Study on sustainability status of smallholder oil palm plantations Jambi Province, Sumatra Indonesia

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Abstract. The growth of oil palm plantations in Indonesia is growing rapidly. Issues of oil palm plantations that are not environmentally friendly are continuously exposed. The purposes of this research are, 1) To determine the role of smallholder in managing oil palm plantations, 2) To analyse the status of sustainability of oil palm plantations, 3) To find sensitive attributes that affect the sustainability of smallholder oil palm plantation management. Analysis method is to answer the first objective which is done descriptively, the second objectives was conducted with MDS approach, with Rappalm, third objectives are to analyse attribute lever was conducted with Leverage analyse. The result of the research is that smallholders can cultivate oil palm plantations. The status of sustainability indicated a very sustainable status (80.41), meaning that economic factors and social factors leverage ecological factors to be sustainable. This means that smallholder should improve the pattern of oil palm crop farming, with lever attributes, namely tree planting among islands of oil palm (plot scale). The integration of sensitive attributes, with the economic dimension and social dimension, produced a research output which have provide solutions sustainability of the smallholder oil palm plantation.

1. Introduction
Palm oil is one of the main commodities of the plantation sub-sector that attracts serious attention from the government, investors and farmers, especially since the 1990s. The actual development of oil palm industry in Indonesia began in 1970s, the period of the 1980s to the present was the era of quick development. Originally, the oil palm plantation actors consisted of the State Plantations (PBN), but at the same year also opened a room for the Private Large Plantations (PBS) and Smallholding Estates (PR) through the form of PIR (Perkebunan Inti Rakyat/ Nucleus Estate and Smallholder Scheme), and later developed into the private plantation forms [1].

The development of agribusiness-based palm oil plantation is a rural-oriented economic development. The target of development of the plantation sector should be to increase the income of rural communities and improve the welfare of farmers. Thus, the expected number of poor people, especially in rural areas can be reduced as even distribution of development; thus, making sustainable palm oil development for rural development that considers aspects of economic, social and environmental balance [2].

Data on the development of oil palm area from 1999 to 2016, the growing land area of oil palm plantations in Indonesia. The area of oil palm plantations from 1999 increased rapidly until 2016. In
1999, the area of oil palm plantation was 3,901.802 hectares. In the sixteen-year period it increased dramatically to 11,118.795 hectares. The total area managed by private companies covered 5,754.718 ha, 4,656.648 ha was managed by smallholders, and the remaining 707.429 ha was managed by state-owned enterprises [3]

Related to commodities, oil palm has a strategic role in supporting the growth of the Indonesian economy since the export of palm oil in recent years has continued to increase. Cumulative value for GDP of plantations continued to increase significantly, from Rp. 81.66 trillion in 2007 grew to Rp. 153,731 trillion in 2011 and continued to soar through the Rp. 159.73 trillion in 2012, or an average annual growth of 14.79% in 2015 [4].

Although the development of the plantation sector, especially oil palm plantations, is encouraging, there are many challenges related to environmental issues. There are many issues within the management and maintenance of oil palm plantations that are considered not environmentally friendly [5] although economically oil palms have provided an increased level of income for welfare. [6]. Oil palm crops have also led to changes in natural forests [7]. Furthermore, the behaviour of farmers who tend not to practice intensive plantation management, results in low productivity and tends to back rumours that oil palm crops are grown in monoculture at the farmers' garden level.

While it is believed that oil palm plantation development contributes greatly to rural development and farmer welfare, the management of oil palm plantations by farmers should pay attention to aspects that ensure environmental sustainability and social responsibility of the community. The hallmark of sustainable development is development that embodies current needs without diminishing the ability of future generations to realize their needs [8]. The concept of sustainable development in a region aims to fulfill the needs of people living independently based on the ability of natural resources, human resources, capital and technology without diminishing the ability of future generations [9]. To achieve that, it is necessary to know the status of sustainability. Sustainability can be categorized into levels of non-sustainable, less sustainable, adequately sustainable, and sustainable. To recognize the status, it is necessary to study the ecological, social and economic factors that are interrelated and can support the development of the region through sustainable development.

