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REGULAR RESEARCH ARTICLE

Revisiting the Implications of RSPO Smallholder Certification Relative to Farm Productivity in Riau, Indonesia

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ABSTRACT

Indonesia is the largest global producer of palm oil, and smallholder plantations control 40.5% of the national palm oil area. As an essential part of the global supply chain, including palm oil smallholders in RSPO certification schemes is critical for the global market and for achieving environmental sustainability outcomes. This study was conducted in Riau Province, a major palm oil producing region. First, the study investigated RSPO certification implications through a case study in two oil palm smallholder groups in Pelalawan District and Kuantan Singingi District. Second, we analyze the driving factors of palm oil smallholder productivity at the landscape scale by developing an estimation model (panel data regression) using a data set from years 2012-2021 in 11 districts/cities. The findings across the two smallholder groups show that applying RSPO's principles, criteria, and standards gave group members collective direct social-economic and environmental benefits. Applying RSPO standards contributes to gradually increasing smallholder plantations' Fresh Fruit Bunch productivity by 15-20%. Nevertheless, our model shows implications of RSPO Smallholder certification do not significantly contribute to smallholder productivity improvement at the landscape scale. In contrast, increasing oil palm areas does not guarantee increased smallholder productivity in Riau. Smallholder oil palm area expansion also has the potential for higher deforestation if there is no central and local government control and improvement support from related parties. For this purpose, RSPO smallholder certification should be encouraged to pursue broader positive impacts on social, economic, and environmental dimensions at the landscape level.

KEYWORDS

Sustainable palm oil; Smallholder certification; Land expansion; RSPO; Good agricultural practices.

1. INTRODUCTION

The palm oil industry has grown significantly in Indonesia in the few decades and has become an essential feature of Indonesia's national economy (Purnomo et al., 2018). Approximately 50% of global palm oil comes from Indonesia (Erniwati et al., 2017). The export value of Indonesian palm oil in 2018 reached US$ 18.31 billion, contributing up to 3.5% of the National Gross Domestic Product (Ditjenben, 2019). Since 1980, Indonesia's oil palm plantation areas have increased to 14.32 million hectares (48.6 times) in 2018, with an increase in Crude Palm Oil (CPO) production at 42.88 million tons (59.5 times) in the same period {Formatting Citation}.

However, the high land expansion of oil palm plantations in the tropics has made it one of the most controversial commodities traded globally, primarily due to social and tenurial conflicts (Lai et al., 2022; Rustiadi & Veriasa, 2022), environmental impacts (Ivancic & Koh, 2016; Purnomo et al., 2018; Tacconi et al., 2019), overlapping oil palm plantation land with forests rich in biodiversity and carbon (Murphy et al., 2021; Pacheco et al., 2020; Tacconi et al., 2019; Xu et al., 2022) and the reduction of wildlife habitat (Cazzolla & Velichevskaya, 2020; Geldmann et al., 2019), and the rapid change of land use to oil palm causing food insecurity (Sudrajat et al., 2021).

Hence, increasing public concern about environmental issues has pushed for palm oil to establish global sustainability standards and certification schemes (Brandi et al., 2015; Carlson et al., 2018). Since 2004, the Roundtable on Sustainable Palm Oil (RSPO), a voluntary certification mechanism, has been established as a globally standardized palm oil supply chain instrument (Ivancic & Koh, 2016). Initially, this certification scheme was oriented towards large producers (companies); however, later standards developed to encompass smallholders [1] (Brandi et al., 2015). The involvement of smallholders in the RSPO certification scheme is critical because smallholders are an essential part of the global palm oil supply chain (Pacheco et al., 2020; RSPO, 2019). Smallholder plantations currently control 40.5% or 5.82 million hectares of Indonesian oil palm plantations (Ditjenbun, 2020), predicted to increase to 60% by 2030 (Martens et al., 2020). Certification is considered one way to convince the global market that oil palm plantations fulfill environmental sustainability principles (Carlson et al., 2018). Given the growing development of smallholder oil palm plantations, which also increases environmental and biodiversity pressures, it is crucial to continue to promote and improve RSPO certification mechanisms for smallholders (Apriani et al., 2020; Brandi et al., 2015; Pacheco et al., 2020).

RSPO smallholder certification ideas and concepts to support smallholders in moving towards sustainability and livelihood improvements focus on increasing productivity and sustainable practices at the smallholder level (RSPO, 2019). Applying RSPO principles, criteria, and standards to smallholders seeks to increase productivity and optimize yields through improved agricultural and management practices by strengthening farmer groups (De Vos et al., 2021; RSPO, 2019). Specifically, initiatives aim to achieve long-term economic and financial viability for smallholders; support responsibility towards employees, individuals, and communities affected by smallholders; and, support environmental responsibility and conservation of natural resources and biodiversity (Molenaar et al., 2013).

