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Smallholders' Oil Palm Agroforestry in Jambi and Central Kalimantan: Barriers and Factors Influencing Adoption

(*Agroforestri Kelapa Sawit Sekala Kecil di Jambi dan Kalimantan Tengah*: *Hambatan dan Faktor-faktor yang Mempengaruhi Adopsi*)

Ari Susanti[1*], Hero Marhaento[1], Dwiko Budi Permadi[1], Budiadi[1], Muhammad Ali Imron[1], Hermudananto[1], Handojo Hadi Nurjanto[1], Denni Susanto[1], Heri Santoso[2], Irfan Bakhtiar[2], & Siti Maimunah[3]

[1]Faculty of Forestry, Universitas Gadjah Mada, Yogyakarta, Indonesia
[2]Indonesian Biodiversity Conservation Trust Fund (Yayasan Kehati), Jakarta, Indonesia
[3]Muhammadiyah University Palangka Raya, Indonesia
**Email*: arisusanti@ugm.ac.id

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Indonesia, oil palm agroforestry, social forestry, adoption, barriers

ABSTRACT

Oil palm has become an important export commodity for Indonesia and has been cultivated by both smallholders and large scale companies mainly as monoculture plantations. Research suggests that this massive monoculture practice has led to adverse impacts on natural and social systems. Smallholders encounter difficulties to cope with extreme climate events such as long dry seasons, fluctuating commodity price and long-term tenure insecurity. We argue that oil palm agroforestry (OPAF) could become a promising and realistic alternative to deal with these problems under social forestry (SF) program. To date, OPAF has been adopted by merely small number of smallholders in Indonesia in a limited scale. This article aims at analysing the barriers and factors which influence the decision of smallholders in adopting OPAF. We employ a hybrid method which combines qualitative and quantitative analysis. Binary logistic regression models were constructed to identify factors influencing OPAF adoption. Our findings suggest that education, having side job and relative location of smallholders' have significantly influenced smallholders' decision in adopting OPAF. Knowledge gaps especially on the yields and management of OPAF have likely led to low OPAF adoption.

KATA KUNCI
Indonesia, agroforestri kelapa sawit, perhutanan sosial, adopsi, penghambat

INTISARI

Kelapa sawit telah menjadi komoditas ekspor penting bagi Indonesia. Sebagian besar kelapa sawit diproduksi dari kebun-kebun kelapa sawit monokultur yang dikelola baik oleh petani skala kecil maupun perusahaan skala besar. Hasil penelitian menunjukkan bahwa praktek monokultur yang massif ini telah mengakibatkan dampak kurang baik terhadap sistem alam dan sosial. Petani skala kecil juga mengalami kesulitan dalam menghadapi kondisi cuaca ekstrim seperti musim kemarau yang panjang, fluktuasi harga komoditas kelapa sawit dan ketidakamanan tenure dalam jangka panjang. Kami berpendapat bahwa agroforestry kelapa sawit (OPAF) dalam skema perhutanan

sosial dapat menjadi alternatif yang realistis dan menjanjikan untuk menyelesaikan permasalahan tersebut. Sampai dengan saat ini, OPAF sudah diadopsi secara terbats oleh petani skala kecil di Indonesia. Artikel ini bertujuan untuk menganalisis hambatan dan faktor-faktor yang mempengaruhi pengembilan keputusan petani skala kecil untuk mengadopsi OPAF. Dalam penelitian ini kami menggunakan metode hibrida yang mengkombinasikan analisis kualitatif dan kuantitatif. Model analisis regresi logistik biner digunakan untuk mengidentifikasi faktor-faktor yang mempengaruhi adopsi OPAF. Hasil analisis menunjukkan bahwa tingkat pendidikan, pekerjaan sampingan dan lokasi dari petani skala kecil mempunyai pengaruh yang nyata terhadap pengambilan keputusan adopsi OPAF. Kurangnya pengetahuan terutama terkait hasil produksi dan pengelolaan OPAF menjadi penyebab rendahnya tingkat adopsi OPAF.

