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Research article

Oil palm smallholders and the road to certification: Insights from Indonesia

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ABSTRACT

Smallholder-managed oil palm plantations are a major driver of economic welfare and rural development. However, compared to industrial producers, smallholders are associated with lower farm productivity and disproportionately higher rates of illegal land clearing. Therefore, a balance must be struck between mitigating adverse externalities and strengthening favorable outcomes to ensure smallholders' sustainable integration into the palm oil industry. Certification schemes are proven instruments for achieving this goal by introducing best agronomic practices and standards. Yet, despite the availability of certification, adoption rates among smallholders remain low. Using Indonesia as a case study, we extend existing research by investigating how altering identified barriers to smallholder certification affects their acceptance. Through a discrete choice experiment conducted with 251 Indonesian oil palm smallholders, the results of our mixed logit models indicate smallholders' positive attitude towards certification schemes and their general willingness to adopt one. While 62% of respondents acknowledge the direct environmental impact of oil palm cultivation, 84% recognize the potential of certification schemes to contribute to environmental protection. Our results further show that smallholders are more likely to adopt a certificate with increasing amounts of farm management trainings and cash premiums. Moreover, we highlight the pivotal influence of farmers' risk attitudes and locus of control in shaping adoption decisions. Our novel findings are relevant to researchers and industry stakeholders as they provide valuable insights into pathways for the design of certification schemes, which catalyzes smallholders' economic integration as well as environmental wellbeing.

1. Introduction

Over the last decades palm oil demand has surged, driven by its exceptional yield efficiency compared to other vegetable oils and its wide usage across various industries (Corley and Tinker, 2008). This has translated into the expansion of oil palm plantations, which played a vital role in rural development (Tabe-Ojong and Molua, 2024), particularly in Indonesia (Qaim et al., 2020). Smallholder-managed oil palm plantations in particular contributed to economic growth by providing income opportunities for rural households and thereby considerably reducing the Indonesian poverty rate (Gatto et al., 2017; Kubitza and Gehrke, 2018). However, oil palm expansion is also associated with environmental destruction and threats to biodiversity (Dalheimer et al., 2024), exemplified by the near extinction of the Orangutan (Morgans et al., 2018). Furthermore, smallholder-managed farms are often linked to lower productivity, disproportionally high rates of deforestation and illegal land openings (Ibanez and Blackman, 2015; Lee et al., 2014; Rudel et al., 2009).

Therefore, there is a need to mitigate the adverse consequences of the oil palm boom and foster positive outcomes, such as the economic welfare of rural, smallholder communities, to facilitate their sustainable integration into the industry (Santika et al., 2019) and strengthen their overall resilience (Hendrawan et al., 2024)). Indeed, balancing economic growth and sustainability is a global goal reflected in the United Nation's Sustainable Development Goals (hereinafter SDGs) to whose achievement this study directly contributes. In particular, this study contributes to SDGs 12, 13 and 15. SDG 12 promotes *Responsible Consumption and Production*, in particular sustainable agricultural practices with reduced environmental impacts. This study identifies pathways to increasing adoption rates of certification schemes among smallholders in order to eventually foster the adoption of environmentally friendly farming techniques and address challenges like illegal land clearings. Illegal land clearings in turn are a focal point of SDG 13 *Climate Action* as deforestation further contributes to carbon emissions. Certification schemes explicitly aim to prevent deforestation, thereby contributing to climate action and protecting biodiversity, which in turn ties in with

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SDG 15 *Life on Land* as it promotes sustainable land use.

Research has demonstrated that certificates, particularly for tropical agricultural goods, are efficient tools to foster efficiency while curbing negative externalities on small-scale farms (DeFries et al., 2017; Gather and Wollni, 2022; Glasbergen, 2018; Handschuch et al., 2019; Sellare et al., 2020). However, for the majority of small-scale farmers the adoption process proves to be difficult and poses many barriers (Meemken et al., 2021). Particularly within the palm oil industry, the required organizational degree, land titles, documentation, and lack of knowledge on production obligations perpetuate smallholder certification, resulting in negligible adoption rates among them (Brandi et al., 2015; Morgans et al., 2018; Watts et al., 2021).

