Perceived Environment-Economic Benefits and Factors Influencing the Adoption of Indonesian Sustainable Palm Oil Production System by Smallholder Farmers

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Abstract. Palm oil industry plays a vital role in Indonesia economy. The palm oil industry can also support sustainable development since it is based on renewable natural resources. The contribution to sustainable development is hampered if oil palm production system, especially of smallholder farmers is not sustainable. Smallholder farmers consist of almost half of the total of oil palm plantations in Indonesia. The sustainability of oil palm farming of smallholder farmers may influence significantly to the overall sustainability. The adoption of Indonesia sustainable palm oil production system by smallholder farmers may improve the sustainability of oil palm farming. This study aimed to find out if perceived environment-economic benefit differed between conventional and sustainable oil palm farmers and to uncover factors affecting the adoption of Indonesia sustainable oil palm production system. The respondents were selected using a purposive sampling method, comprising of 313 conventional smallholder farmers and 167 smallholder farmers implementing Indonesian sustainable palm oil production system. A structured-questionnaire used to gather data. Descriptive statistics and logic regressions were utilized to analyse the data. The results show that the perceived environment and economic benefit is higher for farmers adopting sustainable palm oil production than conventional farmers. Several factors which were the age of farmer, formal and non-formal education, income, total land managed, the involvement of farmer in a cooperative, and environmental management did not motivate farmers to adopt Indonesian sustainable palm oil production system. While the experience of the farmers, family size, main job, involvement in farmer’s association, doing good cultivation practice, and plantation management influenced the adoption of Indonesian sustainable palm oil production.

1. Introduction
Palm oil industry plays a vital role in Indonesia economy, both national and local economy. In 2017, Indonesia exported 28.8 million tons of crude palm oil (CPO) with an export value of US $ 20.4 billion which grew an average of 6% per annum in the last five years [1]. Vast oil palm plantations and smallholder oil palm plantations contributed to the export value. Smallholder oil palm plantations cover 40% of the total planted areas. Data of [1] shows that the acreage of oil palm plantations in Indonesia is 14 million hectares, of which 5.6 million hectares are smallholder oil palm plantations. CPO production from smallholder oil palm plantations amounted to 12.7 million tons or 34% of Indonesia’s total CPO production. Smallholder oil palm plantations are the primary source of income for more than 3 million farmers. The economic role of the palm oil industry will become increasingly more important as the palm oil industry relies on renewable natural resources that have the potential to support Indonesia’s
economy and development over the long term. The palm oil industry can also support sustainable development since it is based on renewable natural resources.

For Indonesia, the development of oil palm plantations is not only an essential part of the economic growth of the agricultural sector but also concerns on rural development, as well as one of the efforts to alleviate poverty [2], [3]. This vital role of oil palm plantation is because oil palm plantations are developing new economic growth centres, creating jobs in rural areas and increasing people's incomes [4]. However, in contrary to having economic benefits and tangible contributions, the development of oil palm plantations is also perceived to cause social and environmental problems. Social issues include land conflicts [5] and social conflicts resulting from low bargaining power of the people [6]. Environmental issues facing oil palm plantations include the effect of greenhouse gas emissions due to the opening of new plantation land [7], degradation of wildlife habitat, loss of diversity [8], [9], [10] and chemical fertilizer pollution [11]. These societal and environmental issues should be reconciled if the sustainability of oil palm production is expected.

Oil palm plantation has also become the backbone of the farmers' household local economy, such as in Bengkulu Province. In Bengkulu Province, most of the oil palm plantation is a smallholder plantation (68%) involving 380 thousand farmers [12]. According to [13], the economy of smallholder oil palm plantations is highly sensitive and vulnerable to the fluctuation of fresh fruit bunches (FFB) prices because oil palm commodities are the primary source of the household income. Increasing adaptive capacity by boosting the productivity of smallholder palm plantations may decrease the vulnerability of oil palm farmers to FFB price fluctuation. Good management practices (GMP) may increase the productivity of smallholder farmers. The implementation of GMP in the management of large oil palm plantation proves that productivity increased to reach 5.7 ton of CPO per hectare per year or 24.3 ton of FFB per hectare per year [14]. The reduction of the gap between exploitable yield and realized yields or increased productivity or intensification of smallholder oil palm plantations has enormous potential to support economic growth, increased adaptive capacity of smallholder farmers, and the reduction of social and environmental problems arising from the extension of oil palm plantations [15].