Indonesia has at least three different sustainable certification standards related to the palm oil sector. First, the Indonesian Sustainable Palm Oil (ISPO) is a mandatory governmental certification scheme that aims to achieve certification for all Indonesian growers, including smallholders. Second, RSPO is a voluntary international standard for palm oil that resulted from a multistakeholder initiative. Third, International Sustainability and Carbon Certification (ISCC) is a voluntary international standard that focuses on sustainable biomass production for biofuels under EU-REDD (Brandi et al., 2013). Voluntary sustainability standards are market-driven mechanisms mainly created and promoted by palm oil producers and companies to address social and environmental issues in the production, processing, and trade of palm oil products (Lai et al., 2022).

Previous studies on RSPO smallholder certification in Indonesia positively impact production inputs, significant yield, effective management, and marketing (De Vos et al., 2021), capacity building and empowerment (Hutabarat et al., 2019), transparency, innovation or technology support, and financial support (CSR funds) (Napitupulu et al., 2018), positive changes in farmer behavior, which have implications for suitable application of the RSPO principles and criteria (Rosyani et al., 2019), smallholder household welfare (Napitupulu et al., 2018) and reduced village poverty (Santika et al., 2021). However, several problems at the smallholder level, such as high dependency

[1] Oil palm smallholders are identified based on the area of land cultivated. RSPO defines an independent smallholder as a farmer whose farm or plantation area is under 50 hectares. It identifies smallholders by setting the limit for land area. However, the definition differs from what the government has already specified, which is that it is under 25 hectares area.

with NGOs and donors (Apriani et al., 2020), do not receive seeds and fertilizer subsidies and often move without legal access to their cultivated land (Yutika et al., 2019). Even the RSPO can widen income inequality among smallholders because one of the critical conditions of certification is that farmers prove legal ownership of their land, and those who do not own it are economically disadvantaged (Krishna et al., 2017). Furthermore, although regulatory support already exists, for example, through the Smallholder's Palm Oil Rejuvenation (*Peremajaan Sawit Rakyat*) policy[2], the reach of the policy and access to funding for independent oil palm smallholders' businesses is yet another different obstacle (Yutika et al., 2019).

Although many studies have found positive impacts from RSPO certification at the smallholder level, there have not been many studies related to the effect of smallholder RSPO certification on the productivity level of smallholders at the landscape scale. As the province with the most extensive palm oil plantations in Indonesia (BPS, 2020), and the first location to have its independent smallholders certified by the RSPO, Riau provides an ideal location for this study and its ability to provide an overview of the role of RSPO certification at the landscape governance scale.

Our study focuses on the implications of RSPO certification on the smallholder level in Riau and investigates the driving factors of smallholder plantation productivity. The main research question is, "Can RSPO certification improve smallholder oil palm productivity at the landscape level?" This study conveys field findings regarding the potential positive impact of RSPO certification on changes in farmer behavior, plantation management, and social, economic, and environmental improvements with case studies focusing on two smallholder groups in Riau Province. The study also contributes to developing an estimation model for the impact of sustainability interventions through RSPO certification at a landscape scale.

2. METHODS

2.1 Study area

This broader study was conducted in 11 districts/cities in Riau Province (Figure 1). Riau Province is the largest palm oil plantation area in Indonesia, with an area of 2.86 million hectares or 32.87% of the province's total area (BPS, 2020). However, the delineation of actual oil palm plantations shows a larger area, namely 47% (4,170,482 ha) of the total area of Riau Province (P3ES-KLHK, 2020). Around 1.6 million hectares of palm oil plantations are owned by smallholders (Ditjenbun, 2020).

Specifically, the case study was conducted in two smallholder groups, i.e. the Amanah Association in Pelalawan District and the Mandiri Association in Kuantan Singgigi District. The Amanah Association was the first independent oil palm smallholders' association to receive RSPO certification in Indonesia in 2013 through support from various parties. When it was first formed, the Amanah Association consisted of 10 farmer groups with a total of 349 members, with a plantation area of 763 ha located in 3 (three) villages, namely Trimulya Jaya Village, Bukit Jaya Village and Air Mas Village, Pelalawan District. As part of the 2022 RSPO re-certification, the number of members increased to 411 households, covering a land area of 1,048 hectares. The Mandiri Association is an independent smallholders' organization that received RSPO certification in 2019. Currently, 75 association members have a certified plantation area of 150.93 ha (Veriasa et al., 2022).

