farming practice without uniformity production input.

Based on inefficient agricultural evidence, farmers in the study area tend to expand their agricultural land because it had a logical outcome that increases the yield of oil palm. **Chapter 4** presented the determinants of recent expansion of oil palm plantation in over several years of planting. The study used Probit model to estimate driving factor of oil palm land expansion in two decades up until the survey was conducted in 2013. The descriptive result indicated that 73% out of 271 farmers in study area has expanded their farmland with the average of 4-8 hectares (medium scale). Furthermore, Probit estimate results pointed out that several variables including income earned from oil palm, number of family member, land ownership status, farmer organization, extension program and soil type of oil palm farmland had positive effect on probability of farmers' decision on expanding oil palm farm size. Economics motive was found to be a dominant factor to oil palm expansion implying the dependency of oil palm cultivation as main source of income. In addition, referring to Logit estimate result (in **Chapter 5**), the main drivers to expand oil palm farms were: human capital availability (family members involved in farming practices), financial assets (credit support), land ownership certification, and market variables (participation in a contract farming scheme and access to market).

Objective 2 aimed to evaluate the impact of oil palm expansion to the farmers' welfare, and the findings were covered in Chapter 5 and Chapter 6. We considered welfare effect by analyzing farmers' income, per-capita expenditure and food security. **Chapter 5** provided better understanding on the causal effects of farmers' agricultural activities in to farmers' welfare (income and per-capita expenditure). To avoid self-selection biased, PSM was applied to analyze the driving factors of oil palm expansion and its' impact on annual farmers' crop income and per-capita expenditure. We used 271 samples (taken from survey in 2015) which divided into two groups; adopter or Expansion group; refer to farmers who expanded oil palm farmland and non-adopter for farmer who did not do expansion (Non-Expansion). The average treatment effect indicated that expansion of oil palm farm size raised farmers' incomes and thereby increases the percentage of house-holds per-capita expenditure implying that oil palm farmers status are living above the poverty line. Farmers in both the expansion and non-expansion groups were shown to be able obtain higher incomes than if the other farmers that had not expanded farm sizes. From the analysis, the result emphasize that oil palm expan-sion has reduce poverty problem in Indonesia.

In order to furtherly analyze oil palm expansion effect on farmers' food security status; OLS and quantile regression were applied in **Chapter 6**. We used 3 food security indicators, namely food expenditure, nutrition intake from daily food and nutritious food. OLS revealed that socioeconomic factors influencing food ex-penditure and calorie intake of oil palm farm households such as dummy variable of farmer expanding farmland, household head's education, number of family (negative), and joining food sufficiency program. Based on quantile regression analysis, the calorie consumption effects were positive and consistent across quantiles. It implied that land expansion and income earned from the oil palm may increase the total calorie from food and total calorie from nutritious food. Fur-thermore, the result indicated expanded farmland had a negative impact on food budget across quintiles due to the expenditure behavior. Household that fall into this category spends much of their budget on non-food expenditure, particularly on agricultural investment, child's education and luxury goods. On the other hand, food self-sufficiency exists as farmers produced food products from their own garden such as vegetables, poultry product, and livestock.

7.2 Recommendation

Based on the main finding of this study, several recommendation are constructed and directed to both government and farmers, that relates to three important oil palm expansion covered by this study; performance, adoption, and welfare effect. The results of technical efficiency analysis suggest that yield levels were mainly constrained by improper agronomic management practices, such as inadequate dosage and application of fertilizers and ageing of oil palm tree. Therefore, policy makers should focus on improving the public agricultural extension service and the availability of fertilizers through, reducing transaction costs or providing fertilizer subsidies. This study indicated that farmer organization is a significant factor that relates a farmer to increase in productivity. Therefore, farmers should always be encouraged to actively join the association and involve in their programs in order to get better access to technical guidance, subsidies and useful information.

This study highlighted that decision to expand farmland were influenced by economics motivation, market access, human capital and financial/ assets. Based on the results, immediate policy measure can be suggested to improve smallholders' access to the processing industry aiming to secure farmers' income, e.g., 1) availability of small to medium-sized processing mills and 2) smallholder marketing cooperatives. In terms of human capital, it is important to facilitate education facilities that help farmers or their successor to expand oil palm farmland more sustainably in the future. Lastly, services from financial organization that aims to provide expansion and operational credit to farmers should be broaden widely to reach out less experiences farmers. Hence, all farmers should be able to a have financial access to expand their farmland in the future.