The implementation of sustainable palm oil principles and criteria, such as Indonesian Sustainable Palm Oil (ISPO) can encourage the development of palm oil plantation industries to continue to provide economic benefits and minimize the negative impacts of oil palm plantations, both adverse social and environmental effects [16]. Reference [17] indicated that the smallholder plasma farmers implementing ISPO earned a higher income than non-plasma farmers who did not implement ISPO. However, various things such as socioeconomic factors of farmers [18], as well as farmer organizations and institutional contexts [19] can be obstacles to the adoption of ISPO in the management of smallholder oil palm plantations, in particular, smallholder non-plasma farmers.

By 2014, sustainable palm oil plantations have produced more than 12 million CPO with an increasing trend. Implementation of sustainable palm oil management provides benefits to producers, especially income benefit due to increased production and quality of CPO as well as offering better and more profitable prices. Also, market opportunities for CPO generated from sustainable oil palm plantations are more open [19]. In Indonesia, the implementation of sustainable palm oil is either mandatory or voluntary. Oil palm plantation companies are required to implement sustainable palm oil management, while the adoption of sustainable oil palm plantations of smallholder plasma and non-plasma farmers is optional. According to [19], the existence of oil palm plantations of the smallholder non-plasma and the livelihood of farmers is vital from the perspective of development and environment. The participation of smallholder non-plasma oil palm plantations in the implementation of sustainable palm oil management will improve the practice of plantation management to reduce environmental impacts due to the improvement of agricultural chemicals applications. Also, the application of Indonesia sustainable palm oil will increase the potential for economic benefits due to improved yields [20] as well as more open market opportunities for palm oil produced from sustainable oil palm plantations due to consumer demand [21]. The contribution of oil palm plantation to sustainable development may be hampered if oil palm production system, especially of smallholder farmers is not sustainable. The adoption of Indonesia sustainable palm oil production system by smallholder farmers may improve the sustainability of oil palm farming. The sustainability of oil palm farming of smallholder
farmers will contribute significantly to the overall sustainability of the oil palm industry. A study that provides an overview of the challenges and interventions that can be applied to sustainable palm oil plantation implementation on smallholder plantations has not been widely implemented [19]. Therefore, research that can encourage and facilitate the adoption of sustainable palm oil of smallholder plantations is needed. This study aimed to find out if perceived environment-economic benefit differed between conventional and sustainable palm oil farmers and to discover factors affect the adoption of Indonesia sustainable palm oil production system.

2. Materials and Methods
This study was conducted in Bengkulu Province with respondents span to two district locations, namely North Bengkulu and Central Bengkulu Districts. The respondents were smallholder farmers not implementing ISPO (65.2%) and smallholder farmers implementing ISPO production system (34.8%), as shown in table 1.

| No | District          | Non-ISPO | ISPO  | Total |
|----|------------------|----------|-------|-------|
| 1  | Central Bengkulu | 173      | 67    | 240   |
| 2  | North Bengkulu   | 140      | 100   | 240   |
|    | Total            | 313      | 167   | 480   |

The analysis of perceived environment-economic benefits of adopting sustainable palm oil management mainly utilized "with" and "without" implementation approach, as described by [22]. Ordinal scale response of the question was assigned 1 if the answer to the question about the perception of environmental and economic benefits was answered by the respondent with "Strongly disagree" and assigned 2 to 5 if the answer to the question about the perception of environmental and economic benefits was answered by the respondent "Disagree", "Neutral", "Agree" and "Strongly agree". The responses then were compared using a mean comparison between the perceived benefits of smallholder farmers and smallholder farmers adopting ISPO.

While the data and information for the analysis of the influencing factors collected primarily include data on the demographic and socio-economic characteristics of respondents as well as farmer activities related to the group of farmers, cooperatives, implementation of good agricultural practices, estate, and environmental management.

