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Environmental Indicator of Oil Palm Cultivation for Smallholder Farmers

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Abstract. The growth and performance of yield production of oil palm are depending on the good agricultural practices (GAP). Fundamentally, the sustainability of an agricultural land can be achieved through the implementation of GAP by oil palm farmers. The GAP is carried out by farmers to make sure the oil palm product meets the requirement of food security, safety, quality and environmental protection. However, it is not well-practiced by smallholder farmers due to limited knowledge and exposure on sustainable agriculture practices. Thus, the aim of this study is to develop a set of indicator for tracking and assessing environmental sustainability of oil palm cultivation for smallholder farmers. The set is developed through the specific objectives that are to examine the purpose of GAP, to review environmental indicator in the agriculture sector, and to recommend the environmental indicator to be adopted by smallholder farmers in oil palm cultivation context. The indicator of oil palm cultivation is assessed using content based analysis and interview. Meanwhile, the recommended environmental indicators are divided into three farm phases, namely farm preparation, management, and production. The set is basically used to test the sustainability of oil palm farm for the development of better quality of life between smallholder farmers in terms of environmental aspects. Later on, it would lead to the environmental, social, and economic sustainable development in the long run as the overall purpose of the study is to create awareness of a quality project design, and monitor, as well as manage the cross-cutting issues of the environmental aspects.

Keywords: indicator, environment, smallholder farmers, oil palm cultivation

1. Introduction

The scenario of Malaysian agriculture sector has experienced a rapid development since the country's independence. In 1957, the agriculture sector has contributed 46% to the national gross domestic product (GDP). This is so because a country with its availability of agricultural land has a great potential for the development of oil palm as the main commodity crop. Currently, oil palm cultivation is rapidly expanding with the total area of 5,076,929 hectares on December 2012 (Malaysian Palm Oil Board [MPOB], n.d.). This has made Malaysia as the second largest producer and the largest exporter of the palm oil market all over the world (Kushairi et al., 2009). It involves private estates, supported smallholders (managed by government and state agencies) and independent smallholders. Therefore, the oil palm producers are encouraged to apply GAP in order to sustain the volubility of environmental, social and economic sustainability. It is one of the significant applications for sustainable agriculture development. In fact, all oil palm producers should absolutely apply GAP in order to increase the oil palm's growth performance and yield production.

As such, the aim of this study is paid to develop a set of indicator for tracking and assessing environmental sustainability of oil palm cultivation for smallholder farmers. Accordingly, the aim could be fulfilled through the specific objectives that are to examine the purpose of GAP, to review environmental indicator in the agriculture sector, and to recommend the environmental indicator to be adopted by smallholder farmers in oil palm cultivation context. A group of smallholder farmers are chosen as the scope of the study since they are not well-practicing the GAP due to limited knowledge and exposure on sustainable agriculture practices. Despite all its merits, 51% of the overall Malaysian oil palm cultivation is

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planted by the independent and supported smallholders who produce 11.9 million tonnes of palm oil annually (CAB International, n.d.). This has lead to the application of GAP among smallholder farmers for sustainable oil palm production through the exposure on appropriate selection of indicator. In essence, the indicator of oil palm cultivation is assessed using content based analysis and interview session as a method for the development of a set of indicator. Consequently, the set of indicator is considered as a sustainable agriculture approach in an agriculture sector since it holds the principles of sustainability which consists of environmental, social and economic dimensions.

2. Literature Review

2.1. Good agricultural practices (GAP)

Good agricultural practices (GAP) is a method applied in the agriculture sector. Generally, it is carried out by farmers to make sure the agriculture sector meets the requirement of food security, safety, quality, and environmental protection. Its application is also supported by a collection of indicators in environmental, social and economic dimensions. Although the application of GAP is influenced by this set of indicators, there is a growing acceptance of the idea that GAP needs to consider different farming systems and land scales for a successful GAP's application (Smith and McDonald, 1998; Food and Agricultural Organization of the United Nations [FAO], 2008). This is supported by a study conducted by Anizah and Nor Zalina (2013) in recognising agroforestry as a sustainable agriculture approaches that are able to solve the issues of food security, safety, and environmental protection. The study also reveals multiple merits of agroforestry in environmental benefits particularly for air, water and soil improvement. The benefits can be seen in agro-ecosystem services including biodiversity conservation, carbon sequestration, and climate change mitigation (Anizah and Nor Zalina, 2013).