Introduction

The Oil palm has become an important agricultural export commodity for Indonesia. The export of oil palm products has been significantly contributing to national income. The Ministry of Forestry estimated that in 2019 oil palm occupied more than 16 million ha and around 40% of those are managed by smallholder farmers. These oil palm plantation produced total export values of oil palm products amounted USD 16.5 billion and contributed around 10.3% to national GDP (World Bank 2019). However, research suggests that this massive monoculture practice has led to adverse impacts on natural and social systems (Susanti 2016). The natural system has been affected mainly by the massive conversion of existing agricultural lands, peat lands (Koh et al. 2011) and natural tropical forests (Margono et al. 2014) into monoculture oil palm plantations. The conversion of existing agricultural lands, peat lands and tropical natural forests into oil palm plantations has led to biodiversity loss (Vijay et al. 2016), disturbed hydrological system (Merten et al. 2016), led to land subsidence (Hooijer et al. 2012; Saputra et al. 2017), recurrent fires and GHG emissions (Page & Hooijer 2016). This also has increased the competition for the remaining lands, the risks of local food insecurity and unsustainable growth (Susanti 2016).

In Indonesia, oil palm was introduced to stimulate development and alleviate poverty especially in rural areas (Susanti & Maryudi 2016). However, the impact of oil palm expansion on rural livelihood is not universally positive. Rather, the impact of oil palm development on the livelihood of rural communities varied. It is very much depending on the relationship between the rural community with nucleus companies and or oil palm mills (Jelsma et al. 2017). The differences in the relationships have created asymmetric access to knowledge, technologies, land and financial schemes in establishing oil palm plantations (Budidarsono et al. 2013). In the long run, it has resulted in increasing inequality of income distribution. For example, trans-migrants involved in oil palm programs or so called supported smallholders have gained better financial benefits compared to those who have not been involved (Jelsma et al. 2017). Groups of forest dwellers who used to collect timber and non-timber forest products have had difficulties because of the forest loss (Colchester 2006), leading to the increasing incidence of land and natural resources related conflicts. In addition, regions that highly depend on certain commodities such as oil palm have shown boom and bust economic growth instead of sustainable long term growth. This especially created high uncertainty of commodity price at the farmer

level which directly impacted households income (Susanti 2016). The boom and bust economic growth is often subsidized by the exploitation of land and natural resources such as natural forest exploitation.

In this article, we argue that oil palm agroforestry (OPAF) could become a promising and realistic alternative to reconcile environment, social and economic aspects to promote inclusive oil palm production. This is especially important for oil palm smallholders to cope with uncertainty of oil palm commodity price and weak-land tenure problems. The evidence has shown that smallholder farmers have voluntary adopted oil palm agroforestry (OPAF) in various places at limited scale (Budiadi et al. 2019; Slingerland et al. 2019). Little is known about the barriers of adoption of OPAF which resulted in limited adoption of OPAF and factors which could influence smallholders' decision in adopting OPAF. Therefore, this article aims at analysing barriers and factors which influence the decision of smallholders in adopting OPAF.

Oil Palm Expansion in Indonesia

Oil palm was first introduced to Indonesia in 1911 by the Dutch administration through the establishment of the first commercial plantation in the east coast of Sumatera. Palm oil production grew rapidly due to the increasing demands for its derivative products in the global market. This development stopped during the Second World War. It took until 1970s before the Indonesian government began to stimulate oil palm expansion again (Susanti 2016).

In the earlier phase of oil palm expansion, oil palm production was mainly done in the form of plantations coupled with transmigration programs, aiming at stimulating development and alleviating rural poverty in the outer islands (Budidarsono et al. 2013). Within the framework of this program many rural poor from Java and Madura moved out to less densely populated islands to join the oil palm development and become supported smallholders, in which many of them were able to accumulate capital in relatively short period. Increasing number of smallholder farmers has voluntarily adopted oil palm into their existing faming system. However, up to now oil palm has been widely adopted and cultivated as monoculture plantations by both smallholders and large scale companies.

With government supports on regulations, infrastructures and credit schemes as well as the lucrative financial benefits from oil palm production, oil palm emerged as one of Indonesia's most important crops (Susanti & Maryudi 2016). In 2006, Indonesia become the world´s main producer of palm oil and together with Malaysia, Indonesia controls over 85% of the world´s market of palm oil (FAO 2019a). This rapid expansion of oil plantations is an Anthropocene phenomenon and a result of multiple factors which simultaneously work at local, national and global levels and have shaped the speed and direction of oil palm expansion in Indonesia (Susanti 2016).