[2] Presidential Regulation No. 61/2015 jo. Presidential Regulation No.66/2018

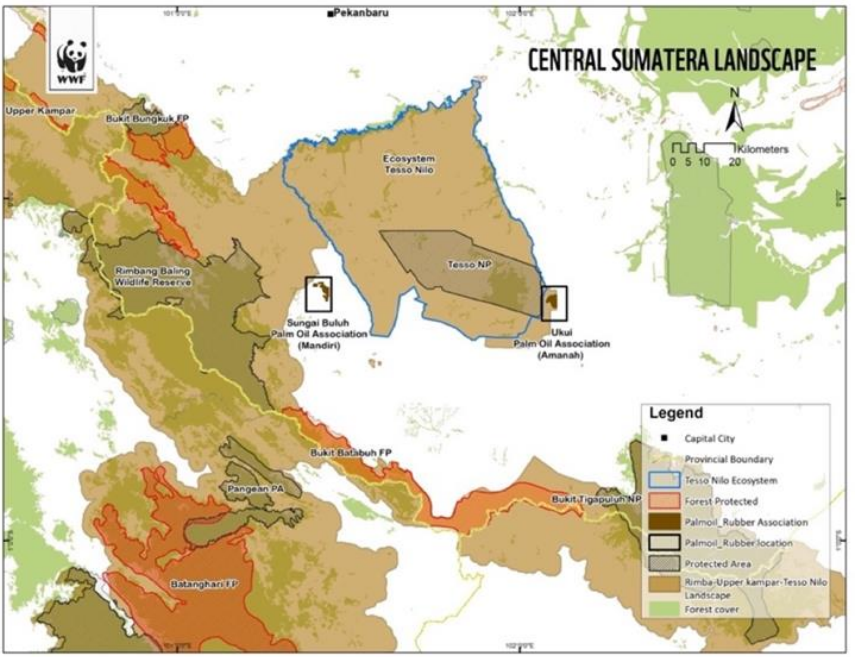

Figure 1. Map of the study area
[Source: WWF Indonesia]

2.2 Data collection

The study was conducted from November 2020 to December 2021. Field observation, in-depth interviews and Focus Group Discussion were conducted in two RSPO certified smallholder groups. Data collection included gathering information on the benefits of certification, implementation gaps in the field and some technical issues encountered. To verify the data, we conducted stakeholder workshops which involved provincial agencies and Pelalawan and Kuantan Sengingi District agencies, the University of Riau, WWF, SPKS, Fortasbi and RSPO.

We used time series and cross section data from 2012-2021 to develop an estimation model. The data on smallholder plantations cover 11 district/cities in Riau Province and was collected from the Palm Oil Statistics data from the Directorate General of Plantations at the Ministry of Agriculture of the Republic of Indonesia. The RSPO smallholder data was obtained from RSPO official data, the Riau Provincial Plantation Agency, and Fortasbi.

2.3 Analysis

2.3.1 Implications of RSPO certification for smallholders

The analysis uses case studies on two smallholder groups in Pelalawan District (Amanah Association) and Kuantan Singingi District (Mandiri Association). To conduct analysis on implications, we applied a basic concept of smallholder certification, which focused on sustainable production at the smallholder level (Figure 2), i.e., ways to optimize harvests, ensure fair prices, increase positive impacts on social-economic aspects, and minimize environmental impacts (Molenaar et al., 2013; Pacheco et al., 2020).

For this reason, we focus our analysis on the significant impacts of implementing Good Agricultural Practices (GAP) (Euler et al., 2016; Lee et al., 2014), including economic (Hutabarat et al., 2018), social (Apriani et al., 2020), and environmental benefits (Bishop & Carlson, 2022). All obtained data were compared with relevant literature (Table 1).

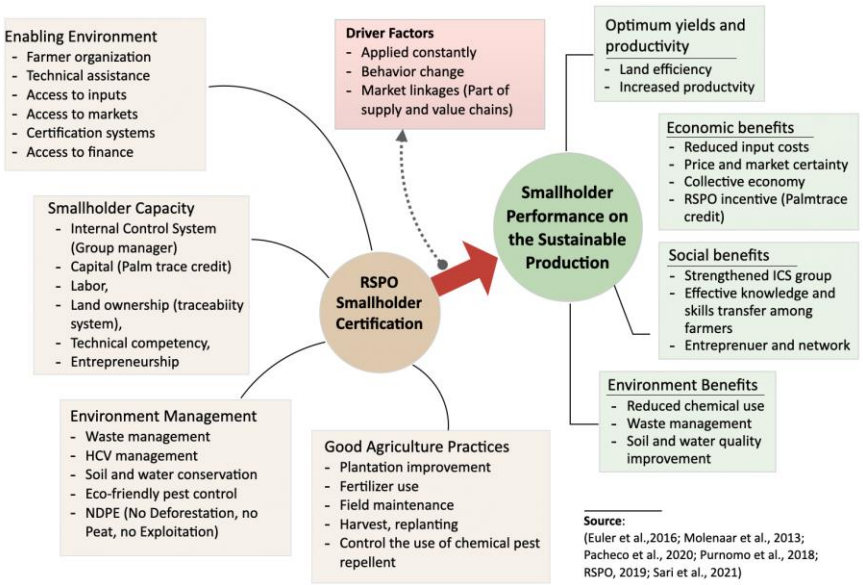

Figure 1. Framework of sustainable smallholder production through RSPO certification