Moreover, this study found the evidence that oil palm expansion has a great impact to farmers' welfare. Government should also to consider determinants that enhance the impact of oil palm expansion to rural livelihood. Nutrition educational program was found as one of important strategy to improve farmers' food security status. Recent program such as national food self-sufficiency program that educate rural household regarding nutritious food should be widely disseminate. This study also found negative effect of number of family member on food expenditure and intake, suggested that government have to review family planning policies. Lastly, policy makers should secure the functioning and accessibility of sufficient, safe and nutritious food items to satisfy the nutritional demand of the rural population.

7.3 Future direction of research

This study found that the oil palm farmers that expanded their farmland had impact to their livelihood as a result of improved incomes, per-capita expenditures, and food security status. The challenge remains how to represent the actual scenario of the whole country (because the data collection was restricted only some parts of the country), which can represent for respected locations but which may fail to represent the whole country. Future studies should further analyze the wider socio-economic implications of oil palm expansion in the other region that potential as oil palm producer.

There was theoretical or conceptual considerations, particularly when interested in the impact analysis, then one should not control for income from oil palm, because income gains seem to be the main mechanism how oil palm could affect the dependent variable.

There are many issues and demanded solutions that need to be address in the present time of oil palm agricultural sector. This is important since still lack of study that highlight these issues and to support government and other stakeholder to develop policy from farmers' perspective. If implemented well, smallholder oil palm cultivation can be a powerful tool that supports oil palm expansion program in Indonesia.

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2. Alwarritzi, W., Nanseki, T., & Chomei, Y. Factors Determining Household Level Farmers' Decision to Expand Oil Palm Farmland in Indonesia. Journal of the Faculty of Agriculture, Kyushu University, Vol. 60(2) page 563-568. (Date of publication 2015/09)

3. Alwarritzi, W., Nanseki, T., & Chomei, Y. Impact of Oil Palm Expansion on Farmers' Crop Income and Poverty Reduction in Indonesia: An Application of Propensity Score Matching. Journal of Agricultural Science, Vol. 8(1) page 120-131. (Date of publication 2016/01)

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5. Alwarritzi, W., Nanseki, T., Chomei, Y., Blanco Ea, X., Marte, W., & Khoy, R. Farmers' Perceptions on Agricultural Technical Service and Its Determinants in Colombia: A Case Study of Fedearroz Service in Ibague Province. Journal of the Faculty of Agriculture, Kyushu University, Vol. 62(1) page 237~224. (Date of publication 2017/02)

6. Khoy, R., Nanseki, T., Chomei, Y., Blanco Ea, X., Marte, W. & Alwarritzi, W. Analysis of Demands for Farming Technologies and Appropriate Transfer Methods of Rice Farmers in Ibague, Tolima, Colombia. Journal of the Faculty of Agriculture, Kyushu University, Vol. 62(1) page 245~253. (Date of publication 2017/02)

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2. Alwarritzi, W., Nanseki, T., & Chomei, Y. (2014). Analysis Of The Factors Influencing Technical Efficiency Among Oil Palm Smallholder Farmers In Indonesia. The 5th Sustainable Future for Human Security (SustaiN 2014). (Date of presentation: 2014/11/20)

3. Alwarritzi, W., Nanseki, T., & Chomei, Y. (2015). Impact of Oil Palm Expansion on Farmers' Income in Indonesia: An Application of Propensity Score Matching to Control for Observable Characteristics, Annual Meeting of Farm Management Society of Japan. (Date of presentation: 2015/09/12)

4. Alwarritzi, W., Nanseki, T., & Chomei, Y. Blanco Ea, X., Marte, W. & Khoy, R. Farmers' Perceptions on Agricultural Technical Service and Its Determinants in Colombia: A Case Study of Fedearroz Service in Ibague Province. Annual Meeting of Farm Management Society of Japan. (Date of presentation: 2016/09/17)