For this rapid oil palm expansion, substantial lands have been converted into monoculture oil palm plantations which includes forest lands, agricultural lands and peatlands (Koh et al. 2011). This massive land conversion into monoculture oil palm plantations has created global concerns mainly on the environmental and social impacts especially related to deforestation. Although at global level forests have become the capital for development in almost every civilization and in different timelines (FAO 2012), forest resources have been increasingly valued as being the last bastion for conservation (Perfecto & Vandermeer 2008).

Global markets have been increasingly required more sustainable oil palm productions. Responding to this, many certification schemes on oil palm production and oil palm products have emerged to

promote sustainable oil palm production. At the global level, RSPO has become the most prominent certification system in which the criteria were developed especially to meet the market in the EU and USA. The design of RSPO was not intended to be applied to small-scale oil palm producers (Brandi et al. 2015). Although elaborations have been made, certified oil palm plantations are mostly managed by large scale companies (RSPO 2019).

As response to the fact that limited oil palm producers were able to meet the RSPO standards, the Ministry of Agriculture has drawn up a mandatory certification policy system for sustainable oil palm production which is called Indonesian Sustainable Oil Palm (ISPO) certification system which was launched in 2009, first implemented in 2011 and enacted by Presidential regulation no 44/2020. By March 2019, nearly 30% of total oil palm plantations in Indonesia were ISPO certified (Anggraini 2019). In addition, the Government of Indonesia also issued the Presidential Instruction No. 10/2011 on natural forest and peatland moratorium which has been renewed every year and in the last renewed Presidential Instruction (No. 8/2018) also includes replanting programs to improve the productivity of smallholder oil palm plantations.

However, more efforts are required to result in sustainable oil palm production and to solved the root problems which lies in the social relations of nature in the production of oil palm (Pye 2019). Many environmental and social problems linger around the production of oil palm and have created increasing global concerns. For example, there are around 3.4 million ha or around 20% of the total oil palm plantations in Indonesia have occupied the state forest areas (Auriga 2019).

The EU decision in excluding palm oil as a biodiesel source starting in 2019 is a strong indication of this global concern. This EU decision on the use of palm oil as biodiesel has influenced global commodity market for oil palm products and especially Indonesian economy as the world´s largest oil palm producer. Although it is still growing, the growth of monoculture oil palm plantations in Indonesia has been decreasing in the last ten years because the global market for vegetable oil is nearly saturated and the uncertainty of global market of biofuels is increasing. It is estimated that the annual growth of oil palm production around 1.8% in the coming ten years (FAO 2019b). Responding to this situation, the Government of Indonesian (GoI) has promulgated 20% (B20) renewable energy blended policy with palm oil biodiesel (The Jakarta Post 2018). This energy blended policy has been increased to 30% (B30) by 2019 and in the future the target will be 100% (B100). These policy measures have been seen as viable alternatives to boost domestic consumption of crude palm oil (CPO) and to reduce fossil fuel imports (The Jakarta Post 2019).

Indonesia Social Forestry (SF) Program and OPAF

SF is a government program started in 2007 on promoting sustainable forest management within the state forest areas or customary forest/ private forest operated by local/ customary community. The SF initiative is an integral part of the national program on equitable economy. The SF aims at contributing to the improvement of community welfare, environment and social capital. In the operational level, SF could be in the various schemes namely village forest, community plantation forest, community forest, customary forest, forestry partnership or private forest. These schemes were formulated to accommodate the diversity in tenure status, forest types, community groups and therefore the management and utilization of the forest resources.

Prior to the SF program, the acceptance and the awareness of communities' roles in forest managements were limited. Regulations were

promulgated to support the roles of communities in forests management but the progress of granting permits to communities had been relatively slow. The SF program is part of the government efforts to accelerate the process of granting permits to communities by resolving forest land tenure conflicts and enhancing community participation in forest management. Around 12.7 million ha of forest lands are allocated for SF program nationwide. By January 2021, around 4.3 million ha have been reallocated into SF license holders in the form of various SF schemes (MoEF 2021).

