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Factors Determining Household Level Farmers' Decisions to Expand Oil Palm Farmland in Indonesia

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The increasing demand of oil palm related products has led to a rapid expansion of oil palm plantation in Indonesia. Master Plan for Acceleration and Expansion of Indonesia's Economic Development (MP3EI) stated that oil palm is one of agricultural major sector on the limelight of development, with Sumatera Island as focus for rapid production. The actualization of MP3EI brings opportunity for smallholder farmers in Indonesia to expand any available land for oil palm cultivation and makes oil palm as main sources of income. This research examines factors underlying the probability of smallholder farmers expanding oil palm farm size over two decades. Household level survey was conducted to point out potential problem in four neighboring villages in Riau Province in Sumatera Island of Indonesia in 2013 and 2014. It was found that 75% of smallholder farmers expand the oil palm farmland from small scale to medium scale and 60% of them were engaged planting since the era of 1990's. Result of probit model estimated income earned from oil palm as the most important factor relates to farmers' decisions to expand oil palm farmland. This study also highlighted the significant role of land tenure system, extension service, farmers organization and geographical condition to the probability of farmers to expand oil palm farmland.

Key words: Household Level Farmers, Income, Oil Palm Expansion, Probit Model

INTRODUCTION

The demand oil palm, well known as one of main sources of biofuel and food industry, has increased dramatically and led to a rapid expansion. South East Asian region and particularly Indonesia is the most productive for its plantation (USDA, 2007). Governmental support has been shown in the Master Plan for Acceleration and Expansion of Indonesia Economic Development (MP3EI) which focus on developing oil palm plantation, with Sumatera as the center for production. The aim of oil palm development is to provide job opportunity to reduce poverty in rural area. The MP3EI policy brings an huge opportunity for smallholder farmers to actively participate in oil palm sectors in Indonesia. It was reported that smallholder farmers in the study area have occupied about 52% of total plantation area (Dinas Perkebunan Provinsi Riau, 2010).

Many studies 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).

The purpose of this paper is to investigate 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 owner-

ship information from farmers. Second, econometric model is used to investigate the factors behind farmers' decision to expand farm size over several years of planting. The study is expected to reveal the economics motivation and other social and physical characteristics of farmers that contribute to future projected expansion.

MATERIAL AND METHOD

Sample and study site

The primary data was gathered by structured questionnaire to 271 household level farmers in 2013. The study sites were under Pelalawan Regency administration, Riau Province, western part of Sumatera, Indonesia. Hence, the study take places in four selected villages, of which are 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)”. The study area has variation of socio–economics characteristic of farmers and these 4 villages were attributed with geographical differences, particularly the characteristic of soil. Referring to the Reproduction Soil Map mineral soil was covering 3 selected villages (MR, MJ and KJ) and peat land was existed in the southern part of LO village (Kemenhut RI, 1989). Additionally, when the second survey was conducted in 2014, it was found that the number of farmers joining the association has increased from 58% in 2012 to 65% in 2014. Thus, we decided to update information regarding the percentage of farmer joining the group in the analysis of this study.

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Probit estimation

Farmers' decisions on expanding oil palm farm size is presented in dichotomous dependent variables. Assuming the Y dependent variables is decision of farmers to expand their oil palm farmland after several years when they first time cultivate, then it will take 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.

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

with the marginal effect for the normal distribution.

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

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 cor-

rectly 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 $[(\Phi(\hat{\beta}_0 + \hat{\beta}_1 Z_i) \leq 0.5)]$, 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.

Empirical Model

A probit model is developed in this study to investigate the underlying factors of farmers' decision on expanding oil palm farmland. The dependent variable is whether farmers decided to expand oil palm farm size after several years of oil palm cultivation versus whether 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 train-

Table 1. Description of the variables specified in the model

Notation	Variable acronym	Measurement Unit	Variable definition	Expected Sign
<i>Dependent variable</i>				
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	
<i>Independent variables</i>				
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	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 = Have off farm income, 0 = Otherwise	+/-
Z_7	EXT	Dummy	Farmers' activity on accessing the extension or training program 1 = Have accessed 0 = Otherwise	+
Z_8	GROUP	Dummy	Membership of 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,	+/-

ing or contact with extension agent (EXT), and membership of farmers organization (GROUP). The model also accounted 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 are also incorporated into the model (SOIL). A complete description of variables specified, measurement unit and expected outcome sign is presented in Table 1.

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

The impact of farming experience on making decision is still unclear. Herath and Takeya (2003) argued that as experience increases (and therefore farmers ages increase), the ability of farmers' to adopt new innovation is decrease, 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.

The amount of annual income earned from oil palm is included to reflect the importance of oil palm cultivation as the major income sources of the farmers' household. The higher income earned is the higher is 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 motivate by the benefit from the oil palm production.

The evidence of land ownership status varies in sev-

eral cases. One case from Herath and Takeya (2003) found that land ownership was negative and significant 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 is 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 a collateral of credit to the finance institution. Hence, this variable is assigned as positive in this model.

Dummy variables of off farm income also take 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 and Skuras (1998), an increase of off-farm annual work units' decreases the probability of decision of farmers to enhance their farming technology in Greece, but the relationship is not significantly different. Based on previous study, it is difficult to assign the sign of this variable.