Data collection was carried out through interviewing respondents using a questionnaire. The questionnaire was in the form of open questions and questions with dichotomous answers accompanied by opportunities to elaborate the answers. The questions in the questionnaire were intended to identify the demographic and socio-economic characteristics of the respondents as well as farmers' activities related to farmer activities in farmer's group, cooperatives, the implementation of good agricultural practices, estate, and environmental management.

Data on demographic and socioeconomic characteristics and activities of respondents collected were used as explanatory variables, including:

a) Age. Age is a continuous variable.

b) Formal education. Formal education indicates the level of education of respondents that are binary variables with a score of 1 for the level of education that is less than high school and a value of 2 for the level of high school education and higher.

c) Non-formal education. Non-formal education is an education that was once followed by respondents, including agricultural extension and farming courses. Non-formal education is a binary variable with a value of 2 for respondents who have attended non-formal education and a value of 1 for respondents who have never attended non-formal education.

d) Family size. Family size is the number of all family members who still live in one house with the respondent. Family size is a continuous variable.
e) Main job. The main work is the main job of the head of the household which is a binary variable with a value of 2 for respondents whose main occupation is farmers and a value of 1 for respondents whose main job is not a farmer even though they have an oil palm plantation and are respondents.

f) Income. Income is the amount of family income. Income is a continuous variable.

g) Farming experience. Farming experience is the number of years respondents have cultivated oil palm. Farming experience is a continuous variable.

h) Total land managed. The total area of land managed is the amount of agricultural land planted with oil palm, and the oil palm plantations have produced. Land ownership is a continuous variable.

i) Farmer group. Farmer groups are activities or involvement of respondents in the activities of farmer group organizations, such as farmer groups and farmer contacts. The organization is a binary variable with a value of 2 for respondents who are involved or active in a farmer group organization and a value of 1 for respondents who have never been active in the organization.

j) Cooperative. Cooperatives are activities or involvement of respondents in the activities of cooperative organizations, both as administrators and members. The cooperative is a binary variable with a value of 2 for respondents who are involved or active in a cooperative organization both as administrators and members and a value of 1 for respondents who have never been active in cooperative organizations.

k) Good cultivation practices. The best cultivation practices are respondents' activities in the management of oil palm plantations by implementing the best cultivation practices. The best cultivation practice is a binary variable with a value of 2 for respondents who actively implement the best cultivation practices in oil palm plantation management and a value of 1 for respondents who have never actively implemented the best cultivation practices in the management of oil palm plantations.

l) Plantation management. Plantation management is the respondent's activity in the management of oil palm plantations based on the technical guidelines for oil palm cultivation. Technical instructions in cultivation are binary variables with a value of 2 for respondents who manage oil palm plantations based on technical guidelines for oil palm cultivation and a value of 1 for respondents who have never been active in managing oil palm plantations based on technical guidelines for oil palm cultivation.

m) Management of the environment. Environmental management is a respondent's activity in managing oil palm plantations by implementing environmental management. Environmental management is a binary variable with a value of 2 for respondents who actively implement environmental management in oil palm cultivation and a value of 1 for respondents who have never actively implemented environmental management in oil palm cultivation.

The binary scale response variable $Y = 2$ if the respondent answered the response to the question about the adoption of Indonesian Sustainable Palm Oil (ISPO) with “Yes”, while $Y = 1$ if the respondent answered with “No”.

Data analysis in this research was conducted in two stages, i.e., 1). Exploratory data analysis to get the picture in detail regarding the socio-economic and demographic characteristics of the sample, and 2). Logistic regression analysis which includes the prediction function equation logit model parameters, test parameters, and interpretation of the results of the logistic regression. Regression analysis was used to assess the influence of socio-economic and demographic factors and analysis of response variables of perceived environment-economic benefits.

The regression model used is a logistic regression, because it can describe relationships between multiple explanatory variables with an independent response dichotomy (binary). Logistic regression analysis was performed with the logit transformation as described in [23]. Test-G used to assess the explanatory variables, while the statistical test-Wald used to test parameters $\beta_j$ partially one by one on $\alpha = 10\%$.

