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Independent oil palm smallholder management practices and yields: can RSPO certification make a difference?

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Abstract

Smallholders are a substantial part of the oil palm sector and thus are key to achieving more sustainable production. However, so far their yields remain below potential. The Roundtable on Sustainable Oil Palm (RSPO) aims to include smallholders in sustainability certification to strengthen rural livelihoods and reduce negative environmental impacts. This study aims to determine if and how certified smallholders perform differently from their non-certified counterparts in terms of management practices and yields, and to what extent this is related to RSPO certification. Certified smallholders had significantly better management practices in terms of planting material (*tenera*) and fertiliser use (16.8 vs 4.8 bags ha^{-1} yr^{-1}) and had significantly higher yields (22.5 vs 14.5 ton fresh fruit bunches $ha^{-1}1$ $yr^{-1}1$, corrected for palm age). Planting material and harvesting frequency significantly explained higher yields. These differences could not be attributed to certification per se but were probably due to pre-certification conditions, including strong group organisation. It remains a question as to how sustainability certification can be a driver of change by including smallholders who have relatively larger yield gaps, and who lag behind in eligibility criteria for certification.

1. Introduction

Oil palm smallholders are critical in the goal to achieve a more sustainable palm oil sector which protects both rural livelihoods and the environment (Jezeer *et al* 2019, Razak *et al* 2020). However, smallholder yields often lag far behind large-scale estates (Euler *et al* 2016, Monzon *et al* 2021, Yield Gap Atlas 2021). Yield gaps are rooted in the use of low-quality planting materials and limited fertiliser use (Woittiez *et al* 2018, Jelsma *et al* 2019), as well as a combination of inefficient plantation design, irregular harvesting, soil and climate conditions, and water availability (Fairhurst and Griffiths 2014, Rhebergen *et al* 2016). Improving yields through better management practices is not straightforward, because there is a time lag of 20–30 months before maximum yield increases are achieved after improving management practices (Woittiez *et al* 2021). In addition, independent smallholders in particular, untied to mills, do not have guaranteed access to the market; their fresh fruit bunches (FFB) may be rejected by mills in times of surplus, or may achieve low prices (Molenaar *et al* 2013). It has been difficult to address these problems, as independent oil palm smallholders have limited access to certification schemes, extension programs, agricultural inputs, credit schemes, and replanting programs (Brandi *et al* 2015).

This study aims to better understand independent oil palm smallholder management practices and yields to explore potential impacts of Roundtable on Sustainable Oil Palm (RSPO) certification on sustainable yield intensification: achieving increased yields, while using agri-inputs in a more efficient and environmentally friendly way. To this end, we compare management practices and yields between certified and non-certified independent smallholders in Central Kalimantan, Indonesia.

So far, 12 753 independent (31 groups from Indonesia) and 151 260 scheme smallholders[5] have obtained RSPO certification (RSPO.org 2021), including seven groups in Central Kalimantan. The rationale behind smallholder certification is that this should improve smallholders' socio-economic conditions, provide access to markets, and reduce negative environmental impacts of palm oil production and land conversion (Selvaraj and Ray 2019). Moreover, certification can lead to better management practices, increasing yields and oil extraction rates, thus improving smallholders' incomes, while reducing negative environmental impacts through safe and limited use of chemical fertilisers and herbicides (Rhebergen *et al* 2016, Woittiez *et al* 2018). Higher yields could reduce the need for expansion, threatening peat and forest areas (Lee *et al* 2014), although higher yields could also be an incentive for new expansions (Maghfirah 2018). For smallholders, reasons to opt for certification include expectations of improved relations with mills, better prices, and access to training and assistance from Non Governmental Organisations or companies (Hutabarat *et al* 2018, see also Blackman and Rivera 2011).

However, there are several challenges for smallholders to become and remain certified. The main constraints include: requirements regarding group organisation and land legality; limited capacity and capital to improve management practices; a lack of knowledge about and connection to the RSPO; and the costs of certification (Brandi *et al* 2015, Rietberg and Slingerland 2016, Hutabarat *et al* 2018, Tey *et al* 2020).

To address these constraints, in 2019, the RSPO introduced a phased approach to independent smallholder certification, enabling smallholders to sell part of their crude palm oil as certified prior to achieving all eligibility criteria. At the same time, in several regions, including Central Kalimantan, a jurisdictional approach is promoted as a way to ensure smallholder inclusion through strong government involvement (Pacheco *et al* 2020, Suwastoyo 2019). While this approach is gaining momentum in debates about sustainable agricultural production and responsible resource management, so far little empirical evidence is available on the outcomes of this approach (Pirard *et al* 2017).