The effects of extension agent contact and farmers group are expected to be positive and significant. Since role of extension and farmers group were clear to increase the efficiency of oil palm production in the study area. The existence of both formal institution increase farmers' knowledge hence farmers were motivated to expand and develop oil palm farmland.

The trend of oil palm expansion has been increasing in recent year and occupying peat land area. The availability of peat land in study area attracts the oil palm farmers to expand their farmland. This variable is introduced to have positive signed to influence farmers' decision.

EMPIRICAL RESULT

Trend of oil expansion size in study area

Table 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 2013. It is found that 75% of farmers expanded the oil palm farm size. As shown in Table 2, 100% of farmers in

Table 2. Land size of oil palm owned by household level farmers from 1990 to 2013

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: Self-surveyed in 2013

village under the NES–Scheme “MJ” and “MR” cultivate oil palm 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 varying and 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 because of dependency to oil palm product as main source of income in the study area.

Characteristics of oil palm farmers

The summary of factors associated with farmers' decisions to expand oil palm farmland is presented in Table 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 secondary school education, which implies that farmers only have basic education and possess minimum knowledge related to agriculture. The study reveals that, most farmers learn know-how based on their experiences which enhanced with contribution from sharing knowledge of farmer group and extension agent. Farmers earn annual income around 6,000 USD in average, but the gap is very far between the highest and the lowest income farmers, revealing that farming practice and scale might be difference among farmers.

Only 25% farmers have income from their off-farm activity, showing that oil palm is the main of income in the study area. Status of oil palm farmland is an important variable in order to expand oil palm farmland. It is useful as collateral when farmers need to borrow money from finance institution. However, It can be found that 94% of farmers own the land certificate issued by The National Land Agency (BPN). Lastly, 10% of farmers

cultivate oil palm in peat soil area, which is found in “LO” area (Alwarritzi *et al.*, 2015).

Estimated probit model

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 and 5) was calculated using STATA 13. The McFadden Pseudo- R^2 is 0.198 indicating that 20% of the variation in the probability of farmers' decision to expand oil palm farmland is explained by the variables used in the model. 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' decisions on expanding the oil palm farmland. In order to examine the estimated coefficient, the average marginal effects of over the sample for determining the probability of farmers' decisions on expanding are presented.

Table 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 2013 and 2014

Number of observation = 271

LR chi2(9) = 61.02 Prob > chi² = 0.0000

Log likelihood = -123.24232 Pseudo R² = 0.1984

Table 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 2013 and 2014

Number of observation = 271

Table 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	5,857	2,306.59	982.65	15,834.08
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: Self-surveyed in 2013 and 2014

Number of observation = 271

The marginal effects can be interpreted as being dependent on the unit of measurement of the independent variables (Greene, 2013).

Based on probability specification estimate (Table 4), it is found that number of family member, income, land status, extension program, farmer group and soil type are shown more likely to expand oil palm farmland which are in-line with the expected prediction. Regarding the off-farm income, it is shown as not significant but farmers were less likely to expand their farmland when they had off-farm income.

Table 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 one unit of annual income earned from oil palm per year, the probability of farmers to expand their farmland increases by 0.011 holding all other variables constant. However, it is proved that when farmers earned 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 a unit increase of farmers' household member, likelihood of expanding farmland increases by 0.060. 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 reduce cost of hired labor.

The dummy variable of land ownership status shows significant and positive effect on decision to expand farmland. This indicates, keeping the other variable held constant, when land certificate for oil palm cultivation exist, the probability of farmers to expand farm size rises by 0.2. According to household survey, financial institution easily gives credit access when farmers have land certificate. This finding in-line with USAID report (2010) which is 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 explained earlier, farmers in the study area gained farming education from extension contact and social interaction through farmers group. It is found that dummy variable of extension contact and farmers group appear to be positive and significantly impacted to farmers likelihood on expanding oil palm farm size. If a farmer who does not have access to extension service and farmers group membership become actively join in both program, the probability of expanding oil palm farmland rise by 0.472 and 0.594 respectively.

The dummy variable representing the soil type implies that if farmers who are cultivated in mineral soil switch to peat soil area, they are more likely to expand by 0.73 when the other variable held constant. Based on the previous study by 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 reproduction map (Kemenhut RI, 1989), the availability of land for agricul-

tural purposes is large and the price of land is relatively cheap compare to mineral land. Even though it is 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.

CONCLUSION AND RECOMMENDATIONS

Major 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 2013. The reason behind farmers' decisions was taken into account in this study to investigate the probability of future oil palm expansion in Indonesia, particularly for smallholders 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 effect on probability of farmers' decision on expanding oil palm farm size. Furthermore, this study has proven that economics motive was the dominant factors to oil palm expansion. This finding implies that farmers in the study area have dependent on oil palm cultivation as their main source of income. Further investigation is necessary to examine the relationship of individual probability of expanding the farm size, income, and other livelihood indicators.

Policy Recommendations

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 as follow:

1. Since oil palm farming requires 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 sources in rural area.
3. Giving more attention on the role of farmer organization in maintaining market networking. Through the farmer organization, farmers may have higher bargaining power when they sell oil palm products to the market compare to farmers without any organization assistance. Hence, when farmers expand their land, they would not worry to sell their products and receive other technical assistance.

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