In practice, many of these forest lands which are reallocated to SF license holders are already in the form of monoculture oil palm plantations. In this case, the license holders should manage at least 100 perennial trees to form OPAF and could keep their oil palm trees until they reach 12 years old as regulated by Ministry of Environment and Forestry (MOEF) No. 83/2016 on social forestry. Thus, OPAF could become one of alternatives to address and reconcile environmental and social aspects towards more sustainable oil palm production within SF schemes.

Agroforestry Adoption

Agroforestry adoption involves complex processes compared to traditional agriculture because the mixed input-output and multiproduct nature of agroforestry could demand more complex management and longer period of testing (Mercer 2004). Studies on agroforestry adoption have identified factors that could influence the process of agroforestry adoption namely (a) preferences which include age, education, gender and socio-cultural status, (b) resource endowments which include income, assets, labour, livestock and credit/savings, (c) market incentives which include potential income gain, distance to market and price effect , (d) biophysical factors which include soil quality, slope, plot size and irrigation, and (e) risks and uncertainties which include tenure, experience, extension and trainings as well as membership of community organization or cooperative (Pattanayak et al. 2003).

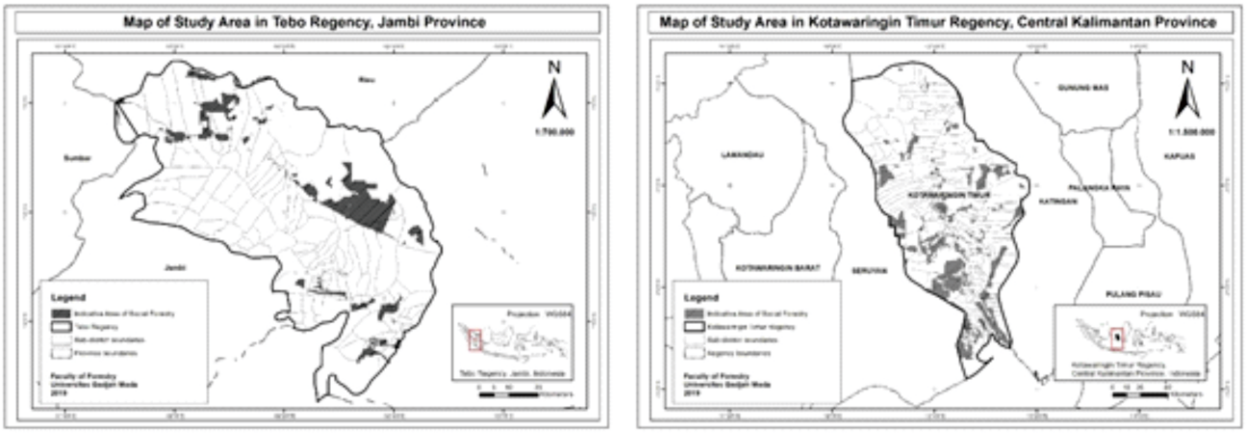
In addition, barriers of agroforestry adoption have also been identified. These include (a) knowledge gaps about potential benefits and costs of the agroforestry innovation, (b) socio cultural strata which hindered the adoption, (c) unsuccessful past experience, (d) lack of capacity such as technical skills, (e) lack of external support such as technical assistance, planting materials and credit and (f) unsupportive legal and institutional framework (Powlen & Jones 2019).

Little is known about OPAF adoption as oil palm has been widely adopted as monoculture plantation worldwide. OPAF practices have been adopted in limited areas such in the rural areas of Indonesia and several other countries (Slingerland et al. 2019). It is also possible that OPAF practices are not well documented because it is relegated by prominent monoculture oil palm plantations

Materials and Methods

Study Area

This research was conducted in Tebo regency in Jambi province and Kotawaringin Timur regency in Central Kalimantan provinces of Indonesia (Figure. 1). In these two regencies oil palm has been expanding rapidly and increasingly becoming an important commodity. To support our objective, we specifically targeted villages which are located in the adjacent of Social Forestry (SF) allocation in the state forest areas and host oil palm plantation. This was done through spatial analysis by overlaying village maps, SF allocation maps, and the maps of oil palm plantations in the forest areas. Villages which have oil palm plantation in the forest areas and Social Forestry allocation areas are considered to be visited. The final