In light of debates about the merits and challenges of new initiatives to make certification more inclusive for independent smallholders, it is necessary to examine if and how RSPO certification leads to different plantation management practices and increased yields, and how this contributes to livelihoods and environmental sustainability. This study aims to find out if and how certified smallholders in Central Kalimantan perform differently from their non-certified counterparts in terms of management practices and yields, and to what extent this is related to RSPO certification. The key questions are: (a) how do certified and non-certified smallholders manage their plantations compared to standards for Good Agricultural Practices, (b) how do different management practices explain variances in yields, and (c), how is this related to RSPO certification?

[5] Participants in a nucleus-plasma outgrower scheme, also defined as 'plasma smallholders'.

2. Methods

2.1. Study sites

We conducted surveys among 228 independent oil palm smallholders, including 128 RSPO certified smallholders in Kotawaringin Barat District and 100 non-certified smallholders in Seruyan District, Central Kalimantan (figure 1). The survey included questions on general characteristics of the smallholders, plantation characteristics (age, cropping system, palm density), plantation management practices, FFB yield, and livelihoods.

2.1.1. Non-certified area

The non-certified area includes the villages A and B in Seruyan District, considered as one area for this study. The villages are predominantly inhabited by indigenous Dayak, whose main sources of income include oil palm, banana, and plantation labour (BPS Seruyan 2018). At least 56% of the respondents practice intercropping, combining oil palm with fruit crops (mostly banana), especially when the oil palms are still young (<ten years). Oil palm is a relatively new crop in Seruyan; people started planting oil palm around 2010.

All oil palm smallholders in the villages are independent, and have never been engaged in a nucleus-plasma scheme. Most independent smallholders in indigenous communities in Central Kalimantan have not received any form of training on cultivating oil palm (INOBU 2016); yet, smallholders in our study gained some experience from working for company plantations. There are no farmer groups or cooperatives for smallholder palm oil production in the area (BPS Kabupaten Seruyan 2018). Oil palm smallholders sell their FFB through local middlemen and all smallholders receive the same price, which is determined by the mill.

2.1.2. Certified area

The certified area, village C in Kotawaringin Barat District, is largely inhabited by transmigrants from Java who settled in the area in the 1980s, and make up 76% of the population in the district (INOBU 2016). Village C is a relatively wealthy village: in addition to oil palm, villagers receive income from rubber, livestock, small enterprises, mining, and government employment (BPS Kotawaringin Barat 2017).

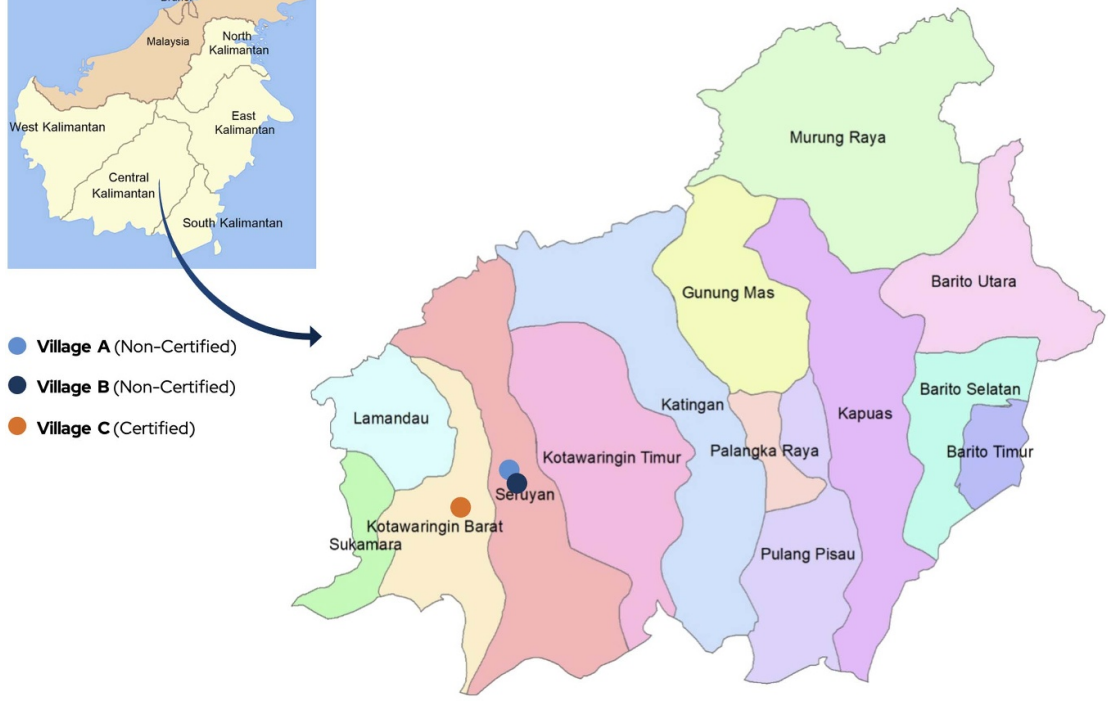

Figure 1. A map of Kalimantan and study sites (above: non-certified areas; below: certified area). Reproduced from https://commons.wikimedia.org/wiki/File:Kalimantan2.png. This Kalimantan2.png has been obtained by the author(s) from the Wikimedia website, where it is stated to have been released into the public domain. It is included within this article on that basis.