Table 1. Aspects and variable analysis of case study

No	Aspects and Variable	Source
1	**Optimize harvest using Good Agricultural Practices** • Pest Control; Study-based measurable use of herbicides and fertilizers; Increased productivity	(De Vos et al., 2021; Euler et al., 2016; Lee et al., 2014; Napitupulu et al., 2021)
2	**Economic benefits** • FFB purchase certainty • Fair price • RSPO Certificate Credit Incentive (Palmtrace)	(Apriani et al., 2020; Hutabarat et al., 2018; Krishna & Kubitza, 2021; Purnomo et al., 2018)
3	**Social benefits** Institutional strengthening	(Apriani et al., 2020; Watts et al., 2019; Rosyani et al., 2019)
4	**Environmental benefits** Integrated chemical waste management; Eco-friendly pest control; Protection and management of High Conservation Value (HCV) area; Soil and water conservation	(Bishop & Carlson, 2022; Molenaar et al., 2013; Pacheco et al., 2020; Watts et al., 2021; Lai et al., 2022)

2.3.2 Driving factors of smallholder plantation productivity in the Riau landscape

The study developed an estimation model using panel data regression analysis to determine the driving factors of smallholder oil palm plantation productivity. Furthermore, the random effect model is used based on the result of the Hausman test with the *p-value* > 0.05. The variables analyzed include smallholder plantations area

(*plasma* & independent smallholders)[3], smallholder palm oil production and the total palm oil plantation area per household. We include RSPO-certified land areas and RSPO-certified household variables to understand the effect of certification on smallholder productivity at the landscape level.

These variables were tested at the district/city level with 110 samples observation (11 units, ten years). Descriptions of the variables are described in Table 2. We used $\alpha = 0.05$ to evaluate the statistical significance (Sarstedt & Mooi, 2014).

Table 2. Description and statistics of variables

Variable	Description	Mean	Std. Dev
Y_{PRDVT} (ton CPO/hectare)	Palm oil productivity based on time series data (2012-2021) in the district/city unit.	3.32	0.55
$X_{TLA\,it}$ (hectare/year)	Total smallholders oil palm area in district/city *i*, year *t*	127,864	75,648
$X_{PRD\,it}$ (ton CPO/year)	Total yield of Crude Palm Oil in the District/city *i*, year *t*	337,892	210,512
$X_{HHLND\,it}$ (hectares/household)	Total oil palm plantation area per household in district/city *i*, year *t*	2.96	1.27
$X_{CLA\,it}$(hectares/year)	Total smallholder plantation area certified by RSPO in District/city *I*, year *t*	187.44	466.98
$X_{CHH\,it}$(household/year)	Total oil palm plantation households certified by RSPO in District/city *i*, year *t*	80.87	202.82

Source: Statistics of Indonesia Plantations 2011-2020; Statistic of National Leading Plantations 2019-2021; N=110

3. RESULTS

3.1 An overview of smallholder palm oil development in Riau Province

Currently, smallholder cultivation amounts to 63.2% of the total area of oil palm plantations in Riau Province. Its area is increasing from year to year, yet the average level of productivity has trended towards decreasing (Figure 3). In 2021, the smallholder plantations area reached 1,614,007 hectares with an average annual productivity of CPO 3.18 tons/hectare. Nationally, the average of annual CPO productivity of smallholder oil palm plantations is still much lower (3.24 tons/hectare) than state plantations (4.42 tons/hectare) and private company operations (4.45 tons /hectare) (Ditjenbun, 2020).

Even though productivity is low, smallholders continue to cultivate palm oil for several reasons, such as (1) the direct benefits from the plasma plantations; (2) the technical characteristics of oil palm trees, including the use of less labor and; (3) high return on investment; and cooperation between large corporations and banks, which brought many advantages but also posed many hurdles (Feintrenie et al., 2010; Krishna et al., 2017).

Based on official RSPO data for 2022, there are 7,798 hectares of RSPO-certified smallholder plantations in Riau Province. This area covers six districts, ten smallholder groups and 3,121 certified households (Table 3). The smallholder oil palm areas certified by RSPO increased significantly in 2019 and continued the following year. However, this increase is still not balanced at only 7,798 hectares or 0.48% of total smallholder oil palm areas (1,614,007 hectares) in Riau Province in 2021 (Figure 4).