In an effort to stress the significance of sustainability in agriculture sector, organization such as Food and Agricultural Organization of the United Nations is applying GAP during farming and post production to provide safe and healthy agricultural products. In parallel, Sime Darby Plantation and MPOB are also demonstrating their commitment in the GAP by applying the practices to their daily operations and the entire supply chain. At the time when Malaysia was applying the GAP, Unilever (n.d.) proposed the evaluation of GAP that has to include agronomic practices and inputs as a consideration for a better GAP's application. Hence, the consideration on the indicator of farming system, land scale, agronomic practices, and inputs may contribute to the development of sustainable agriculture practices. In other words, it can be summarised that the value of GAP is completely on a long term security of agriculture supply chain. The consistent supply for agriculture outputs provides valuable quality of agro-based products, customers trust, and greenery environment through systematic set of indicators.

2.2. Environmental indicator in the agriculture sector

The concept of sustainability generally carries a variety of meaning. The World Commission on Environment and Development (1987) has specified sustainability as a form of sustainable development which meets the needs of the present without compromising the ability of future generations to meet their own needs. Meanwhile, Hess et al. (2000) defined sustainability as the ability of a system at a different farm scale to persist through time. In later years, the definition was concluded as a principle encompassing environmental, social, and economic dimensions, which also known as the principles of sustainability (Dantsis et al., 2010; Anizah and Nor Zalina, 2013). Briefly, sustainability requires the consideration on the environmental aspects in every development including agriculture sector.

Since creating a sustainable environment is important, it is worth paying attention to the application of GAP for finding out whether a system is sustainable or unsustainable. Hence, a strong relationship between GAP and sustainability has been reported in the literature. Sustainability is seen as an approach and property of agriculture (Smith and McDonald, 1998) by recognizing as an alternative ideology, a set of strategies, ability to satisfy goal and ability to continue the agriculture development. According to Gerdessen and Pascucci (2011), sustainability is best measured using reference levels, indicators or benchmarking methods. Importantly, a large number of indicators have been developed in order to assess the agricultural sustainability range from the farm scale to regional and international scale (Dantsis et al., 2010) due to its complexity and multidimensional nature (Sydorovych and Wossink, 2008). Such indicators have been widely referred to in order to understand and measure farm performance through three dimensions of sustainability, namely, environmental, social, and economic (Sydorovych and Wossink, 2008; Dantsis et al., 2010). Theoretically, the indicators are used individually or as part of a set of indicator which relate each other to have a holistic sustainability assessment.

As such, embarking from this position, the focus of the study is on the environmental indicator in agriculture sector. The mounting evidence indicates that it involves agro-ecosystem components including soil, air, water, biodiversity, and agro-ecological management. Meanwhile, the development of environmental indicators is based on the evaluation on farming system, land scale, agronomic practices, and associated inputs through GAP (Unilever, n.d.). Owing to its multi-components, many studies were shown that most of the indicators are sought out through field sampling and laboratory analyses. Only few studies deal with observation and interview techniques, such as agro-ecological management. Table 1 shows the selection of environmental indicators in the agriculture sector by more than 10 researchers.

