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Driving Sustainable Intensification System on Cocoa Farming Practices

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Authors' contributions

This study was conducted in cooperation between both authors. Author JW desingned a research methodology of meta-data analysis based on the body evidences and a systematic review. Author Musyadik contributed the data in supporting the methodology and in order to apply systematic review findings. Both authors read and approved the final manuscript.

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ABSTRACT

Agricultural development needs to pay more attention in the future in order to meet the rising demand of food due to the growing population rapidly in the world. On the other hand, increasing production is needed and land expansion will be considered if farm gate want to produce more food. Moreover, farming practices particulary in developing countries with 500 million smallholders in small-scale and poor-resource farmers are facing changing in climate wich has affected farm productivity. In the past, farming practices in developing countries has been pushed into intensification system without any concerns about environmental impacts. Thus, production has increased but resulting in land degradation, soil erosion, increasing GHG emission, and less ecosystem services. On the other word, this farming practices are not sustainable. Sustainable intensification is the new paradigma in farming practices with considering environmental impact without destruction the ecosystem to produce more food from the output use. This article discussed the potential benefits of future farming practices by performing a systematic review from body evidences elabotaring on sustainable intensification. Finally, this paper is intended to support the respective countries and the sectors in developing strategies for sustainable intensification. In

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summary, based on the study literature we found that cocoa agroforestry system combine with the indigenous technology suggest will be more sustainable for cocoa farming system.

Keywords: Sustainable; intensification; environment; ecosystem.

1. INTRODUCTION

According to Food and Agriculture Organization of the United Nations (FAO) increased biofuel utilization, changing diet patterns and rising the population will affect the high-quality food of demand in the next decade. Moreover, a study of FAO suggest there will be a high demand of food production by 70% in 2050 [1]. Therefore, in order to meet future demand we have to improve the agricultural productivity that it would combat the poverty problem and also would address food insecurity in the world. Some body evidences provide that mostly in developing economies agriculture is continuing to be more unsustainable with linked land degradation, contributed 30% of greenhouse gas emission that affecting climate change, utilization of fresh water by 70% and drivers of deforestation [2-5]. Therefore, the paradigma of modern agriculture should be changed that to be more sustainable in intensification system in order to optimize the production with low external inputs and to minimize environmental damage [6].

Sustainable intensification has been defined as a form of production where in yields are increased without adverse environmental impact and without the cultivation of more land [7]. Moreover, a study found that intensification system in order to be sustainable requires increasing land productivity with ecosystem services to continue producing food in the future. This means that to be more sustainable food system on the farmland should be considering environmental impacts with concern on animal welfare, human nutrition, support rural economies and sustainable development [8].

This study performed a systematic review based on the body evidences in terms of sustainable intensification system. The objective of this paper is to synthesize based on the researcher's critical appraisal of the state of the research field. We shortly discussed the different type of cocoa farming system to describe the current situation of farming practices in the developing countries and Indonesia as well. Moreover, we present the synthesis of agriculture intensification and how this would be sustainable in the future for improving the current farming practices. Finally, we would like to recommend how the cocoa farming system will be more sustainable to enable farmers in the tropics as well as Indonesia. The limitation of this study is that there is no space to discuss a sharp dichotomy between unsustainable or sustainable farming systems.

2. CURRENT SITUATION OF COCOA FARMING SYSTEM

2.1 Contribution of Cocoa Production to the Indonesia's GDP

Agriculture sector in Indonesia has employeed a thousand people working in rural areas and highly contibuted to the Indonesia GDP in 2014 [9]. More than half of workers live in the rural area with 11% lives under poverty line [10]. Indeed, agriculture in Indonesia still plays an important role to reduce poverty in rural area. Indonesia now is the third largest country producing cocoa in the world with the production about 777,750 MT/year (15% of total world cocoa bean production) [11]. In the past 25 years cocoa estate in Indonesia has experienced tremendous growth with massive plantation due to smallholder farmers participation which has been expanded rapidly [12]. This provides the main source of income for a million smallholder farmers and their families in Indonesia and contibuted 93% of national cocoa production. However, in 2015, due to the extremely weather conditions and diseases destroyed cocoa trees in Indonesia's main cocoa growing region - the island of Sulawesi – the production declined 56 percent. [12,13].

2.2 Cocoa Full Sun System Production on Farming Practices and Its Effects

Cocoa farming system in Indonesia mainly practices the full sun system is becoming more and more common among the farmers wich resulted in destroying tropical forest and is considered unsustainable agriculture [14]. The effect of full sun system had been studied In Côte d'Ivoire reveals that third generation of cultivating full sun cocoa has effected environmental damage compare to shade system and resulted in effecting negative impact of ecosystem services and changing of rainnfall

pattern [15]. Full sun cocoa farming practices has affected in increasing temparatures and various pattern of rainfall and making more difficult to establish new cocoa farms. This condition will lead prolonged periods of drought, and increases cocoa seedling mortality [16]. In contrast, massive rainfall will have negative impact of soil fertility due to increased leaching of soils and caused by the lack of farmers applying fertilizer to replace nutriens. This is the environmental impacts in areas where farmers grow cocoa without shade (full sun system) [17]. Another study found that cocoa seed mortality can be affected by prolonged dry seasons. Meanwhile, decreasing pod filling can be caused by short dry season which affect the size of cocoa beans. Moreover, slowing the drying and processing cocoa beans will be able to caused by increased raind and prolonged wet seasons which has effected reducing tha value of cocoa bean and increases the cost of processing both time required and financially aspect [18]. Indeed, extremely weather such as fluctuated temperature and severe rainfall are important factors that impacts on optimum yield [19]. In terms of disease, black pod has been spred by incessant rainfall for several weeks due to humidity concerns which leads the spread of fungal diseases [20].