From the above, it is interesting to know the sustainability of the development of oil palm plantations by analysing the index and sustainability status. This can be formulated as follows:

1. What is the role of farmers in palm oil cultivation?
2. What is the status of sustainable management of smallholder oil palm plantations?
3. Any sensitive attributes that affect the sustainability of palm oil plantations managed by the smallholders.

The purposes of this research are:
1. To know the role of farmers in the oil palm plantation business?
2. To analyse the status of sustainability of smallholder palm oil plantation management.
3. To analyse sensitive attributes to the sustainability of smallholder palm oil plantation management.

2. Research method
This research was conducted in Mekar Jaya Village, Tabir Selatan sub district of Merangin, Jambi Regency, this village obtained RSPO certification in 2014. The sampling approach was independent self-reliant palm oil plantations with 44 households, respectively. Simple Random Sampling was applied.

2.1 Data Analysis
To answer the first objective of knowing the role of farmers used the analysis of categories: data analysis was done descriptively and conducted to determine the role of oil palm farmers in each dimension; that is ecological, economic and ecological dimensions were analysed by using the following percentage formula:
\[ P = \frac{\sum F}{\sum N} \times 100\% \]  

(1)

Note:
\( \sum F \) = Number of frequencies that appear
\( \sum N \) = Total number of respondents

\( P \) = Percentage

Subsequently, the measurement results of the role of oil palm growers were categorized according to the following:

| No | Percentage         | Criteria  |
|----|-------------------|-----------|
| 1. | 89\% - 100\%      | very high |
| 2. | 61\% - 88\%      | high      |
| 3. | 41\% - 60\%      | medium    |
| 4. | 12\% - 40\%      | low       |
| 5. | < 12\%            | very low  |

Source: [10]

To answer the second objective of analysing sustainability status was done using Multi-Dimensional Scaling (MDS) approach, with the Program Rapfish (Rapid Assessment Technique for Fisheries), technique that was developed by the Fisheries Center, University of British Columbia [11]. Based on Rapfish, modification of techniques was tailored to this study and in this study is called Rap-palm.

The data used to determine the status of sustainability is included in the primary data. These data include attributes related to the sustainability of community palm oil management, and include ecological, economic, and social dimensions.

The stages of the implementation of the analysis of oil palm oil sustainability are as follows: conduct review and determine attributes on each dimension of sustainability, i.e. ecological, economic, and social dimensions.

1. The ecological dimension consists of attributes:
   a. Land management without burning
   b. Conservation of undulating land / basin
   c. Use of pesticides
   d. Fertilization
   e. Planting tree crops among palm crops
   f. Selection of seeds
   g. Utilization of river border in the garden
   h. Leaving the tree plant in the basin location
   i. Utilization of midrib, harvest and post-harvest
   j. Use of seeds
  
2. The economic dimension consists of attributes:
   a. Marketing
   b. Marketing facilities
   c. Potential labour
   d. Area of land exploitation
   e. Market availability
   f. Market structure
   g. Production
   h. Availability of production inputs
i. Acceptance and prosperity of farmers
j. Pricing of palm oil

3. The social dimension consists of attributes:
   a. Level of education
   b. Experience of oil palm farming
   c. The social value of plants
   d. Gender
   e. Oil palm farming activities in community social activities
   f. How to clear land
   g. Role in the group
   h. Institutional village
   i. Tradition in palm oil management
   j. Knowledge of riparian area

[12]

The score value which is the index value / sustainability status of each dimension can be seen in Table 2.

| Category       | Status of sustainability |
|----------------|--------------------------|
| 0.00 – 25.00   | Bad (unsustainable)      |
| 25.01 – 50.00  | less (less sustainable)  |
| 50.01 – 75.00  | enough (enough sustainable) |
| 75.01 – 100.00 | Good (sustainable)       |

Source: [13]

MDS is a multivariate analysis method that can be used to analyse metric data (ordinal or nominal scale). This method is also known as one of the ordination methods in an ordination in dimension (ordination in reduced space). Ordination itself is a process of plotting the point of an object along the axes arranged according to an ordered relationship or in a graph consisting of two or more axes.