[3] Indonesia has two categories of oil palm farmers: *plasma* farmers and smallholder farmers. *Plasma* farmers reside in a company's oil palm plantation area and manage their plantations based on company standards, which include guidance, technical assistance, and financial support. Smallholder farmers are independent farmers whose primary income comes from oil palm farming and managing it with their family members.

Although the figure remains small, it does indicate an increase in smallholder interest in participating in RSPO certification (Apriani et al., 2020).

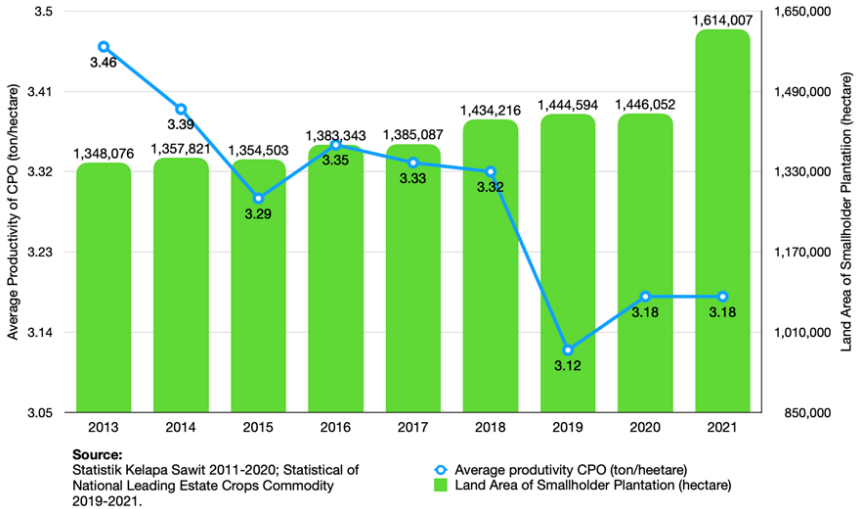

Figure 2. Trends in oil palm land development versus productivity of smallholder plantations in Riau.

Table 3. RSPO-certified independent smallholders in Riau, 2021

No	District/ City	Name of Smallholder Group	RSPO certified area (hectare)	Total certified smallholder (household)	First time Certified
1	Rokan Hulu	Perkumpulan Pekebun Swadaya Kelapa Sawit	1,328	717	2019
		PPKSS-Tayo Barokah	327	151	2021
		Forum Petani Sawit Swadaya Semarak Mudo (FPSS-Semarak Mudo)	620	294	2021
		Perkumpulan Petani Sawit Swadaya Tambusai Sejahtera	0	0	on Process
2	Kuantan Sengigi	Asosiasi Petani Kelapa Sawit Swadaya Mandiri	151	75	2019
3	Siak	Koperasi Beringin Jaya	373	197	2020
		Koperasi Sawit Jaya	245	114	2021
		Asosiasi Pekebun Swadaya Kelapa Sawit Pelalawan Siak (Siak & Pelalawan District)	1172	318	2020
4	Pelalawan				
		Asosiasi Petani Sawit Swadaya Amanah	1048	411	2013
5	Rokan Hilir	Asosiasi Pekebun Swadaya Kelapa Sawit Negeri Seribu Kubah	1950	540	2020
6	Indragiri Hulu	Petani Sawit Swadaya Karya Serumpun	584	304	2021
		Total	**7,798**	**3,121**	

[Source: RSPO Official data on February (2022)]

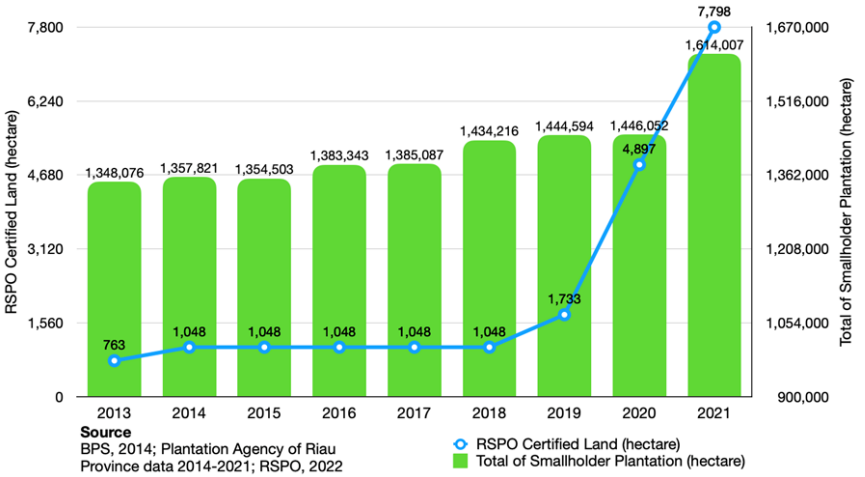

Figure 3. Trends of RSPO smallholder certification in Riau Province.