(a) (b)

Figure 1. Maps of study areas in (a) Tebo regency, Jambi province and (b) Kotawaringin Timur regency, Central Kalimantan province

Gambar 1. Peta lokasi penelitian di (a) Kabupaten Tebo, Provinsi Jambi dan (b) Kabupaten Kotawaringin Timur, Provinsi Kalimantan Tengah

Table 1. List of selected villages and the number of household sampled
Tabel 1. (Daftar desa terpilih dan jumlah rumah tangga contoh)

Province	District	Village	Total of household of sampled
Jambi	Tebo	Sungai Jernih	82
Central Kalimantan	Kotawaringin Timur	Bukit Bamba, Pamarunan, Karangsari, Pareggean	110

list of selected villages (Table 1) was produced through series of focused group discussions (FGD) with key informants which includes government officials, NGOs and village leaders.

Data Collection

Primary data collection was conducted through structured interview with questionnaires (Vaus 2013) to collect data on the major factors influencing smallholders' decision in adopting oil palm agroforestry (Appendix A). The questionnaires consist of open- and close-ended questions. The questionnaires were reviewed by experts at Universitas Gadjah Mada, partner NGOs and two village leaders and piloted with three households in Bukit Bamba village. Following the testing, a total of 192 households were interviewed in the two regencies. However, we excluded interviews that are incomplete and retained 187 households (see Table 1).

The interview was conducted in Bahasa Indonesia, but local (Jawa, Dayak and Melayu) languages were also used for better understanding about the questions. The interviews were conducted by researchers who speak Bahasa Indonesia and at least one of local languages. A purposive sampling strategy was applied in which the households were selected based on the criteria (a) households are practicing agriculture and one of the income sources and (b) households are living in the village permanently. The lists of households which fall into these criteria were gained from the village leaders of the corresponding villages. The households were approached and asked to participate in the study. Specific questions were asked for their consent.

The interview instrument measures the level of household oil palm adoption by asking whether or household combine oil palm with other trees species or not (binary). If the answer is 'yes' additional information about the oil palm agroforestry were collected. These include year of oil palm and trees were planted, species of trees planted and the parcel(s) where the trees were planted.

The household characteristics collected during the fieldwork include (a) age, (b) gender, (c) year of

stay in the associated village, (d) the number years (length) of education and (e) number of family member. The biophysical characteristics were self-reported by the respondents. The respondents were asked to report the number of the parcels they manage and to estimate the size of each parcel in hectares. The total size of the landholding is the sum of parcel sizes.

To measure the motivation for adopting OPAF we asked perceptions about OPAF. A total of 11 statements were used to construct perceptions about OPAF outcomes on (a) household income, and (b) environment. The respondents responded to the statements with their level of agreement on a five-point Likert scale ranging from strongly agree (score 5) to strongly disagree (score 1). Statements used to measure the outcomes of OPAF on household income referred to (a) household income, (b) profit of the farm, (c) income stability, (d) risks of failed harvest, (e) coping with price volatility and (f) household food security. Statements used to measure environmental outcomes of OPAF referred to (a) quality of environment in general, (b) soil fertility, (c) water availability, (d) use of pesticides/ herbicides and (e) availability of livestock fodder. In addition, to measure the barrier in adoption OPAF we also asked perception about OPAF outcomes on (a) willingness to adopt, (b) compensation for adoption, (c) production of oil palm fruits and (d) farm management.

For better understanding about the local context, focused group discussions (FGD) with key informants were conducted and digitally recorded and transcribed. Two FGDs were conducted in Tebo district and three FGDs were in Kotawaringin Timur district. Secondary data such as maps (administrative boundary, social forestry allocation, oil palm plantations) and statistics (related to forestry and oil palm) data were collected from government agencies, NGOs and online repositories.

Data Analysis

All quantitative data analysis was conducted in SPSS version 20. A principle component analysis (PCA) was run to group the perception statements about the outcomes of the OPAF on household income and environment. A reliability test was conducted to examine the strength of variable within the groups. Two new variables, household income and environmental motivation, were formulated after presenting acceptable values of both Cronbach's alpha (α=0.65) and corrected item correlation (>0.4) (Powlen & Jones 2019). The formulation of these two variables was done by taking the mean of the statement in each group. The household income variable was constructed by six statements and the environmental variable was constructed by five statements.