In 1994, the villagers became engaged in a nucleus-plasma scheme with an oil palm company. Now all plasma smallholders have repaid their plasma loans, received land titles for their plots, and have become independent. The land that was previously part of the plasma scheme continues to be fully managed by the former plasma cooperative. However, most people own additional land on which they cultivate oil palm independently. This study concerned only this independent land. As a consequence of the plasma history, the oil palm plantations are mostly managed as monocultures, but five (4.6%) respondents practiced intercropping with fruit trees, black pepper, maize, or rubber. Moreover, as smallholders could follow the example of their plasma plantation, the design of the independent plantations (palm density, planting pattern, and management in the immature phase) is likely to be more optimal than the design of non-certified plantations. In 2017, the cooperative in village C was the first association in Kalimantan to obtain RSPO certification; by 2020 most oil palm smallholders in this village obtained both RSPO and Indonesian Sustainable Palm Oil (ISPO) certification. The cooperative provides fertilisers and credit, and it has multiple business units, such as a supermarket and a travel agency. While the cooperative collectively sells FFB from the plasma area to a mill, FFB from independent plots is sold through middlemen. Certified smallholders do not receive a premium price for their certified FFB, but use the online book-and-claim system Palm Trace (see Hutabarat *et al* 2018).

2.2. Data analysis

To enable comparison between smallholder management practices we developed a scoring matrix for eight management practices: quality of planting material (lower yielding *dura* or the higher yielding hybrid variety *tenera*), harvesting frequency, harvest criteria, weeding frequency, weeding methods, pruning frequency, use of fronds after pruning, and fertiliser application (frequency, type and amount). For some management practices (use of *tenera* seedlings), we used a score of no (0) or yes (1). For other practices, we used a scoring system of 1–5, from bad to good, based on the standard for Good Agricultural Practices by Woittiez *et al* (2016) (see Annex I in the supplementary material (available online at stacks.iop.org/ERL/16/065015/mmedia)). With these scores we calculated a total score for management practices, rescaling all management practices in the same way so that all categories had a maximum score of 1 (Annex I).

We used a multivariate regression model to determine which practices significantly differed between certified and non-certified smallholders. After removing all missing data cases, the input

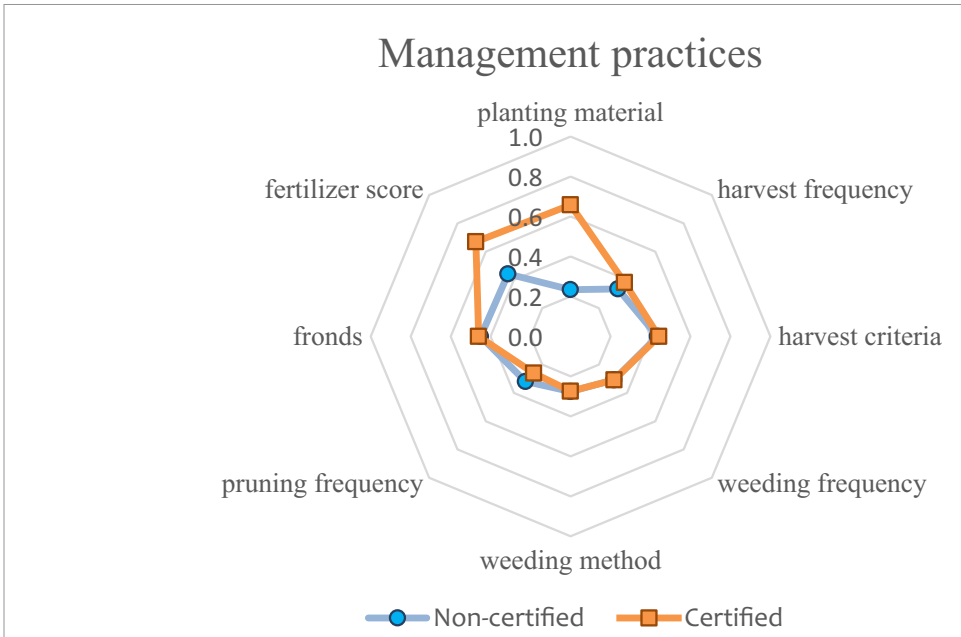

Figure 2. A radar chart indicating mean management scores in eight management categories for certified (orange) and non-certified (blue) smallholders.

for this model was the data of 143 respondents (63 certified; 80 non-certified). A Wilcoxon rank-sum test was used to analyse differences in medians for total management scores (Annex II).