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APPENDIX A:

Questionnaires for Oil Palm Production, Expenditure and Food Intake

2015

GRADUATE SCHOOL OF BIORESOURCES AND BIOENVIRONMENT
LABORATORY OF AGRICULTURAL AND FARM MANAGEMENT
DEPT. OF AGRICULTURAL AND RESOURCES ECONOMICS
KYUSHU UNIVERSITY
6-10-1 Hakozaki, Higashi-ku, Fukuoka, 812-8581, Japan
Tel : +81-92-642-2970, 2972; Fax: +81-92-642-2970, 2972, 2973

Questionnaire No	**:**	
Respondent Group	**:**	**Trans / Non-trans**
Interviewed Date	**:**	

[IMPACT OF OIL PALM EXPANSION QUESTIONNAIRE]

Contact Person : Widya Alwarritzi Email: widyalwarritzi@gmail.com Phone : +62-81287651435

1.1 Household Head Information

Farmer Group Name : ______________________________

Head of Household : ______________________________

Gender : M / F (X_1) (X_1)

Marital Status : 1) Married 0) Otherwise

District : ______________________________

Village : ______________________________

Age : ________ Years old (X_2) (X_2)

Years of Education : ________ Years (X_3) (X_3)

Ethnic Group : 1) Javanese 0) Otherwise (If 0, Specify: ____________)

Off farm occupation : 1) Have (continue to next quest) 0) Otherwise (X_7) (X_6)

If have: 1) Kind of Job: ________ 2) working hours/day: ______ hours; 3) Working day/year:______ days; 4) Wage/year: Rp.______

Other crop activity : 1) Have 0) Otherwise (If 1, Specify: ____________) (X_6) (X_5)

Livestock : 1) Have 0) Otherwise (If 1, Specify: ____________) (X_6) (X_5)

Farming experiences : ______________ Year (X_4)

Phone No : ______________

Email Address : ______________

1.2 Household information (X_5) (X_4)

No.	Family Relationship	Gender (M/F)	Marital Status (M/S)	Age (Years)	Education (Years)	Occupation*	Remarks (X_8) (Give mark if actively join in farming activities)

*) 1) Farmer 2) Government Staff 3) Trader 4) Private 5) N/A 6) Others (Specify)

Note :

2. Land Tenure and Oil Palm Land-size Information

Land status for oil palm (X_{14}) 1) Individual-Certificated 0) Otherwise (specify: ________________________)

How can you get current cultivated land? 1) Inherited 0) Otherwise (specify: ________________________)

How many hectares of your total land (agric. And non-agric.) ? ________________ Ha (X_{13}) (X_7)

Do you cultivate palm oil in peat land area? 1) Yes (Cont. to next quest) 0) Otherwise (X_{20})

How many hectares of your peat land area for palm oil? ________________ Ha (X_{13})

Have you expanded oil palm farm size after first time cultivated? 1) Yes 0) Otherwise (Y)

Will you expand in the future? 1) Yes 0) Otherwise , If no, what is the reason? Credit/limited of land/human resources/technology/regulateon

Total oil palm land: ____________ **Ha** (X_7)

Oil Palm Age of tree (X_{11})	*First Time*		*1st Expansion*		*2nd Expansion*		Remarks
	Bars/ha	**Size (Ha)**	**Bars/ha**	**Size (Ha)**	**Bars/ha**	**Size (Ha)**	
≤ 5 *Years*							
5 - 10 years							
11 - 20 years							
> 20 years							
Total							

2.2 Land for Other Crops (X_{13}) (X_7)

Do you cultivate other crops ? 1) Yes 0) Otherwise

Total Land: ______________ Ha

Variety / Age of tree	Crop 1:		Crop 2:		Crop 3:		Remarks
	Bars	**Size (Ha)**	**Bars**	**Size (Ha)**	**Bars**	**Size (Ha)**	
5 - 10 years							
11 - 20 years							
> 20 years							
Total							