Three binary logistic regression models were constructed for the binary dependent variable. The first binary logistic regression models the relationship between two motivation variables and the binary dependent variable. The second model added household and biophysical characteristic variables (a) year of education, (b) year of stay in the associated village, (c) whether or not having second job, (d) number of family members with age between 15 and 60 and (e) size of total landholding. The third logistic regression model added dummy variable to the second model. This dummy variable accounts for differences between districts which were not controlled in the household level variables included in the regression models.

A bivariate correlation analysis was executed between all independent variables to examine multicollinearity before executing the regression analysis (Table 2). The tolerance (< 0.1) and Variance Inflation Factor (> 10) become the criteria in identifying multicollinearity (Obrien 2007). In the logistic regression models, the evaluation criteria for

the relationships were odd-ratios (Exp (β)) and the significant values (p) for the relationships between each independent variable and the dependent variable. For each regression model AIC was used to measure the fitness of the models.

Results

Characteristics of the Households

A total of 187 interviews were used in the final analysis after removing incomplete interviews. Among the 187 respondents, 91% were male and 9% were female. The average age of the respondents was 46 years with average education of nine years. Around 79% of the respondents were migrants to the corresponding villages which were indicated by the less average years of stay in corresponding village compared to their average age. They have come to the corresponding through various modes of migrations such as (a) transmigration programme, (b) placement for their jobs and (c) independently by family or friends connections. Around 71% of the respondents have identified that being a farmer was their main job. Around 29% of the respondents have identified that farming is not their main job but farming has becoming one of the households' income sources. Around 51% of the respondents have second job in addition to their main occupation. The average total landholding was 3.62 ha with the quartiles of the landholdings are 2.00 ha, 3.00 ha and 4.06 ha. The most prominent type of farms was oil palm plantation (82%).

The T-test was employed to identify variables which significantly different between respondents who adopted OPAF practices and those who did not adopt OPAF practices (Table 3). Respondents who did not adopt OPAF practices tended have longer year of education and bigger size landholding but have less number of family member with age between 15 and 60. They also have lower perception on household income and environmental benefits from OPAF practices.

Table 2. Independent variables correlation
Tabel 2. Korelasi antara variabel-variabel bebas

Independent variable correlation							
	1	2	3	4	5	6	7
Age							
Year of education	-0.249**						
Year of stay	0.159*	-0.125					
Second job	-0.237**	0.217**	0.025				
Number of family members with age between 15 and 60	0.083	0.027	0.285**	0.026			
Total landholding	0.134	0.087	-0.010	0.051	0.139		
Household income motivation	-0.064	-0.182*	0.042	-0.020	0.144*	-0.120	
Environmental motivation	-0.131	-0.256**	0.118	0.045	0.057	-0.196**	0.692**

Remark: *p<0.1; **p<0.05; ***p<0.01; n = 187
Keterangan: *p<0.1; **p<0.05; ***p<0.01; n = 187

Table 3. T-test results (mean and standard deviation) of household and biophysical characteristics of respondents who practice and did not practice OPAF
Tabel 3. Hasil Uji T (rerata dan deviasi standard) karakteristik rumah tangga dan biofisik dari responden yang mempraktekkan dan yang tidak mempraktekkan agroforestri kelapa sawit

Variable	OPAF (16 respondents)	No OPAF (171 respondents)	*p*-values
Age	44.50 (10.185)	46.19 (10.894)	0.551
Years of education	6.56 (3.829)	9.24 (4.161)	0.014**
Years of stay in the corresponding village	27.69 (7.726)	27.39 (12.377)	0.925
Number of family members with age between 15 and 60	3.00 (1.033)	2.59 (1.230)	0.199**
Total landholding	3.39 (1.559)	3.64 (3.242)	0.758
Household income motivation	3.62 (0.611)	3.12 (0.825)	0.018**
Environment motivation	3.85 (0.626)	3.19 (0.898)	0.005***

Remark: *p<0.1; **p<0.05; ***p<0.01; n = 187
Keterangan: *p<0.1; **p<0.05; ***p<0.01; n = 187