Yield data for the non-certified area are based on respondent estimations regarding ton of FFB ha^{-1} yr^{-1}, as records were not available (see Annex I for a note on uncertainty in yield calculation). For the certified area we used yield records from the cooperative.

To analyse variation in yield, we fitted a Linear Model to model yield as a function of smallholder type, plantation characteristics, and management practices. After removal of missing data cases, the input for this model was 119 (42 certified and 77 non-certified). We used this model to identify which set of predictor variables predicted differences in yield (Annex II). All statistical analyses were conducted in RStudio, using the OLSRR package (R Core Development Team 2011, Barton 2018).

3. Results

3.1. Plantation management practices

Certified plantations had significantly older palms of 10.5 ± 4.05 year ($n = 122$) versus 7.7 ± 2.8 ($n = 100$) for non-certified, significantly higher palm density of 136 ± 11.2 palms ha^{-1} ($n = 125$) versus 133 ± 11.4 ($n = 100$) for non-certified and mostly monocultures (95.4% versus 44% for non-certified). In both areas, plantations were in their first planting cycle and were located on mineral soils.

Overall, the certified smallholders scored significantly higher for plantation management practices than the non-certified smallholders. This difference was due to significantly higher scoring for planting material ($p < 0.001$) and fertiliser application ($p < 0.001$) by the certified smallholders; both groups scored similarly for other aspects of management and below standard (figure 2, Annex II).

The certified smallholders mostly obtained planting material from formal distributors, such as the government plantation service, or company nurseries, which are more likely to sell the hybrid *tenera* variety. In contrast, non-certified smallholders often used pulled saplings or discarded seeds from company plantations, which may consist of lower quality *dura* or even sterile *pisifera* palms, or bought saplings through informal distributors, who are more likely to sell the less expensive *dura* variety (figure 3). This means that certified smallholders have a higher yield potential from their higher-quality planting materials.

The non-certified smallholders apply small amounts of fertiliser, and 51% only use a nitrogen-based fertiliser (urea, 4.8 bags ha^{-1} yr^{-1}), which gives a nutrient imbalance (figure 4). In comparison, the certified smallholders all use compound fertiliser (NPK Ponska, 16.8 bags ha^{-1} yr^{-1}), which includes nitrogen (N), phosphorus (P), and potassium (K), and apply various other nutrients. Yet, nutrient amounts and combinations in certified smallholders were also not optimal: mean score = 0.67, while maximum score = 1 would mean at least eight bags of NPK ha^{-1}, and use of empty fruit bunches or borate in addition (Woittiez *et al* 2016). Figure 4 shows that not all certified smallholders applied enough NPK and many did not apply additional nutrients (Annex II).