Through the MDS method, the sustainability point position can be visualized in the form of a triangle diagram, answer the purpose to the three used leverage analysis. The leverage analysis is to determine the sensitive/leverage attributes of each dimension. Leverage analysis is shown by Root Mean Square (RMS). The greater the RMS value changes, the more sensitive the role of the attribute will be to the sustainability status in the relevant dimension [14].

This MDS analysis will also generate stress values, R2, and Monte Carlo analysis. The stress value determines the Goodness of Rapfish. Low stress values indicate good fit, and vice versa. A good model is indicated by a stress value that is smaller than 0.25 (S < 0.25) while a good R2 value is approaching a value of 1. Monte Carlo analysis is determining the error in order to assess the uncertainty in MDS. If the MDS value difference with Monte Carlo value is small, then MDS analysis to determine sustainability is good enough with 95% confidence level. Uncertainty can be caused by errors in scoring that is a repetitive process. All these analyses form a package with the MDS program in Software/Rap-palm.

3. Result and Discussion

3.1 The Role of Oil Palm Farmers

The result of the role analysis shows that the farmers in the research location with the value of the role of 73.33 with the high category, the role that is done by the farmers is in the management of oil palm cultivation, and the role in the institution of the palm oil group and role in the effort to stimulate the increase family income and farmer welfare.
3.2 Status of Sustainability of Palm Oil Plant Management and Attribute

In each ecological dimension, the economic dimension and social dimension as well as the calculation of sensitive attributes are described in the subject below;

3.2.1 Ecological Dimension. The results of the MDS analysis on the Ecological dimension are shown in Figure 2 and the leverage analysis in Figure 3. The value of the sustainability status is 60.41 (quite sustainable). The sensitive attribute is attribute number 5, which is that farmers plant other trees among palm oil plants. Thus, other attributes will be supported by sensitive attributes.

Other attributes that need to be supported are, in the order of the highest value are:

1. The use of seeds according to the seedlings recommended by the BPDPKS, with the use of superior seeds such as Tenerra, Dura and Pisifera, the community at the research location has mostly used the type as recommended, because people realize that the use of good seed types will increase the level of productivity.

2. At harvest and post-harvest time, midribs and litter are collected, then covered around the garden to be used as organic fertilizer. Some farmers do this.

3. Plant protection from pest attacks, not yet using biological protection, not yet using owls (for example Tyto alba) as predators. Farmers still use mousetraps manually.

4. Hydrological protection, such as making water collection pits and monitoring wells in the garden has not been done by many farmers. The wells are made only for the benefit of the household. But the irrigation in the garden remains guarded by farmers.

5. Allow pioneer plants and other forest plants to grow in the riparian area. Most of the farmers do it for the protection of the water system in the plantation and for the protection of the moisture of the land.

6. Some farmers use pesticides, use it to control pests, for example borer insects (Oryctes rhinoceros).

7. Land management and maintenance done without burning. At the time of the research, farmers no longer burn the land, because of the strict action against the burners by the police.

8. Conservation activities at the location of land with high concentration and not planted with oil palm crop, but with trees so that the water system is maintained. A small portion of the farmers do it.

9. Utilization of midrib, harvest and post-harvest.

10. Use of seeds, smallholders use seedlings as recommended.
3.2.2 Economical Dimension. The results of the MDS analysis of the economic dimensions shown in Figure 3 and the leverage analysis in Figure 4 show the value of the sustainability status of 95.51 (continuous). Sensitive attributes are number 9, namely income from oil palm farming that can support welfare of the farmer families. This means that this attribute becomes a key attribute to increase the position of other attributes. This attribute will be a multiplier effect for other attributes. Other attributes in the analysis results are still below the average value of MDS.