2.3 Land for Livestock (X_{13}) (X_7)

Do you have any livestock? **1) Yes** **0) Otherwise**

Total Land: ______________ Ha

3. Production Information *(eX)* *(X_8)*

3.1 Palm Oil (Fresh Bunch Fruits) Production Information

Total Monthly Production in 2014-2015

Month / Period	1st (Kg)	Rp/kg	2nd (Kg)	Rp/kg	3rd (Kg)	Rp/kg	4th (Kg)	Rp/kg	5th (Kg)	Rp/kg	6th (Kg)	Rp/kg
1st												
2nd												
3rd												
Monthly Total												

Month / Period	7th (Kg)	Rp/kg	8th (Kg)	Rp/kg	9th (Kg)	Rp/kg	10th (Kg)	Rp/kg	11th (Kg)	Rp/kg	12th (Kg)	Rp/kg
1st												
2nd												
3rd												
Monthly Total												

3.2 Other Crops Production Information

Month / Crops Variety	1st (Kg)	2nd (Kg)	3rd (Kg)	4th (Kg)	5th (Kg)	6th (Kg)	7th (Kg)	8th (Kg)	9th (Kg)	10th (Kg)	11th (Kg)	12th (Kg)	Total (Kg)	Price Rp/kg

4. Cropping Pattern (Hours/week)

Month / Crop Activity	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
Pesticide Application												
Fertilizer Application												
Weeding												
Harvesting												
Palm oil Transportation												
Others:												

Note : Give information if member of family actively join in farming activities

5. Labor (Man-day) (*X_9*)

Farm Activity	M (Person)	F (Person)	Hours/day	Working day	Wage/Hours (Rp)	Total Wage (Rp)	Remarks
Pesticide Application							
Fertilizer Application							
Weeding							
Harvesting							
Palm oil Transportation							
Others:							

6. Fertilizer and Pesticide *(X_{10})*

6.1. Fertilizer

Fertilizer	Applied Amount (kg)				Total-Subsidized (kg)	Subsidized Price (Rp/kg)	Total-non subsidized (kg)	Non subsidized Price (Rp/kg)
	1st	2nd	3rd	4th				
Urea								
NPK								
Dolomite								
Other Chemical Fertilizer 1) 2) 3)								

6.2. Pesticide

Pesticide	Applied Amount (liter)				Total (liter)	Price (Rp/liter)
	1st	2nd	3rd	4th		
Herbicide						
Insecticide						
Fungicide						

7. Services

7.1 Financing/credit access for palm oil farm activity *(X_{19})*

Do you get credit/loans from finance institution? 1) Yes (Cont. to next quest/table below) 0) Otherwise *(X_{19})*

Institution	Amount (Rp)	Interest/year (%)	Payment Method	Period of payment (Month)	Purpose	Collateral	Remarks
Gov. Bank							
Private Bank							
Microfinance org.							
Family/relatives							
Others:							

8.2 Extension Program

Have you ever participated in training program on palm oil farming? 1) Yes 0) Otherwise (X_{18}) (X_{10})

Institution	No. of Staff Visit (per year) (X_{18})	Extension Place	Type of assistances**	Remarks
Government				
Company				
Academic institution				
Others:				

** Note: 1) Technology transfer 2) Fertilizer application 3) introducing Organic fertilizer 4) introducing new seed variety 5) Others (please specify)

9. Marketing (X_{14})

Target Buyer	Market Distance (Km)	Selling Periods/month	Reason to sell to this buyer***	Amount of product (Kg)	Price (IDR/Kg)	Means of Transportation	Remarks

*** Note: 1) Under contract farming with private company 2) Offered the highest price 3) Provided financial support 4) Gave technical advice 5) Nearby farm location 6) came first 7) Others (please specify)

10. Organization (X_{16}) (X_{9})

Do you actively participate in a farm organization? 1) Yes (Cont. to next quest/table below) 0) No

No.	Name of Farm Organization	Position	Attended duration (Month)	Regular payment (Rp)	Salary (Rp/month)	Purpose	Benefits

11. Share-contract Farming *(X_{20})*

Are you including in the share-contract farming scheme with company or organization? **1) Yes (Cont. to next quest/table below) 0) Otherwise**

No.	Name of Farm Organization	Role in the contract	Contract Duration	Attended duration (Month)	Sharing Percentage (%)	Remarks

FOOD SECURITY STATUS (eX) (Y)

I'm going to ask you some questions about the food brought into your home in the last week for your family to eat. I want to know about all the foods that you bought, ate from your farm or garden, or got from other people (friends, relatives, or the government). Please tell me even if you haven't eaten it yet.