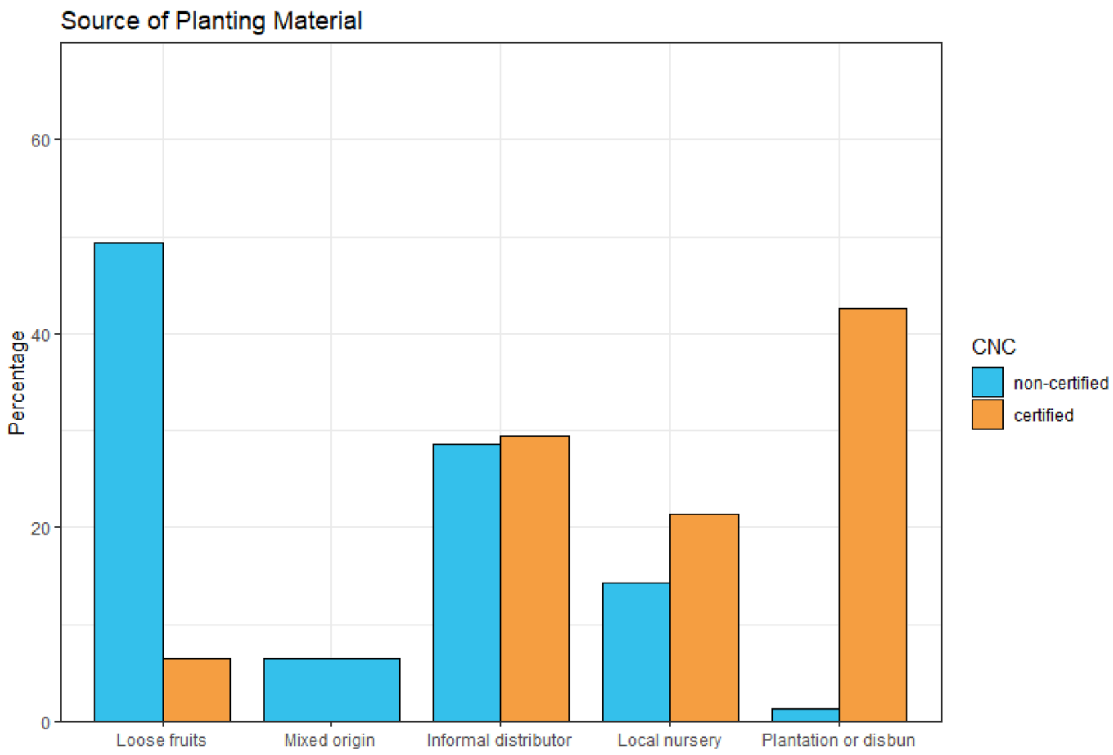

Figure 3. A graph showing where certified and non-certified smallholders obtained their planting materials. Disbun (Dinas Perkebunan) is the government plantation extension service.

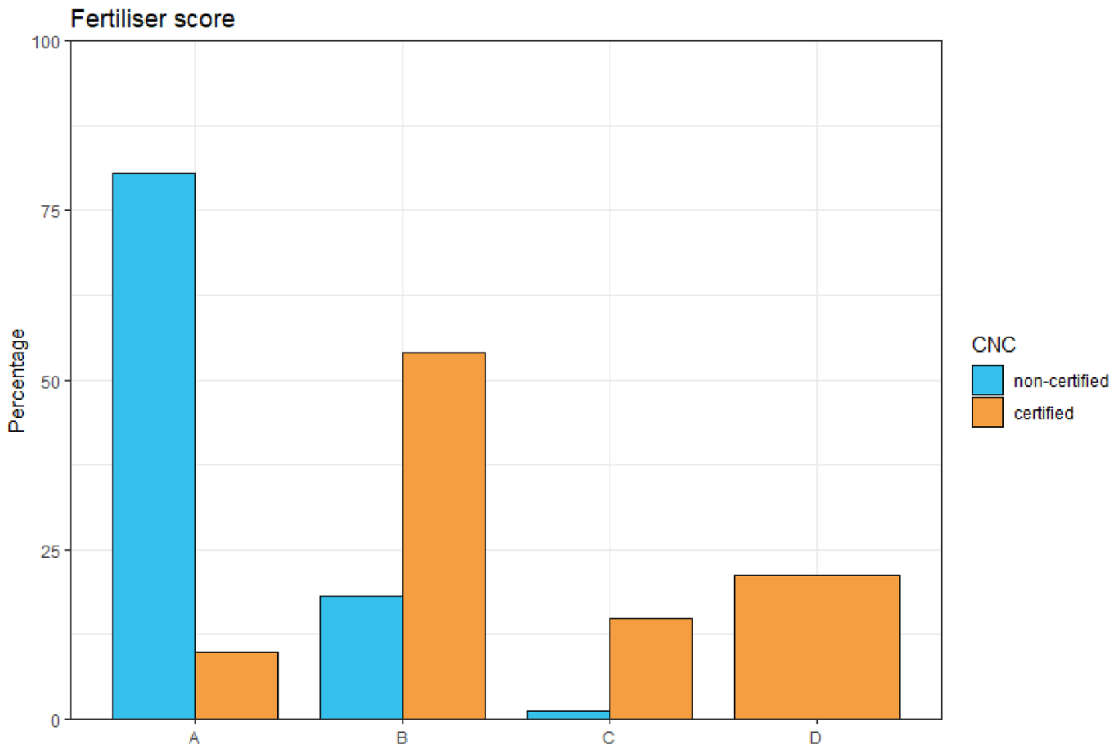

Figure 4. A graph showing the fertiliser score for amount, combination, and frequency of fertiliser application. Certified smallholders scored significantly higher for fertiliser than non-certified smallholders. A= 1-2 nutrients (Urea or NPK < 4 bags ha^{-1}); B= > 4 bags NPK ha^{-1}; C= > 8 bags of NPK ha^{-1} + dolomite or KCl; D= > 8 bags NPK ha^{-1} + borate or Empty Fruit Bunches.