Starting from the highest results of the average results are:
1. Oil palm cultivation equipment are available at the site of the garden or at the village level. Farmers usually buy them at the sub-district level. They are found in the village but in limited numbers and types.
2. Potential of family labour in cultivating oil palm crops; available family labour, available enough to process oil palm. However, harvest time still needs additional labour, such as neighbours and families.
3. Convenience in the marketing of palm products. Marketing TBS (oil palm fruit fresh bunches) oil palm plants is always done in the village, some are sold individually and not in groups at lower selling prices.
4. Extent of oil palm plantations at the level of the research location varies. There is a maximum of 4 hectares, there are 1- and 2-hectare plantations. Because the location of the study is the location of self-help farmers, so the area varied.
5. Farmers' strength in competing with price, some farmers can determine where to market their crops, without any connection to middlemen.
6. A small part of the market is concentrated in a centrally located village and is organized by an oil palm fruit collector/buyer at village level (toke)
7. Production results can overcome the economic problems of farmers, although the level of productivity is still low compared to the level of ideal productivity. However, if prices improve farmers can send their family members to school.
8. Market information is always available at the production plant level and in the village. Usually the information is given by groups with interests at the provincial level. Market price comes from the information of Jambi Provincial Plantation Office.
9. Income from oil palm farming that can support welfare of the farmer family.
10. Determination of the price of oil palm at the village level is still controlled by the middlemen, but not much. Some farmers have been able to master this linkage to middlemen.
### 3.2.3 Social dimension

The results of the MDS analysis of the social dimension shown in Figure 5 and Figure 6 are analyses of sensory attributes, namely the social dimension of the sustainability status value of 91.54 (continuous). Sensitive attributes/levers are attributes of numbers 1 and 9, education level farmers, because with high education, farmers can overcome other attributes that still produce a small value from the average value. Furthermore, the second social dimension whose attributes are above average are the attributes of tradition in the work done by farmers in the research village.

While other attributes that need to get support whose value is still below the average leverage scale are the attributes:

1. Education level of farmers.
2. How to open farming land, there are still those who do it individually, but the farmers begin to realize to form an oil palm plantation group.
3. Farmers are quite active in social activities, and it is this value that supports the value of sustainability in the social dimension.
4. The active role of farmers in the institutional groups of oil palm plantations, some farmers have joined together.
5. The participation of female workers in oil palm farming activities is partly there, but not in all activities of cultivating oil palm. Women are involved in taking the fallen loose fruit of fresh fruit bunches and bringing them to a location to be transported for market.
6. Institutions and organizations that exist in the village, enough to support the market of oil palm crops. There are Village Unit Cooperatives (KUDs) in the supporting villages palm oil market.
7. Knowledge of the protection of oil palm crops in the village, some farmers earn from the experience of farming over generations.
8. Experience in farming methods obtained from parents, then learning from neighbours or friends who plant oil palm in the vicinity.
9. Farmers' perception of kinship values in giving knowledge about cultivating oil palm plantations. Some farmers say it is very important.
10. Knowledge of riparian area.

### 3.3 Multidimensional Analysis

Taken together the ecological dimension the economic dimension and social dimension were analysed using Multidimensional Scaling (MDS), depicted in Figures 7 and 8, with a total value of 80.44 (sustainable) community palm oil management.
The results of the assessment with a continuous status category, this value of total analysis MDS = 80.43 was obtained in the assessment of 30 attributes. Of the three dimensions, namely the dimensions of ecology, social and economy the triangular leverage indicates that the integration resulting from the three dimensions simultaneously has been good, shown in good sustainability status, meaning that the three dimensions still have a have a less point on the deficiency of the MDS value on the ecological dimension. Therefore, to realize sustainable rural economic development, economic, social and ecological aspects must be integrated.

From the economic dimension, palm oil has improved the economy of rural communities. Creating multiplier economic growth in the form of income increase, farmers’ income has been able to sustain the welfare of farmers and can improve the level of education of farming families. It has also been able to increase the high kinship for institutions that have a role in economic and social dimensions. The social dimension has shown the attributes of education and the traditions of oil palm cultivation by palm oil growers. Although it is not high enough, the status value is quite sustainable in ecological status, but has also contributed to the environmental sector.

Therefore, other attributes must be triggered to be able to contribute to the ecological sustainability. There is a positive correlation between ecological, economic and social aspects. This, while improving the economic aspect, will be followed by ecological and social aspects, and vice versa. [15]

According to [16] Sustainable palm oil plantation is the activity of plantation sub-sector. Especially palm oil has become a primadonna and a significant contributor to the Indonesian economy. But its management must pay attention to aspects of sustainability from economic, social and ecological aspects. At present, the development of plantations, especially oil palm, often does not consider the environmental aspects. This is evident from the results of the integration that shows the ecological dimension being the weakest dimension.