Table 1: Selection of environmental indicators in the agriculture sector

Criteria	Indicator	Author
Soil	Land use pattern	Organization for Economic Co-operation and Development (OECD), 1997; Webster, 1999; Rasul and Thapa, 2003
	Land productivity	Gowda and Jayaramaiah, 1998
	Control erosion	Unilever, n.d.; MPOB, 2008; Rodrigues et al., 2010
	Soil quality	OECD, 1997; Rodrigues et al., 2010
	Soil fertility status (pH, organic matter, nitrogen, phosphorus, potassium, sulphur, zinc)	Unilever, n.d.; Agricultural Research for Development (CIRAD), n.d.; Webster, 1999; Sands and Podmore, 2000; Rasul and Thapa, 2003; Rodrigues et al., 2010; Nelson et al., 2010
	Soil protection	Webster, 1999
Air	Air quality	OECD, 1997; Webster, 1999; Sydorovych and Wossink, 2008; Kassie and Zikhali, 2009; Dantsis et al., 2010; Rodrigues et al., 2010
	Greenhouse gas emissions	Unilever, n.d.; OECD, 1997; Webster, 1999; Sydorovych and Wossink, 2008; Rodrigues et al., 2010; Kim et al., 2013
	Change in climatic conditions	Smith and McDonald, 1998
Water	Water availability	Webster, 1999; Kassie and Zikhali, 2009
	Water quality (surface water, ground water, visual water pollution, contaminants in water)	OECD, 1997; Sands and Podmore, 2000; Sydorovych and Wossink, 2008; Rodrigues et al., 2010; Nelson et al., 2010; Kim et al., 2013
	Integrated water management	Gowda and Jayaramaiah, 1998
	Irrigated water consumption	OECD, 1997; Webster, 1999
Biodiversity	Biodiversity within and around the estate	Unilever, n.d.; Webster, 1999
	Agro and natural biodiversity	Unilever, n.d.; OECD, 1997; Sydorovych and Wossink, 2008; Nelson et al., 2010; Kim et al., 2013
Agro-ecological management	Cropping pattern (cropping intensity, crop diversification, multi cropping, cover crop, crop rotation)	Unilever, n.d.; CIRAD, n.d.; Rasul and Thapa, 2003; Dantsis et al., 2010; Nelson et al., 2010
	Use of organic (green manure) and inorganic fertilizers	Rasul and Thapa, 2003; MPOB, 2008; Kassie and Zikhali, 2009; Dantsis et al., 2010; Nelson et al., 2010
	Residue management	Sydorovych and Wossink, 2008; Kassie and Zikhali, 2009; Dantsis et al., 2010
	Pest and disease management	Unilever, n.d.; CIRAD, n.d.; Webster, 1999; Rasul and Thapa, 2003; MPOB, 2008

3. Methodology

This research is conducted qualitatively in nature. It involves the natural setting by using multiple methods that are humanistic and interactive (Creswell, 2003). Such methods include a literature review and a range of interviews. Significantly, studying the environmental indicators in the agriculture sector often requires the overall understanding on sustainable agriculture practices, and this study has included the application of GAP as the starting point for the development of systematic set of indicators for environmental dimension. With the aim to develop a systematic set of environmental indicator for oil palm cultivation among smallholder farmers, interviews were conducted as a supportive method of data collection. Interviews were addressed to six governmental institutions of MPOB which are involved in the GAP during the auditing process for oil palm producers. Qualitative interviewing conducted to explore the knowledge, view, experience, belief, and interpretation of respondent on particular subjects (Gill et al., 2008). The method paves the way for an understanding on the sustainable agriculture, the application of GAP on oil palm cultivation, and the indicators considered during the auditing process.

Studies indicate that there are three dimensions of indicator which play an important role in sustainable agriculture practices. Those include the environment, social, and economic dimensions. Following the studies on sustainable agriculture, the research focuses on the identification of environmental indicator for oil palm cultivation among smallholder farmers as it is greatly neglected due to limited knowledge and exposure on sustainable agriculture practices. Consequently, content analyses were used to analyze 16 studies on the environmental indicator in the agriculture sector, while, data from the interviews were transferred into interview transcript in order to identify the main indicators considered during the auditing process. Subsequently, the list of the parameters gained from the literature and interviews were synthesized, and special attention has been paid to gain insight into which indicators can be operated for micro scale farming system. The synthesis is here understood as a systematic set of environmental indicator for smallholder oil palm farmers which suits with the scale of the agricultural land.

4. Findings and Discussion

The selected studies and interviews from a different point of view on environmental indicator supply sources for the development of the set of indicator for oil palm cultivation in small scale farm. The selection of the indicator is based on the consideration of independence from the size of farm, responsiveness, measurability, and ease of interpretation. From the perspective of the agriculture sector, the indicators range from the specific integration of agronomic aspects at a different level includes micro, meso and macro scale. At the micro or farm scale, the focus of the environmental indicator is on natural resources base and crop production. Interestingly, experts showed that micro, meso and macro scale share similar list of indicator for the GAP. One of the most obvious barriers in environmental indicator is the lack of a common framework of understanding on the application of GAP where different indicator and different farm scale are in use.