3.2 Implications of RSPO smallholder certification

Table 4 shows the study findings regarding the implications of RSPO smallholder certification on various aspects. In implementing Good Agricultural Practices (GAP), a significant change is underway in the application of pest control methods using a Spray Unit Team with operating standards that meet occupational safety and health (Figure 5). Another change is the use of herbicides and fertilizers, which are measurable based on study results. It has implications for reducing the cost of using herbicides and fertilizers. Implementing GAP impacts increased the productivity of independent smallholders' palm oil in a varied and gradual manner (De Vos et al., 2021). In addition, GAP results in many changes on the use of pesticides and chemical waste management.

In the case of the Amanah Association and Mandiri Association, since implementing the RSPO standards, independent smallholder productivity has gradually increased by an average of 17%-20% in after peak (year 20). On plantations managed by the Amanah Association, the productivity of Fresh Fruit Bunch (FFB) per hectare increased from 20 tons/year to 24 tons/year. Meanwhile, at the Mandiri Association plantations, there was an increase in FFB productivity per hectare from 17 tons/year to 20 tons/year. If compared to the results of the study in Sumatra conducted by Lee et al. (2014) and Euler et al. (2016), which states that the average productivity of independent smallholders is around 17.8 to 22.9 tons of FFB/hectare/year in peak (year 15), these findings indicate that productivity in both smallholder associations progressively increased. Based on a cost and benefit analysis conducted by Hutabarat et al. (2018) at the Amanah Association, RSPO certification will be economically feasible if the yield increases at least 14.3% compared to the yield before certification. Thus, the findings of these two associations show that RSPO certification has help secure economic value at the smallholder level.

Economically, cooperation between the Association of Smallholders and Palm Oil Mills and through Delivery Orders (DO) owned by *Badan Usaha Milik Desa* (BUMDES, or Village Owned Enterprise)[4] can provide certainty in purchasing FFB of Association

[4] *Badan Usaha Milik Desa* (BUMDES) or Village-Owned Enterprises are business institutions managed by the village government to accelerate village economic growth through developing local potential. BUMDES is a

members. The RSPO certificate credit incentive (Palmtrace) has also been able to finance certification audits yearly, finance Internal Control System (ICS) management operations, and provide economic benefits to members. However, in the Mandiri Associations' case, the direct economic benefits of selling RSPO certificates to members are insignificant (Table 4) because the certified land area has not been economically scaled yet. Changes in social aspects mainly occur in institutional strengthening of association organization, effective transfer of knowledge and skills between smallholders, broader information access, and improved market networks.

Table 4. The significant changes and implications of RSPO smallholder certification

No	Significant Change	Implications	
		Amanah Association	Mandiri Association
1	**Optimize harvest using Good Agricultural Practices**		
	Pest Control	Integrated pest control using a Spray Unit Team with operating standards that meet occupational safety and health	
	Study-based measurable use of herbicides and fertilizers	Reducing the amount of herbicide use (based on pests and weeds study), reducing costs by 55.5%/hectare/year.	Reducing the amount of herbicide use (based on pests and weeds study), reducing costs by 30%/hectare/year.
		Increasing the efficiency of fertilizer use as a result of regular and scheduled fertilization with compositions referring to recommendations from soil and leaf tests.	
	Increased productivity	Increase FFB production by 20%, from an average of 20 tons/ha/year to 24 tons/ha/year.	Increase FFB production by 17% gradually, from an average of 17 tons/ha/year to 20 tons/ha/year.
2	**Economic benefits**		
	FFB purchase certainty	Certainty of purchase and price of FFB from PT. Inti Indosawit Subur. As a partner, the Association can supply fertilizer from the company.	The certainty of purchasing FFB of planters is guaranteed through a Delivery Order (DO) owned by a BUMDES.
	Fair price	Prices follow prevailing market prices. There is no significant price difference between Certified FFB and non-certified.	Prices follow prevailing market prices. There is no significant price difference between Certified FFB and non-certified.
	RSPO Certificate Credit Incentive (Palmtrace)	The RSPO Certificate Credit Incentive can independently finance an annual certification audit, purchase assets, supplies, and equipment, and establish an association office. The remainder is shared with Association members and ICS staff.	The RSPO Certificate Credit Incentive can only finance certification audits and finance ICS management operations. The benefits of selling certificates to members are not very significant. The remainder is used to distribute groceries to association members and the village's low-income community groups.

mandate from the 2014 Village Law whose development is supported by village funds sourced from the State Revenue and Expenditure Budget.