A study in Malaysia with high temperatures in humid tropical forest and Indonesia as well that it will rise evapotranspiration has effected a shortage water availability or drought conditions. Moreove, insuffucient rainfall and unpredictable climatic conditions had been effected in African regions' cocoa production during the period of 1970's and 1980's in West African and Sahelian [21]. Meanwhile, another study found that the stronger impacts on cocoa production are due to the rainfall and humidity, and following high rainfall and cool temperatures will lead the spread of black pod diseases [18,22] In summary, climate changes affect the three phases of cocoa production viz. seedling, establishment, and processing in different ways and those led to the environmental damage, less ecosystem services and considerable impacts on the other stages in chocolate supply chain [23].

2.3 Cocoa Agroforestry System and Its Sustainability

In the last three decades in Indonesia, agriculture landscape of cocoa production has intensified dramatically and plays an important role for sustainable development including reduction of poverty in rural area [24]. In Ghana, for instance, a study in terms of sustainability found that agroforestry system will be an answer of the current state of agricultural landscape of cocoa growing practices and it will be the best environmental alternative [24], and this has been called a cocoa agroforestry as the one of the best examples of permanent agriculture that protect a forest ecosystem services to support higher levels of biodiversity [25-27].

Many studies provide the evidences of the benefits of agroforestry system that promise the alternative way for common-practice of tropical agriculture in order to serve as carbon sink and biodiversity pools and might play a significant role in mitigating or adapting to climate change [28,29]. Another study reveals that there is a high potential of carbon sequestration in agroforestry system, particularly in the humid tropics [30]. Moreover, there have been many studies on the environmental benefits of agroforestry systems in the tropics [23,28,29].

3. AGRICULTURE SYSTEM AND SUSTAINABLE INTENSIFICATION

As the part an economic system, the agriculture system will respond to high demand production, as well as by innovation to use resources efficiency and to use the input of new source. Unfortunately, this system has been responded imperfectly and might led to hunger and cause environmental damage. This situation is not captured in the current market economy [30]. A successful agriculture is the ability of the system to provide high yield with low economic cost including low environmental cost to preserve key functions in the face of systemic change [31].

Global warming mainly derived from the agriculture activities which responsible for global emission by 19-29% that come directly from agricultural production activities (i.e. N2O and CH4) and indirectly from land cover change driven by agriculture (CO2) [32]. Moreover, a study found that due to the deforestation of 11.45 Mha which has occured in Indonesia between 2000 and 2010 resulted in 8.59 GtCO2e of emissions from deforestation and peat land degradation [32]. Modern agriculture has substantial impacts on the biophysical environment on the earth system that can reduce the objective of sustainable long-term in agriculture system. [33,34]. Therefore, we need to take the action to push toward agriculture sustainable intensification in order to get

optimum production and consider social and political aspect, and ecosystem services [8,34-36]. Those aspects is the crucial factor as the strategies to make production system more efficient at lower externality costs (environment impact and resources used) [30,34,37]. For instance, to give more productivity of crop system we have to improve irrigation techniques, increasing yield per unit input, and minimizing greenhouse gases by implementation of climate-smart agriculture [31,38,39]. Those are the objectives in order to maintain environmentally firendly of crop production system with considering externalities cost. [40], and to reach sustainable goals without destroying environmental system as the capital in the long-term sustainability [41].

The comprehension of ecosystem approach should be supported by intensification of crop production system in the future to produce food more efficient and more sustainable from the farm up to 2050 in agriculture system in order to meet demand of the world's food system and maintain the higher productivity, low inputs and minimize environmental damage [42]. This is what we need to change the current cocoa farming system to be more sustainable providing that increase crop production significantly and reduce the externality cost [43]. A previous study in several developing countries found that use of resources efficiently such water, less pesticide, and improving soil fertility resulted in increasing crop productivity by 79 percent [44]. Ecosystem approach with the concept of environmentall friendly in the intensification system resulted in agriculture production more sustainable [45,46]. Another study found that changing from the common practices into intensification system without considering ecosystem services may not be profitable for farmers [47].

In order to increase agriculture production sustainable intensification relay on the maintenance of natural resource base simultanously [48]. The aim of sustainable intensification is to provide land use solution which should balance between forest preservation and the inhabitans of livelihood needs [49,50]. Therefore, agroforests are considerably provide sustainable intensification [50,51], and offer smallhoder farmers to increase cocoa production, minimize externality costs, and enhance the capacity to manage the risks [52]. This would help farmers to increase their income with less ecosystem costs providing that cooperating and delivering both private and public benefits [53].

4. CONCLUSIONS

Learning from the past and take care into the future based on the experiences we need to take into account the sustainable goals to make cocoa production system more sustainable. There is no 'maggic bullet' solution in order to recommended sustainable intensification system. Agroforestry system offers the benefits for the smallholder farmers to reduce the externality costs (the cost of environmental damage) with ecosystem approach to let the crop grow efficiently with low inputs, minimize the effect of greenhouse gases with shaded system and provide the income generations.

To foster sustainable intensification system on cocoa farming practices in developing countries and Indonesia as well, farmers should be encouraged by fundamental changes in agricultural development policies and institutions such as affordable inputs, reasonable crop price, others form such fertilizer subsidies, incentives for green product, and applying the externality cost.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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