1. Since last [day of week today] did you or others in your household acquire any [name of food item]?

   Go through entire list first, and then go to q3–q9 for items with "yes."

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Rice and Cereal	Yes= 1 No = 0	Code	How much did you buy		How much did you buy?	How much did you eat from own production?		How much would you spend if you bought?	How much did you receive from other people?		How much would you spend if you bought ?
			Quantity	Unit	IDR	Quantity	Unit	IDR	Quantity	Unit	IDR
Maize flour		101									
Rice, local		102									
Rice, husked		103									
Rice, imported		104									
Millet		105									
Bread		106									
Buns		107									
Noodles/spaghetti/macaroni		108									
Breakfast cereal		109									
Cake		110									
Other											

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Roots, tuber, and Plantation	Yes= 1 No = 0	Code	Quantity	Unit	IDR	Quantity	Unit	IDR	Quantity	Unit	IDR
Cassava dried		201									
Cassava flour		202									
Potatoes		203									
Sweet potatoes		204									
Cake		205									
Other_____		206									

Other_____		207									

UNIT CODE: 1) Kilogram 2) Gram 3) Liter 4) Milliliter 5) Centimeter 6) Packet 7) Loaf 8) Unities 9) Marg. Tin, 1 kg 10) Marg. Tin, 1/2 kg 11) Cup, 1/4 liter 12) Spoon 13) Soda bottle lid 14) Rice sack, 25 kg 15) Oil tin, 20 liter 16) Bucket 17) Heap 18) Bunch

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Pulses, nuts, and seeds	Yes=1 No=0	Code	How much did you buy		How much did you buy?	How much did you eat from own production ?		How much would you spend if you bought it?	How much did you receive from other people?		How much would you spend if you bought it?
			Quantity	Unit	IDR	Quantity	Unit	IDR	Quantity	Unit	IDR
Beans, dry		301									
Peas, dry		302									
Lentis		303									
Groundnuts, in shell		304									
Groundnut, shelled		305									
Coconut, young		306									
Coconut, mature		307									
Baked beans		309									
Other_____		310									

Vegetables	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
	Yes= 1 No = 0	Code	Quantity	Unit	IDR	Quantity	Unit	IDR	Quantity	Unit	IDR
Carrots		401									
onions		402									
Garlic		403									
Cabbage		404									
Cassava leave		405									
Spinach		406									
Eggplant		407									
Sweet corn fresh		408									
Beans fresh		408									
Tomato fresh		409									
Tomato canned		410									
Sweet corn		411									
Other_____		412									

UNIT CODE: 1) Kilogram 2) Gram 3) Liter 4) Milliliter 5) Centimeter 6) Packet 7) Loaf 8) Unities 9) Marg. Tin, 1 kg 10) Marg. Tin, 1/2 kg 11) Cup, 1/4 liter 12) Spoon 13) Soda bottle lid 14) Rice sack, 25 kg 15) Oil tin, 20 liter 16) Bucket 17) Heap 18) Bunch

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Fruits	Yes=1 No=0	Code	How much did you buy		How much did you buy?	How much did you eat from own production?		How much would you spend if you	How much did you receive from other		How much would you spend if you bought it?
			Quantity	Unit	IDR	Quantity	Unit	IDR	Quantity	Unit	IDR
Banana sweet		501									
Oranges		502									
Grapefruit		503									
Lemons		504									
Avocadoes		505									
Guavas		506									
Mangos		507									
Papayas		508									
Passion fruit		508									
Watermelons		509									
Peaches, canned		510									
Pear, canned		511									
Other_____		512									

Meat and poultry	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
	Yes=1/No=0	Code	Quantity	Unit	IDR	Quantity	Unit	IDR	Quantity	Unit	IDR
Beef, with bones		601									
Beef, without bones		602									
Pork, with bones		603									
Pork, without bones		604									
Goat, with bones		605									
Goat, without bones		606									
Liver		608									
Kidney		608									
Heart		609									
Chicken		610									