Table 4. Results of binary logistic regression analysis
Tabel 4. Hasil analisis regresi logistik biner

	Dependent variable: Adopt OPAF or not		
Independent variables	Model I	Model II	Model III
Household income motivation	1.190	1.177	0.511
Environmental motivation	2.171*	2.118	1.281
Year of education		0.812***	0.800**
Year of stay		0.968	0.962
Second job		5.041**	4.378**
Number of family members with age between 15 and 60		1.634*	1.627
Total landholding		1.014	1.074
Dummy: Kotawaringin Timur			35.933***
AIC	106.827	103.317	95.311

Remark: *p<0.1; **p<0.05; ***p<0.01; n = 187
Keterangan: *p<0.1; **p<0.05; ***p<0.01; n = 187

Table 5. Respondents´ perception about the outcomes of OPAF on yields and farm management
Tabel 5. Persepsi responden tentang hasil panen dan pengelolaan kebun agroforestri kelapa sawit

Statements	strongly disagree	disagree	neutral	agree	strongly agree
I am willing to adopt OPAF	2%	30%	26%	26%	16%
I need no compensation to adopt OPAF	17%	14%	29%	35%	5%
OPAF produces less fruit yields	1%	11%	28%	41%	19%
OPAF demands more complex farm management	1%	9%	28%	51%	11%

Remark: n = 187
Keterangan: n=187

Factors Influencing OPAF Adoption

The binary logistic regression Model I with household income and environmental motivations in the equation (Table 4) shows that only environmental motivation was statistically significant with Exp (β) 2.171 and $p<0.1$. In Model II, year of education (Exp (β) = 0.812) was statistically significant with $p<0.01$, having second job (Exp (β) = 5.041) was statistically significant with $p<0.05$ and number of family member with age between 15 and 60 (Exp (β) = 1.634) was statistically significant with $p<0.1$. Model III, the final model, has percentage accuracy of classification (PAC) 91.4%. In this model, year of education (Exp (β) = 0.800) and having second job (Exp (β) = 4.378) were statistically significant with $p<0.05$ and district (Exp (β) = 35.933) was statistically significant with $p<0.01$.

In the Model III, the relationship between year of education and OPAF adoption is negatif (β = -0.223). Controlling for all other variables in the model, for every additional year of education will decrease the odds of a respondent in adopting OPAF by nearly 20%. The relationship between having second job and OPAF adoption is positive (β = 1.477). Controlling for all other variables in the model, respondents who have second job are more than four times as likely to adopt OPAF as those who do not have second job. The relationship between the district and the OPAF adoption is posyitive (β = 3.582). Controlling for all other variables in the model, respondents who were located in Kotawaringin Timur district are nearly 36 times as likely to adopt OPAF as those who were located in Tebo district.

Barriers in Adopting OPAF

Interview data identified that more than one forth of the respondents have neutral opinion on the statements about OPAF (Table 5). This could indicate that they have very limited information about OPAF. The reason could be (a) there is example of OPAF in their region but the OPAF is beyond the respondents' proximity or (b) there is sufficient example of OPAF but the respondents have no information about the OPAF practices and its benefits in their region. Around 42% of the respondents indicated their agreement on adopting OPAF.

Farmers percieved adopting OPAF as adding

other perennial trees, crops and/ or livestocks into their existing oil palm farm. In the case that additional perennial trees, crops and/or livestocks have potentially good price in the market, they need no compensation for each oil palm trees which are replaced by other trees. One respondent stated,*'As a farmer we will grow any plant which gives us a good price in the market'*. Around 40% of the respondents indicated their agreement on no compensation to adopt OPAF.

Many respondents also percieved that OPAF produces less fruit yields (60%) per hectare of their farm. This might be the case that within OPAF scheme the number of oil palm trees need to be reduced to provide sufficient spaces to other species/trees in each unit of land. This perception has created hesitation in adopting OPAF as expressed by one respondent from Kotawaringin Timur district that said, *'It is almost impossible to mix oil palm with other trees on one plot of land....The oil palm trees will be less productive or slowly die'*. The reason might be that there is no sufficient information on the benefits of OPAF at operational level in the region. However, some respondents have perceived that the adoption of OPAF will unnecessarily reduce the fruit yields in each unit of land. These respondents might see that the addition of trees species could potentially improve soil conditions and lead to the increasing of fruit yields as confirmed by recent study (Gérard et al. 2017).