3. Results and Discussion
Demographic and socio-economic characteristics of farmer respondents based on the results of the survey showed that the age of respondents ranged between 19 to 82 years old with an average age of 48 years. The family size is between 1 person per family up to 7 people per family with an average of 4
people per family. Income of the family ranged between Rp.700,000,- to Rp. 20,000,000,- with an average income of Rp.3,870,000,-. The farmer experience in managing oil palm plantation varied between 1 year to 36 years of experience with an average experience of 8.5 years. The total area of land managed varied between 0.25 to 10 hectares with an average land managed of 1.25 hectares. The demographic profile of farmer respondents presented in Figure 1.

Figure 1. The demographic profile of farmers

Overall, the majority of farmers in the productive stage of age which were 31 to 50 years of age (63%) with 6 to 15 years of experience in oil palm farming (76%). However, most farmers only manage plantation with acreage of 2 hectares or less (73%). From the level of educational attainment, most of the respondents graduated from Elementary to Junior High School (68%) and did not have non-formal education experiences (93%), such as farmer training courses and agricultural extension.

The proportion of farmer activities showed in table 2. The results indicated that more than half of farmers tend to inactive in farmer’s association and cooperation, and are not implementing good cultivation practices, plantation and environment management. Table 3 presents the results of logistic regression analysis to determine demographic and socio-economic factors that influence the adoption of ISPO of respondent farmers. The perceived environment-economic benefit is higher for farmers adopting ISPO than smallholder farmers not adopting ISPO. Some factors, such as the age of farmer, education, income, farm acreage and the involvement of farmer in cooperation did not influence the adoption of ISPO by smallholder oil palm farmers. While other factors, such as family size, the main
job as oil palm farmer, years of experience, the involvement of farmer in association and implementation of good cultivation practices affected the adoption of ISPO by smallholder farmers.

Table 2. Activities of farmers.

| No | Items                                | Yes (%) | No (%) |
|----|--------------------------------------|---------|--------|
| 1  | Involvement in farmer's association  | 41      | 59     |
| 2  | Involvement in cooperation           | 6       | 94     |
| 3  | Implementing good cultivation practices | 39     | 61     |
| 4  | Implementing plantation management   | 42      | 58     |
| 5  | Implementing environment management  | 11      | 89     |

Table 3. Deviance table.

| Source                      | DF  | Adj Dev | Adj Mean | p-Value |
|-----------------------------|-----|---------|----------|---------|
| Regression                  | 13  | 244.13  | 18.78    | 0.000   |
| Age of farmer               | 1   | 2.41    | 2.41     | 0.121   |
| Formal education            | 1   | 0.56    | 0.56     | 0.456   |
| Non-formal education        | 1   | 1.45    | 1.45     | 0.229   |
| Family size                 | 1   | 4.28    | 4.28     | 0.039   |
| Job                         | 1   | 4.12    | 4.12     | 0.042   |
| Income                      | 1   | 1.39    | 1.39     | 0.239   |
| Years of experience         | 1   | 12.33   | 12.33    | 0.000   |
| Farm acreage                | 1   | 2.09    | 2.09     | 0.149   |
| Farmer’s association        | 1   | 9.95    | 9.95     | 0.002   |
| Farm cooperation            | 1   | 2.06    | 2.06     | 0.152   |
| Good cultivation practice   | 1   | 36.63   | 36.63    | 0.000   |
| Plantation management       | 1   | 6.14    | 6.14     | 0.013   |
| Environment management      | 1   | 1.80    | 1.80     | 0.180   |

The higher the numbers of household and the longer the farmers experience, the more likely the farmer adopts ISPO. The respondent who the main job is smallholder oil palm farmer tends to implement ISPO. Also, the farmer who involves in the farmer’s group and implements good agriculture practice and plantation management is more likely to adopt ISPO.

4. Conclusions
The perceived environment and economic benefit are higher for farmers adopting sustainable palm oil production than conventional farmers. Several factors which were the age of farmer, formal and non-formal education, income, total land managed, the involvement of farmer in a cooperative, and environmental management did not motivate farmers to adopt Indonesian sustainable palm oil production system. While the experience of the farmers, family size, main job, involvement in farmer’s association, doing good cultivation practice, and plantation management influenced the adoption of Indonesian sustainable palm oil production.

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