Duck		611									
Canned beef		613									
Sausage		614									
Other_____		615									

UNIT CODE: 1) Kilogram 2) Gram 3) Liter 4) Milliliter 5) Centimeter 6) Packet 7) Loaf 8) Unities 9) Marg. Tin, 1 kg 10) Marg. Tin, 1/2 kg 11) Cup, 1/4 liter 12) Spoon 13) Soda bottle lid 14) Rice sack, 25 kg 15) Oil tin, 20 liter 16) Bucket 17) Heap 18) Bunch

Fish and seafood	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**
	Yes= 1 / No = 0	Code	How much did you buy		How much did you buy?	How much did you eat from own production?		How much would you spend if you bought it?	How much did you receive from other people?		How much would you spend if you bought it?
			Quantity	Unit	IDR	Quantity	Unit	IDR	Quantity	Unit	IDR
Fish, whole 1 cm		701									
Fish, whole 2 cm		702									
Fish, whole 3 cm		703									
Fish, whole dried		704									
Fish, fresh fillet		705									
Fish, dry fillet		706									
Fish, dry whole		707									
Fish, tuna, canned		708									
Fish sardines, canned		709									
Shrimp		710									
Crab		711									
Lobster		712									
Other_____		713									

Milk and diary product	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**
	Yes=1/No=0	Code	Quantity	Unit	IDR	Quantity	Unit	IDR	Quantity	Unit	IDR
Cow milk, liquid		801									
Goat milk, liquid		802									
Evaporated sweetened milk		803									
Yogurt		804									
Cheese		805									
Cow milk powder		806									
Infant formula		807									

Chicken egg		808									
Duck egg		809									
Other_____		810									
Other_____		811									

UNIT CODE: 1) Kilogram 2) Gram 3) Liter 4) Milliliter 5) Centimeter 6) Packet 7) Loaf 8) Unities 9) Marg. Tin, 1 kg 10) Marg. Tin, 1/2 kg 11) Cup, 1/4 liter 12) Spoon 13) Soda bottle lid 14) Rice sack, 25 kg 15) Oil tin, 20 liter 16) Bucket 17) Heap 18) Bunch

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Oil and fats	Yes= 1 No = 0	Code	How much did you buy		How much did you buy?	How much did you eat from own production?		How much would you spend if you bought it?	How much did you receive from other people?		How much would you spend if you bought it?
			Quantity	Unit	IDR	Quantity	Unit	IDR	Quantity	Unit	IDR
Peanut oil		801									
Coconut oil		802									
Palm oil		803									
Margarine		804									
Shea butter		805									
Animal fat		806									
Other_____		810									
Other_____		811									

Miscellaneous	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
	Yes=1/No=0	Code	Quantity	Unit	IDR	Quantity	Unit	IDR	Quantity	Unit	IDR
Fruit juice		801									
Coffee		802									
Tea		803									
Sugar		804									
Salt		805									
Honey		806									
Jam		807									
Other spices___		808									

UNIT CODE: 1) Kilogram 2) Gram 3) Liter 4) Milliliter 5) Centimeter 6) Packet 7) Loaf 8) Unities 9) Marg. Tin, 1 kg 10) Marg. Tin, 1/2 kg 11) Cup, 1/4 liter 12) Spoon 13) Soda bottle lid 14) Rice sack, 25 kg 15) Oil tin, 20 liter 16) Bucket 17) Heap 18) Bunch