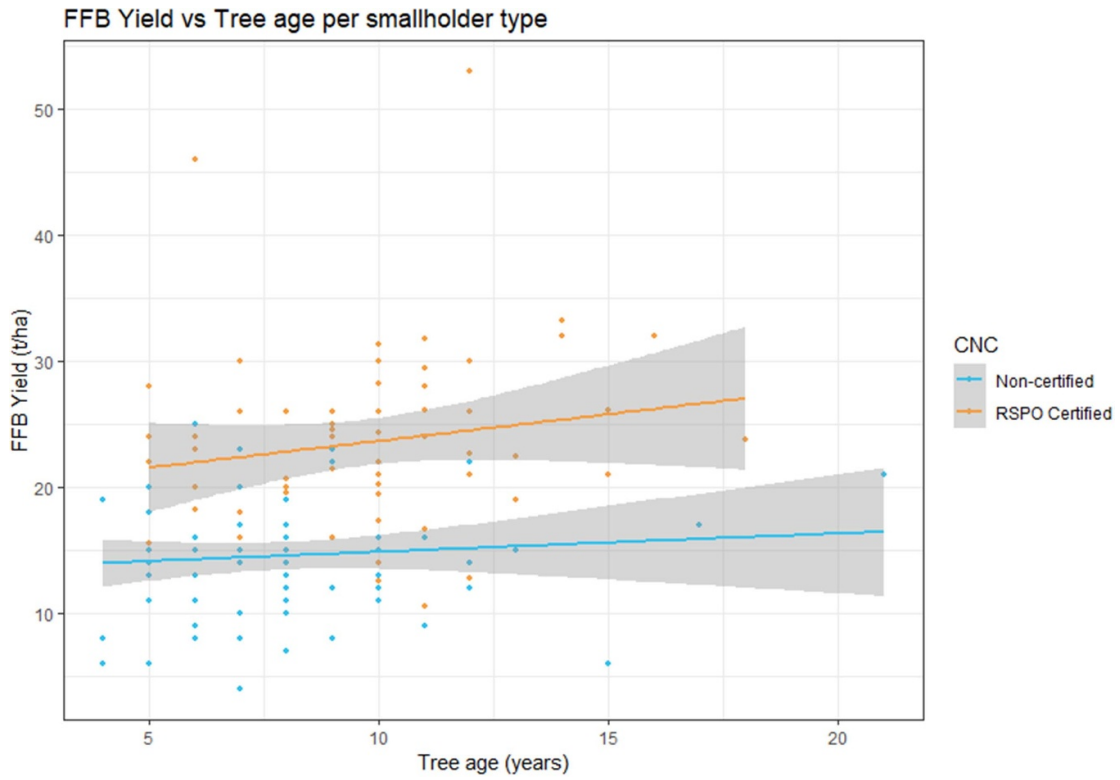

Figure 5. A graph representing estimated yield in relation to palm age, comparing certified (orange) and non-certified (blue) smallholders. The outlier of 53 t ha^{-1} yr^{-1} was excluded from analyses. Note that a normal physiological relationship between palm age and yield would start with a steep line up and then reach a plateau at around ten years.

Certified and non-certified respondents stressed that fertilisers were expensive and not always available. The non-certified smallholders only had access to the government-subsidised fertiliser urea, which is actually intended for paddy. Certified smallholders can obtain different kinds of subsidised fertiliser through the cooperative, and order non-subsidised fertilisers through the oil palm middlemen. Organic fertiliser is not applied by the non-certified respondents. In contrast, 43.7% of the certified smallholders apply organic fertiliser: many certified smallholders owned cows, and the cooperative in village C has a livestock program (separate from oil palm plantations). The cooperative also has arrangements with mills to receive back empty fruit bunches, but respondents said this was expensive due to transportation costs.

Good nutrient management includes maintenance tasks, like weeding and pruning, for optimal nutrient uptake. These tasks are performed less often than recommended, but we found no significant difference between certified and non-certified smallholders. From our respondents, 54% keep understory grasses and weeds between the palms, while 42% weed their plantation completely clean. Most respondents used either paraquat or glyphosate, or both as herbicides.

We did not find a significant difference in harvesting frequency; the majority of our certified respondents (85%) and non-certified respondents (64%) said they adhere to harvesting cycles of 14 days, transporting FFB within 24 h after harvesting. However, from follow-up interviews, we learned that in the non-certified area harvesting intervals are often irregular. Respondents explained that the decision to harvest is partly based on cash needs, the price of FFB, and uptake availability of the middlemen.

3.2. Yields

Certified smallholders had significantly higher FFB yields than non-certified ones, irrespective of palm age (figure 5): 22.5 versus 14.6 t ha^{-1} yr^{-1}, respectively. To investigate variation in yield we modelled a set of predictor factors. After model selection three predictors remained in the final model based on 119 observations. No significant interactions between predictors were found (Annex II).