No	Significant Change	Implications	
		Amanah Association	Mandiri Association
3	**Social benefits**		
	Institutional strengthening	Organization of smallholders by Association (Internal Control System Group) as the parent organization of farmer groups.	
		More effective transfer of knowledge and skills between smallholders.	
		Better information networks and access to market.	
4	**Environmental benefits**		
	Integrated chemical waste management.	Chemical waste management is carried out by a separate unit with adequate installations.	
	Eco-friendly pest control	Pest control with owls kept in plantations using a wild-release model.	
	Protection and management of High Conservation Value (HCV) area	The HCV assessment was carried out independently using the RSPO's simplified HCV Guidelines. Next, a plan is drawn up for managing and protecting the HCV area. Protecting HCV areas includes protecting river riparian areas by planting forest plants and bamboo and not spraying and chemical fertilizing on river riparian areas.	
	Soil and water conservation	Provide cover crops, regularly arrange fronds ("U" shaped), create a circular space under the oil palm tree, and make drainage ditches.	

[Source: Primary data, 2020, Observations, in-depth interviews and FGDs with ICS staff and members of the Association]

Economically, cooperation between the Association of Smallholders and Palm Oil Mills and through Delivery Orders (DO) owned by BUMDES can provide certainty in purchasing FFB of Association members. The RSPO certificate credit incentive (Palmtrace) has also been able to finance certification audits yearly, finance Internal Control System (ICS) management operations, and provide economic benefits to members. However, in the Mandiri Associations' case, the direct economic benefits of selling RSPO certificates to members are insignificant (Table 4) because the certified land area has not been economically scaled yet. Changes in the social aspect mainly occur in institutional strengthening through the organization of associations, effective transfer of knowledge and skills between smallholders, broader information access and better market networks.

Figure 5. Integrated pest control using a Spray Unit Team

Furthermore, significant changes in environmental aspects are the implementation of soil and water conservation, including the management of chemical waste, which is carried out separately with adequate installations; natural pest control (using owls kept

in plantations by a wild-release model); protection of High Conservation Value areas namely river riparian protection by planting forest plants and bamboo, and not applying chemicals on the river's riparian areas (Figure 6).

Figure 6. Soil and water conservation activity: (a) providing mulch, regularly arrange fronds ("U" shaped); (b) creating a circular space under the oil palm tree; (c) making drainage ditches.

3.3 The driving factors of smallholder plantation productivity

Regression analysis shows that three factors influence the productivity of smallholder palm oil plantations: the total smallholder oil palm area, the total yield of FFB and the total oil palm plantation area per household. However, two factors have a negative influence on productivity (Table 5). The increase in the area of plantation land and the total area of plantation land per household reduces the productivity of palm oil yield per hectare in Riau Province due to the inability of both independent and plasma smallholders to manage large-scale plantation land.

Furthermore, the area of land and smallholders certified by the RSPO has not significantly contributed to increased productivity at the landscape scale. This is because we found that only 0.48% of the total smallholder oil palm plantations areas are certified by the RSPO. Furthermore, only 0.5% or 3,121 households have been RSPO certified out of the total smallholders, namely 620,104 (Ditjenbun, 2020).

Table 5. Summary of regression analysis

Variable	Estimate	Std. Error	t-value	Pr(>|t|)	
$X_{TLA/t}$	-8.0325e-06	1.9515e-06	-4.1160	8.333e-05	***
$X_{PRD/t}$	2.9909e-06	5.9808e-07	5.0008	2.681e-06	***
$X_{HHLND/t}$	-1.6535e-01	4.4184e-02	-3.7424	0.0003153	***
$X_{CLA/t}$	4.2078e-04	2.7891e-04	1.5086	0.1347825	
$X_{CHH/t}$	-1.2549e-03	6.7000e-04	-1.8730	0.0642029	

Note: Y=PRDTV

4. DISCUSSION

We confirmed that applying RSPO certification standards contributes positively to smallholders, mainly in socio-economic aspects. Changes in farmer cultivation behavior through sustainable agricultural practices can reduce production costs and increase yields. The certification approach that requires group organizations (Hutabarat et al., 2019) thus has important implications for strengthening farmers' social capital, increasing farmers' knowledge and skills collectively, and access to information and marketing (purchasing and price certainty) coordinated by associations/smallholder groups (Table 3). These findings are in line with studies in Central Kalimantan (De Vos et al., 2021; Watts et al., 2021), Riau Province (Hutabarat et al., 2018) and Jambi Province (Apriani et al., 2020; Napitupulu et al., 2018; Rosyani et al., 2019).