From the analysis, the set of the indicator is developed for the whole farm plan for the improvement of farm productivity, reduction of water pollution, reduction of erosion, better nutrient, manure and fertilizer management, and better pest and pesticide management especially for micro scale farming. Yet, the impact is not only promoting sustainable agriculture, but it also considers for a better quality of life. Table 2 shows the list of environmental indicator, which are developed by considering the available indicator in the agriculture sector and its suitability to be implemented for oil palm cultivation. The proposed environmental sustainability assessment system consists of 38 integrated indicators, which are focused on three phases: i) farm preparation, ii) farm management and iii) farm production. The study suggests that this set of environmental indicators and its respective measurement can be evaluated and assessed without using field sampling or laboratory analyses, but through observatory and interview techniques.

Table 2: Environmental indicator for small scale oil palm cultivation

Criteria	Indicator		
	Farm Preparation	**Farm Management**	**Farm Production**
Site history and management	Land tenure Slope	Land conservation Agro and natural biodiversity	Unproductive sites Land productivity
Soil management	Land use pattern Soil type	Control erosion and surface runoff Soil fertility and moisture	-
Irrigation system	Water availability Efficiency method	Irrigated water consumption Integrated water management	-
Agro-ecological management	Choice of seedling Use of alternative crop	Crop rotation Cover crop Use of fertilizers and agrochemical Waste management and disposal Integrated pest management	Crop diversification
Fertilizer management	Nutrient requirement Integrated nutrient management	Fertilizer utilization Fertilizer application machinery Organic fertilizer	-
Harvesting	Protecting, recycling, replacing and maintaining the natural resources base		Ripeness standard Zero unripe tolerance Loose fruit collection Prom delivery
Post-harvest handling	-	Green manure management Application of organic manure	Product nutrition, quality and taste Impact on the local economy

The environmental indicators gathered from this study are seen as a comprehensive environmental tracking and assessment tool. In any case, it can be evaluated through field observation with the availability of tools. The evaluation is straightforward and allowing the active participation by the smallholder itself. It is also used at a low cost and the reports are generated in easy interpretation. In this way, the sustainability assessment through three phases of procedures is considered as a baseline in providing sustainable farming system. Notably, the indicators are sufficient for field sustainability assessment at the micro scale for the preparation of procedures towards certification from the MPOB. Relatively, the indicators focus on the environmental aspect, and then the mutual interaction between indicators is simultaneously giving positive impacts towards social and economic aspects. Therefore, the results obtained in the sustainability assessment according to particular indicators offer the smallholder farmers the knowledge on how to comply with the sustainable environmental standards and the socioeconomic benchmarks.

4.1. Farm preparation

The action plan for sustainable oil palm cultivation should be started with farm preparation for balance environmental, social, and economic impacts. First and foremost, the smallholder farmers need to understand the importance of continuous improvement through farm preparation phase. It basically involves the criteria of site history and management, soil management, irrigation system, agro-ecological management, fertilizer management and harvesting. Furthermore, the effectiveness of farm preparation is significantly contributed by the status of land tenure system and land rights. This allows the smallholder to demonstrate the rights in their landholdings by choosing suitable land use pattern, seedlings, and alternative crop for their farm productivity.

Indeed, the role of environmental indicator in sustainable agriculture desires more understanding in land use pattern and planning since the early stage of farm preparation. In any case, the productivity of land is depending on the land use pattern. The alternatives are certainly available. And the specific arrangement of agricultural components directly increase land productivity and product values. Hence, the experts exposes that there are many types of alternative crops are suitable to be integrated with oil palm crops during immature and mature phase for additional income including *Bactris gasipaes, Eurycoma longifolia, Musa sapientum, Saccharum officinarum, Ipomoea batatas, Citrullus lunatus Schard, Arachis hypogeal, Zea mays, Ananas comosus* and *Carica papaya*. Among the various species proposed, the selection of the species is mostly on the high market value for a short-term profit return such as *Musa sapientum*. The benefits may reflect more on the economic aspect, but it does also reflect on the nutrient supply for the soil fertility improvements. Thus, the integration of various alternative crops is considered as one of the most effective tools for sustainable agriculture practices to improve the efficiency of agro-ecosystems which can reduce environmental problems and economic costs for farm maintenance.