Model 1: yield $\sim$ certification (yes/no) + palm age + palm density + education + land size + intercropping + planting material + fertiliser score + harvesting frequency + certification $\times$ palm age + intercropping $\times$ palm age + certification $\times$ harvesting frequency + certification $\times$ planting material.

Certification, planting material of the *tenera* variety, and increased harvesting interval of 14 days compared to 30 days had a significant positive impact on yield. A harvesting interval of 21 days compared to 30 days did not significantly explain variance in yield.

The factor certification refers to being a member of the certified group or not; it does not relate to the impact of certification itself.

4. Discussion

4.1. Differences in management practices

The certified respondents scored significantly higher for management practices. The key differences were in quality of planting materials and fertiliser application. Certified respondents mostly used *tenera* seedlings, whereas non-certified smallholders used *dura* seedlings. This means that the certified smallholders have a higher yield potential (Corley and Tinker 2015). Planting material was chosen years before certification; therefore, this is not a consequence of certification. However, as smallholders may convert new land into oil palm, or replace underperforming palms, knowledge about seed varieties can importantly impact yield potential.

Certified respondents used more of and a larger variety of compound and organic fertilisers, whereas non-certified smallholders typically only used one type of single-nutrient fertiliser in small amounts. Appropriate fertiliser application allows the better seeds to express their higher yield potential (Woittiez *et al* 2021). Harvesting, weeding, and pruning intervals were similar, but for both areas this was below the recommended frequency. An optimal harvesting interval of 7–10 days increases total harvested yields (Lee *et al* 2014). Although non-certified respondents were said to harvest every 14 days, in reality this is irregular and strongly dependent on the price of FFB and uptake availability of the middlemen; hence, their average is probably lower than for certified smallholders. Timely pruning and weeding of the circle around the trunk are important to enable efficient harvesting. However, clean weeding of the entire plantation, practiced by 42% of all respondents, is not in line with Good Agricultural Practices recommendations, which stress that understory vegetation is important for soil biodiversity and decomposition (Ashton-Butt *et al* 2018) and reduces run-off of topsoil and of applied nutrients. While paraquat is forbidden by the RSPO, except in exceptional cases of weed outbreak under strict conditions, at least 53% of the certified smallholders use this herbicide. Respondents reported that it is difficult to find an alternative to deal with woody weeds.

Our findings show that there is scope for yield increase through improvement of management practices, in both the certified and the non-certified areas. Moreover, cost reduction might be achieved with more balanced nutrient management and reduced use of herbicides. RSPO certification could contribute to these management practices by providing training on oil palm cultivation. However, the implementation of knowledge is dependent on input supply, capital, and labour availability, as well as local supply chain conditions determining collection frequency and pricing of FFBs. The RSPO's contribution to shaping these conditions is equally important. Following Rhebergen (2019) we propose to start with improving low-cost 'yield-taking' management (shorter harvest intervals, proper weeding, and plantation access), which give immediately higher yields through better crop recovery. When resources are available this can be followed by investment in more expensive 'yield-making' management (proper fertilisation) that leads to more and larger bunches but has a larger time span before giving results. Improved seeds can only be implemented at (re)planting.

4.2. Differences in yields

The certified respondents had significantly higher yields compared to the non-certified respondents (22.5 and 14.5 ton FFB ha^{-1} yr^{-1}, respectively). When compared to yields that can be obtained from plantations in Central Kalimantan under optimal conditions, yields found in this study are far below attainable yield. However, yields of the non-certified smallholders are comparable to yields obtained by other smallholders in Central Kalimantan (INOBU 2016, Monzon *et al* 2021) and other regions (e.g. Molenaar *et al* 2013, Euler *et al* 2016, Woittiez 2019), while the certified smallholders had higher yields. Their yields are comparable to yields obtained by large-scale plantations in Central Kalimantan (Monzon *et al* 2021; Annex III), albeit at different palm ages; hence, the yield gaps of these smallholders are still larger.

In our study harvesting frequency and planting material significantly explain higher yields. These two factors are also evident from other studies (e.g. Corley and Tinker 2015 for planting material, Lee *et al* 2014 for harvesting frequency). This study could not confirm the contribution of good nutrient management, although this is proven by other studies (e.g. Woittiez *et al* 2018). The reasons for this might be that fertiliser application is irregular and it depends on the availability and quality of the fertilisers. Moreover, as non-certified smallholders did not keep records of yields, their estimations may have been overoptimistic. Another factor that might have diluted the relationship between management practices and yield is that respondents do not necessarily score well on every aspect of management, and good nutrient management may be cancelled out by poor planting materials and low frequency of harvesting. Moreover, as there is a time lag between application of better management practices and the production of new palm fruits, it might be too soon to tell if yields increased after certification.