Furthermore, we also found implications from increasing income for all group members collectively. Although there is no significant difference in the selling price of FFB (Apriani et al., 2020), support from RSPO Palmtrace incentives, reduced production costs, and increased yields could improve the income of oil palm smallholders gradually in the long term as certification schemes help achieve economic feasibility (Hutabarat et al., 2018). This fact also responds to the study by Krishna & Kubitza (2021), which stated that oil palm expansion (non-RSPO) only has positive implications for individual interests. Suppose the management of smallholder plantations is carried out in an organized manner on a group scale with sustainable palm oil standards. In that case, opportunities for collective benefit implications will be even greater.

Our findings are notable in the smallholder behavior changes in environmental management. This covers broader efforts to mitigate significant environmental damage, such as reducing the use of chemicals in cultivation, implementing natural pest control, and implementing sustainable plantation management. In contrast, smallholder efforts to protect and manage HCVs are still carried out on a small scale and need to be improved. According to Watts et al. (2021), besides providing economic and other benefits, RSPO Smallholder certification can also potentially reduce deforestation and environmental degradation. Until now, Indonesian smallholders still face significant challenges in meeting sustainability standards (Jelsma et al., 2017; Watts et al., 2021), such as conservation issues where there are still findings of non-compliance and are referred to for improvement in recertification (Bishop & Carlson, 2022). These include a lack of monitoring and proper management of HCV areas and inadequate capacity building of smallholders. This case generally mirrors other oil palm smallholders across Southeast Asia (Lai et al., 2022).

Estimation model findings show that at the landscape-scale, expanding smallholder plantation land and increasing the area of plantation land owned by each household reduces the productivity of smallholders. The increasing oil palm area does not guarantee increased smallholder productivity at the Riau landscape scale. This finding was also confirmed by Sari et al. (2021) that palm oil smallholders in South Sumatra, Central Kalimantan, South Sulawesi, Lampung, Jambi and Bengkulu generally

experience land inefficiency because land expansion increases the number of trees planted, even though the yield is lower. Although the large palm oil industry has long been accused of causing adverse impacts such as deforestation (Tacconi et al., 2019), land grabbing, tenurial conflicts (Rustiadi & Veriasa, 2022), and indirectly through ecosystem services, the development of smallholder palm oil plantations also has negative impacts that must be addressed (Ayompe et al., 2021).

In this model, only an increase in palm oil production will significantly increase the productivity of smallholders. Potential productivity should be achieved by intensifying the land by implementing good agricultural practices (Napitupulu et al., 2021) supported by a combination of biophysics, water management, climate and chemical land suitability (Euler et al., 2016; Herdiansyah et al., 2020) as the principle, criteria, and indicators of RSPO Smallholder certification. For this reason, RSPO smallholder certification should be encouraged to pursue broader positive impacts on social, economic and environmental considerations at the landscape scale (Ayompe et al., 2021).

5. CONCLUSIONS

RSPO certification has gradually changed sustainable behavior of smallholders in several aspects. This contribution can be seen from implementing sustainable agricultural practices, which positively impact palm oil productivity, income generation of certified smallholders, and improved environmental management to prevent significant damage. Even though this study shows an increase in the sustainable behavior among certified smallholders, there is still underperformance in conservation aspects (HCV management and protection). The conservation issue is a significant challenge for smallholders in meeting RSPO standards (Bishop & Carlson, 2022), which could potentially reduce deforestation and improve environmental conditions (Jelsma et al., 2017; Watts et al., 2021).

Furthermore, at the landscape scale, our estimation model shows that increasing oil palm areas do not guarantee increased smallholder productivity due to land efficiency (Sari et al., 2021). The achievement of smallholder RSPO certification in Riau Province has not contributed to landscape scale productivity. Our findings show positive results on the productivity of certified smallholders. However, the RSPO certification achievement in Riau Province is still too small, namely only 0.48% of the total smallholder oil palm plantation areas and 0.5% of total smallholders (Table 3). It has the potential for higher land expansion and deforestation if no central and local government control and improvement support is implemented across stakeholders. Currently, oil palm plantations have reached 47% (4,170,482 ha) of the total area of Riau Province (P3ES-KLHK, 2020). The expansion of oil palm land will be a problem in the future on the adequacy of land allocated for space in Riau Province, for example, for settlement, conservation and protection, as well as for the cultivation of other commodities.

For this reason, support from the government and related stakeholders is necessary to accelerate the achievement of RSPO certification for smallholders in Riau Province. We believe that if the RSPO smallholder certification continues to be encouraged, it will be able to pursue landscape-scale productivity levels followed by broader positive impacts on social, economic, and environmental issues.

Finally, the limitation of this study is not being able to obtain an overview regarding the implications of RSPO smallholder certification for land expansion that causes deforestation. Further studies related to the implications of RSPO certification for both large and smallholder plantations on ecological aspects (such as natural forests) are

needed to understand spatial and visual trends, including whether increasing smallholder productivity can control land expansion for oil palm plantations in Riau Province.

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