2. Total Expenditure for food (weekly) : IDR _____________

3. **Total food group consumed by household:**

4. Within 1 year, how do you feel about you and your family food status?

1) Very unsecure 2) Unsecure 3) Somehow secure 4) Secure 5) Very secure

NON-FOOD EXPENDITURES

Monthly Expenditures

Fuel and Lighting (E-1)	**Code**	**Quantity**	**Unit**	**Price (IDR)**
Firewood	E101			
Jute stick	E102			
Kerosene	E103			
Gas (natural, bio-gas)/LPG	E104			
Electricity	E105			
Pit coal, char coal, wood coal	E106			
Other	E107			
Total E-1				
Cosmetic and Cleaning (E-2)				
Moisturizer for skin	E201			
Perfume etc.	E202			
Hair cutting, styling, shaving, etc.	E203			
Hair oil, hair cream, combs, clips, etc.	E204			
Razor, razor blades, shaving cream and lotions, etc.	E205			
Beautifying items (others)	E206			
Bath soap, shampoo, toothpaste, etc.	E207			
Washing soap, powder for cloths	E208			
Washing/ laundry expenses	E219			
Vim/ dish cleaning supplies	E210			
Mosquito spray/coll	E211			
Tissue/toilet paper	E212			
Other	E213			
Total E-2				
Transport, Travel and Other Misc. Charges (E-3)				
Bus fare	E301			
Other transport fare	E302			
Bicycle maintenance, tyres, tubes repairs etc.	E303			
Motor-cycle maintenance, repairs, etc.	E304			
Car maintenance, repairs, etc.	E305			
Diesel	E306			
Motor oil/CNG. etc	E307			
Telephone bill/ charges/mobile	E308			
Telegram, postal and courier service expenses, etc.	E309			
Salaries and wages of drivers	E310			
Salaries of guards, gardeners, housekeepers etc.	E311			
Other	E312			
Total E-3				

Annual Expenditure

Housing Related Expenses (E-4)	Code	Quantity	Unit	Price (IDR)
House rent (rented house)	E401			
Imputed rent (owner-occupied or other)	E402			
Water/ sewerage charges	E403			
Home additions/ improvements	E404			
Painting	E405			
Other routine maintenance/ repair	E406			
Other related services/ expenses	E407			
Total (E-4)				
Medical Treatment ((E-5)				
Doctor's fees	E501			
Other practitioner's fees (homeopath etc.)	E502			
Medicines	E503			
Ayurvedic/ Kbiraji	E504			
Medical Tests (X-ray, blood, urine etc.)	E505			
Hospitalization, clinic charges, etc.	E506			
Dental related expenses	E507			
Maternity expenses	E508			
Health-related travel/ incidental expenses	E509			
Total (E-5)				
Educational Expenses (E-6)				
Registration fees	E601			
Examination fees	E602			
School fees	E603			
Personal Teaching expenses	E604			
Text book/ note books/ stationary	E605			
Hostel Expenses	E606			
Other	E607			
Total (E-6)				
Remitances, Ceremonies, Gifts (E-7)				
Remittances to others living separately	E701			
Donation for religious purposes	E702			
Expenditure on Hajj	E703			
Expenditure on marriage	E704			
Births ceremony	E705			
Expenditure on deaths	E706			
Other	E707			
Total (E-7)				

Annual Expenditure (cont`)

Recreation and Leisure (E-8)	Code	Quantity	Unit	Price (IDR)
Books, newspaper, magazines, story books	E801			
Cinema	E802			
Video cassette purchases and rental etc.	E803			
Audio cassette purchases etc.	E804			
Photography	E805			
TV/ video/ satelite license fees, etc.	E806			
Other	E807			
Total (E-8)				
Misc. Household Durable (E-9)	E901			
Radio	E902			
Two-in-one	E903			
Black & White Television	E904			
Colored Television	E905			
VDO game set	E906			
VCD/ VCR/dish antenna/cable membership fees	E907			
Washing machine, iron, etc.	E908			
Guitar/ orchestra/ harmonium	E909			
Typewriter, personal computer etc.	E910			
Electric fans, air-conditioners, coolers, etc.	E911			
Cameras, handicam, etc	E912			
Total (E-9)				
Other Annual Expenditures (E-10)				
Taxs, Interest, ETC.	E1001			
Personal Articles (Jwlerly, bags, gold etc)	E1002			
Insurance Expenditures	E1003			
Furniture and related peripherals	E1004			
Garment (clothing, houese garment, etc)	E1005			
Cooking equipments	E1006			
Total (E-10)				

Total Non-Food Expenditure: X_{11} **IDR. ____________**

(Total (E-1) + Total (E-2) + Total (E-3) + Total (E-4) + Total (E-5) + Total (E-6) + Total (E-7) + Total (E-8) + Total (E-9) + Total (E-10))