4.2. Farm management

The farm management involves the practices of organizing and operating farm for maximum production and high profit returns. It draws attention to the natural resources, fertilizers, pests and crop diversification in the making of sustainable agriculture practices. During the farm management process, waste management and disposal are among the important indicators that need to be managed properly to avoid pollution in terms of air, water or visual. An appropriate disposal management of chemical fertilizer containers should be adopted to prevent hazardous chemicals. In addition to these aspects, the usage of natural waste as organic matter can maintain the soil health and structure, and increase nutrient and water efficiency, as well as reducing the possibility of soil loss. As an example, organic materials such as empty fruit bunches (EFB), mill effluent and palm shell are recycled, composted and soaked as organic fertilizer.

In terms of mechanization, the GAP also reduces the transportation costs for the transport waste from oil palm cultivation due to the condition of soil structure that is unable to afford the vehicle weight. For this reason, the practices encourage the implementation of zero burning techniques especially during planting or replanting process. In other words, the green manure is decomposed for organic fertilizer application. It is one of the sustainable ways to protect, recycle, replace, and maintain the natural resources base. Furthermore, the usage of integrated pest management (IPM) is considered as the key in sustainable pest control. The application of IPM and leguminous cover crops reduces the usage of agrochemical products including chemical fertilizer, insecticides, pesticides and herbicides. In addition, the consideration on agro and natural biodiversity shows a basic understanding on the appropriate species suitable to be integrated or provided in oil palm cultivation. Technically, oil palm cultivation supports fewer biodiversity than forest area due to its plantation structure, namely uniform age tree, lower canopy and sparse undergrowth. The concern on the protected species or area for high biodiversity value may encourage the smallholder to conserve and protect the habitat, especially when the oil palm cultivation is located in the areas of high conservation value.

4.3. Farm production

The indicators for farm production are generally derived from the farm preparation and management phase. In micro scale agriculture, the production risks are related to land productivity, crop diversification and product values. The benefits are directly intertwined between social and human capital as well as the local economy of the smallholder farmers. Apparently, the rural communities are mainly dependent on the sustainable local agriculture in order to build and sustain the growing communities. In relation to the human capital and local economy consideration, the value is starting from the appropriate implementation of GAP through environmental indicators.

The result of the analysis suggests that product values of oil palm must consider the indicator of ripeness standard, zero unripe tolerance, loose fruit collection, and prom delivery to ensure optimum production of high quality product. It is worth noting that, the indicators also positively applicable for alternative crops. For micro scale agriculture, crop diversification is one of the most importance indicators during farm production. The product values, from various alternatives of crops, provide additional income for smallholder farmers especially during replanting and immature phase of oil palm cultivation. In this way, the production of various crop products other than oil palm gives positive impacts on local societies especially for farmers with limited economic sufficiency.

5. Conclusion

The mechanism for sustainable agriculture development requires close systematization. In order to fulfil the future need, it requires sustainable improvement to meet the triple challenge of food security, adaptation and mitigation of climate change. The development can be achieved through sustainable approaches that best suit the needs of diverse smallholder farmers in different places. Therefore, GAP is a strategy carried out by farmers to make sure the oil palm product meets the requirement of food security, safety, quality and environmental protection. The role of GAP is supported by the environmental indicators as benchmarks in assessing the sustainability of the agricultural land. To assess the sustainability of the agricultural land, the indicators are applied as practical tools. The assessment viewed through three phases (farm preparation, management and production) in which each phase needs to be fulfilled in order to be acknowledged as sustainable farming system. To conclude the study, the finding reveals that this systematic set of environmental indicator must be included as guidelines at the beginning of the planning stage for oil palm cultivation. Consequently, it can be used as a framework for evaluating the GAP and sustainability of the farms. This would lead to the environmental, social and economic sustainable development in the long run as the overall purpose of the research is to create awareness of a quality project design. This study shows that the selection of environmental indicator for oil palm smallholder farmers can be environmentally friendly, and socially and economically beneficial.

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7. References

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