4.3. Potential impact of RSPO certification on management practices and yields

While this study was originally intended to assess the impact of RSPO certification, it appeared that

non-certified and certified smallholders had fundamentally different starting positions, potentially confounding with the impact of certification (see Sellare *et al* 2020). For example, the smallholders that were certified by the RSPO were already organised in farmer groups and cooperatives, had multiple sources of income, and they had more than 20 years of experience producing palm oil as plasma smallholders. Also, the village was located close to one of the main roads crossing the province, which enables easy transportation of FFB to mills and facilitates access to shops and distributors of agri-inputs.

Multiple studies have found that independent smallholders are a highly heterogeneous group, and that transmigrants with a plasma background, like the certified smallholders in this study, have favourable preconditions for RSPO certification (see Jelsma *et al* 2017, Hutabarat 2019, Dharmawan *et al* 2021). However, as these smallholders already perform relatively well with regards to sustainability standards, the impact of certification might be higher for smallholders who are further away from such standards (Sellare *et al* 2020). Therefore, the challenge for the RSPO is to reach smallholders that are not already well organised and lack knowledge about producing palm oil. If our non-certified respondents wish to opt for certification, they will face several challenges, including having to organise in a group and complete land legality. It will also be difficult to achieve compliance to standards for Good Agricultural Practices, when the reasons for non-compliance are rooted in socio-economic conditions and organisation of the supply chain as much as in lack of knowledge (Jelsma *et al* 2017). In particular, access to good planting material and fertilisers is limited, and smallholders do not have guaranteed access to markets.

However, it is striking that compared to the certified area, the management practices of non-certified respondents were not too different. Regarding practices that are important for environmentally responsible palm oil production, certified and non-certified respondents used similar amounts of herbicides, including highly toxic paraquat. In the non-certified areas the majority of the respondents practiced permanent intercropping in their oil palm plantations, which was also found for independent smallholders elsewhere (Azhar *et al* 2017). Should smallholders need to change their management practices to comply with RSPO Principles and Criteria, then it is important to assess how this would impact their other crops. Particularly in areas where yields are low and uptake is irregular, it may be attractive for smallholders to maintain their other crops to reduce their dependence on oil palm.

4.4. Limitations and future research

The key limitation of our study is that findings on management practices and yields from our small sample cannot be generalised for independent smallholders across Indonesia. Management practices and the extent to which they impact yield will vary depending on supply chain, as well as soil and climate conditions. However, the key aim of this case study is to show that the way smallholders manage their plantations varies, and that options for yield intensification depend on local supply chain conditions (e.g. access to fertiliser), as well as knowledge increase (e.g. knowledge on correct harvesting).

Our finding that non-certified and certified smallholders have different pre-certification conditions is highly relevant to the current debate on the merits of both a phased approach to certification and a jurisdictional approach. The new RSPO standard for independent smallholders addresses the costs and benefits of certification by advancing revenues as reward of partial certification. This may be a solution to overcome the slow return on investment related to the slow yield response to improved management practices. However, the standard does not provide solutions to challenges regarding legality and group organisation. These issues may be addressed better in (tandem with) a jurisdictional approach with strong involvement of the local government. The current focus of the Indonesian government on making their national ISPO certification mandatory, may lead to an acceleration in granting official land titles (but see Dharmawan *et al* 2021). At present, the non-certified smallholders seem to have a long way to go before they can obtain certification as the requirements set by the RSPO standards are not in accordance with their situation. The outcomes of this study indicate the need to research heterogeneity among independent oil palm smallholders, in terms of group organisation, supply chain connections, legality, productivity, and plantation management practices, including different preferences for monoculture or intercropping, to align certification strategies with the abilities, motivations, and needs of different smallholder types.

5. Conclusion

The certified smallholders in our study had significantly higher management scores and higher yields. They scored better on aspects that facilitate higher yields, such as good-quality planting materials and good nutrient management. The pre-certification conditions of the certified smallholders, such as prior experience as plasma smallholders, high-level group organisation, and access to agri-inputs and credit through the cooperative, possibly explain higher scores for management practices and higher yields. In contrast, in areas where smallholders are relatively new to oil palm, where the infrastructure and supply chain around palm oil are not yet well established, and smallholders are not organised in groups, and lack the required legal documents, it will be more challenging for smallholders to achieve certification. Further examination into how RSPO certification can

include smallholders that have less-favourable pre-certification conditions is needed.

Data availability statement

The data that support the findings of this study are available upon reasonable request from the authors.

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