According to [11], conventional development has succeeded in increasing economic growth but failed in social and environmental aspects. Therefore, sustainable palm oil plantation development is required.

Development of sustainable agriculture, according to [17], is to conserve land, water without damaging the environment, can be technically appropriate, economically feasible and socially acceptable.

Sustainability indicators are tools used to provide information directly or indirectly about a system in the future from various dimensions such as ecology, economics and social aspects. Its use becomes important for consideration in the planning and development of the next system.

In [11], classify sustainability indicators into two types:
1. Condition indicators, i.e. indicators that explain the current state of the system relative to expected conditions.

![Figure 7. Triangle Value of Sustainability and Index of Smallholder Oil Palm Farm](image-url)

![Figure 8. Results of Multi-Dimensional Analysis Integration](image-url)
2. Trend indicators, these are changes in the system based on the time dimension so that it can be used to monitor the tendency that will occur in the system.

Development is a dynamic change towards better conditions. In principle, development is an effort made to achieve a better condition [11]. Development is not just a mere condition or living conditions, but a process that will continue to lead to a better situation than previous conditions.

Development process that utilizes natural resources is often done without regard to environmental sustainability, so that there will be an imbalance or disturbance to the environmental ecosystem. Therefore, during the past decades, experts have established the concept of sustainable development.

Sustainable development is essential for fulfilling human needs and improving the quality of human life. At the same time, development must be based on efficiency and limited use of community resources, natural, human, social as well as economic resources.

This concept is in line with sustainable development globally [18] "Sustainable development is development that embodies current needs without reducing the ability of future generations to realize their needs". Since late 1980s, studies and discussions to formulate a universally sustainable, operational and accepted concept of sustainable development has continued to be in various dimensions and components. They are based on three pillars: economic pillar, social pillar and ecological pillar [18].

With the word sustainability, economic sustainability (profit), the continuity of human social life (people), the sustainability of the natural ecology (the planet), comes the pillar of Triple-P. Sustainable development is development that has the following characteristics:

1. Profitability and economic viability. Farmers can generate profits in a stable production level.
2. Ecological sustainability. Agroecosystem quality is maintained or enhanced, by maintaining ecological balance and conservation of biodiversity. Where ecologically sound agricultural system is a healthy agricultural system and has high resistance to pressure and disturbance.
3. Social justice. Agricultural system that has social character that can guarantee the existence of justice in access and control of land, capital, information and markets for those involved without distinguishing the social, economic, gender, religious or ethnic groups.
4. Humanity and respect of local culture. Respect the existence and treat wisely all kinds of efforts that exist where agricultural development takes place. That is, agricultural development can adapt to ever-changing conditions, such as population growth, new policy challenges and changing market systems.

According to [15] sustainable development is viewed from the aspect of human well-being, a development that has techniques and ways to maintain and sustainably improve welfare in terms of ecological, social, and economic sustainability aspects. The same thing was also expressed by [15] that sustainable development is interrelated between economic, social and ecological systems so that studies on sustainable development and welfare are synergistic studies. The study of human welfare is also a study of sustainable development and vice versa that cannot be separated from each other.

4. Conclusion
The instinct of farmers' farming is quite sustainable, as shown by some farmers who are already practicing sustainable farming, with ecological, economic and social considerations. Proven 30 attributes were analysed with MDS and leverage analysis, showing:

1. Economic dimension of the value of its sustainability status is 95.51 (continuous). Sensitive attribute/lever number 9 is the increase in farmer's income that can improve the welfare of the farmer's family.
2. Social dimension of the value of sustainability status is 91.54 (continuous) attribute sensitive/leverage, attribute number 1 is the level of education of farmers and attribute number 9 is the tradition of farmers in the cultivation of coconut plants, which still retain traditional values.
3. Ecological dimensions for the sustainability status value is 60.41 (quite sustainable). Attribute sensitive/leverage: attribute number 5, i.e. farmers plant other trees among palm oil crops, such as jackfruit, mango, durian, sungkai (Peronema canescens), petai (Parkia spp.) and jengkol (Archidendron pauciflorum).

4. Finally, multidimensional (integrated) status value is 80.43. This means that the status is in the sustainable category.

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