Most of the respondents (62%) also perceived that adding other perennial trees and the integration with other crops or livestock breeding demands more complex farm management compared to monoculture oil palm plantations. This is mainly because respondents have seen that the integration of trees, crops and/or livestock in their farms as an additional task which could also have implication on additional costs.

Discussion

The final model (Model III) of regression analysis indicates that year of education has negative correlation with OPAF adoption. This might be that smallholders have percieved monoculture oil palm plantation is associated with progress and connection to the modern world and OPAF has been relegated as traditional farming strategies and less productive (Therville et al. 2011) and smallholders with higher education might have more exposure to modern world as they might pursue their education outside their villages and have possibilities to see other places than their own villages. In this case, the potential financial benefits of adding perennial trees or other crops in their farms might not be explored or there might no obvious potential markets for other commodities than oil palm in the region. These gaps of information could shape the perception of smallholders on OPAF (Fleming et al. 2019). The model also indicates that smallholders that have second jobs are likely to adopt OPAF. Having second jobs indicates that the smallholder households have more diverse income sources. Such smallholder households may take risks investing in various perennial trees, crops or livestock because farming is not their dominant source of income. The location of the smallholders has statistically correlated with the OPAF adoption. The location could be associated with tree planting tradition, reforestation program, or potential market for perenials tree products. In our case, we observed that there is increasing demand for timber with the establishment of a new timber processing factory in Kotawaringin Timur district. This might be percieved as market for timber produced from their OPAF. Income and distance to market variable affected smallholders´ decision in more than 50% and 70% respectively of studies on agroforestry adoption (Pattanayak et al. 2003).

This study suggested that knowledge gaps on

yields and management of OPAF become the main barriers of OPAF adoption. From this result we learned that OPAF demonstration plots might facilitate smallholders' experimentation to accumulate knowledge and experience in OPAF management and increase OPAF adoption. The demostration plots could also facilitate farmer-to-farmer communication to minimize language gaps in disseminating OPAF innovation (Martini et al. 2017). In addition, external supports in the form of technical assistance from the nearby Forest Management Units (FMUs), involvement of NGOs and Universities could also influence smallholders adoption (Powlen & Jones 2019).

We also suggest that further studies are needed to explore how regulations on mechanisms and the limitation of time frame to keep oil palm in the state forest areas within social forestry schemes will influence OPAF adoption by smallholder farmers and external supports in adopting OPAF especially supports from the government agencies at multiple levels.

Conclusion and Recommendation

Based on the analysis of the factors and barriers in adopting OPAF, we conclude that more efforts and collaboration among stakeholders are needed to eliminate the barriers of OPAF adoptions. This is especially in providing examples and filling the knowledge gaps on OPAF yields and management.

Beyond the factors and barriers we have analysed and discussed in this article, we would like to add several policy recommendations as follows:

(a) The time frame of keeping oil palm as regulated by Ministry of Environment and Forestry (MOEF) No. 83/2016 on social forestry should be adjusted to the actual conditions and evidence in the fields. In addition, within OPAF oil palm trees become holistic components of the agroforestry system and contributes to the stand structure formation and ecosystem functions. In this case, a regulation of certain time frame to keep oil palm is unnecessary.

(b) In addition, the Omnibus law No. 11/2020 mandated among others the agrarian reform in which forest lands become the important part of it and OPAF within social forestry schemes is likely to be adopted as one of alternatives to achieve the agrarian reform in forest lands. This could be a good momentum to revise the related regulations to support its implementation in the field, including the revision of Ministry of Environment and Forestry (MOEF) No. 83/2016 on social forestry.

(c) The oil palm yield from OPAF within the social forestry schemes should be considered as a legal non timber forest product especially during the transition (target period) from monoculture oil palm into fully OPAF. During this target period, farmers could sell their oil palm yields to the nearby oil palm mills (PKS). This is particularly important because farmer households could still earn from oil palm harvest while waiting for the harvests of newly added tree species. In addition, the government could also gain non-tax revenue (PNBP) from the oil palm yield as a legal non timber forest product within social forestry schemes.

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