Despite the discourse on the challenges that confront oil palm smallholders when attempting to adopt certification schemes (Brandi et al., 2015; Glasbergen, 2018; Morgans et al., 2018; Santika et al., 2020; Watts et al., 2021), the specific configuration that these certificates should assume to align with oil palm smallholders' realities and thereby enhance their acceptance remains unexplored. Our study bridges this gap by investigating the optimal design of certification schemes. Furthermore, we investigate the role of behavioral factors, such as smallholders' risk attitude, in their decisions to adopt certification schemes. In particular, farmers' locus of control and perceived control over outcomes, have been found to shape adoption decisions related to agricultural practices (Abay et al., 2017; Mohan, 2020; Wuepper et al., 2023). Locus of control and perceived control reflect individuals' perceptions of their ability to manage their lives and farms, respectively. In our context, this translates to their confidence in managing farm operations under a certification scheme.

Therefore, this study answers the following questions: 1) Are oil palm smallholders generally willing to adopt a certification scheme? 2) Which specific attributes of a certification scheme are most relevant to farmers' adoption decision? 3) How should certificates be designed accordingly to optimally nudge small-scale farmers into their adoption in order to foster sustainability in the palm oil industry? and 4) Which role do behavioral factors play in farmers decision-making?

The objective of our study is to address the currently low adoption rates of certification schemes by identifying which factors actually drive smallholders' adoption decision. We are the first to put oil palm smallholders center-stage, and address this gap in the literature by conducting a discrete choice experiment among Indonesian oil palm smallholders. This experimental approach allows us to precisely identify the drivers of farmers' adoption decisions, highlighting pathways for the essential and sustainable integration of small-scale farmers into the industry. Furthermore, we delve into the influence of distinct behavioral factors, such as risk attitude and locus of control, on smallholders decision-making process regarding the adoption of a certification scheme. Our experimental approach allows us to intentionally introduce new attributes, enabling the exploration of new dimensions and previously unconsidered factors in farmers' certification preferences.

The remainder of this paper is organized as follows: Section two discusses the literature, sets the background of this study and derives its hypotheses. The third section describes the experimental design and data collection. Section four explains the methodology, while the fifth section presents and discusses the results. Section six concludes our study.

2. Literature review and hypotheses development

During the past 50 years, the land area under oil palm cultivation in Indonesia has grown from 100,000 ha to 15 million hectares (Ritchie et al., 2021). This expansion can be traced back to the nation's transmigration program, which acted as a catalyst by encouraging families to relocate away from the main island of Java. Initiated by the Indonesian Government in the late 1970s, this program facilitated oil palm cultivation through the provision of financial and technical assistance in the form of starter packs (Apriani et al., 2020; Gatto et al., 2015; Krishna et al., 2017).

Today the Indonesian palm oil industry can be differentiated between smallholders and industrial producers.[1] Within the context of smallholder managed oil palm plantations, two main categories can be identified: scheme smallholders and independent smallholders. Scheme smallholders are associated with a specific mill to which they sell their harvest. Typically, these mills provide agronomic inputs to smallholders. In contrast to scheme smallholders, independent smallholders are not associated with a specific mill and usually rely on sales via middlemen (Glasbergen, 2018), typically at lower prices compared to scheme smallholders (Lee et al., 2014). Nowadays around, 95% of Indonesian smallholders cultivate oil palm independently (Qaim et al., 2020). In comparison to rubber, which is the second dominating cash crop in the region, oil palm requires less labor input per hectare allowing households to cultivate larger areas with the same manpower (Euler et al., 2016; Krishna et al., 2017). Nonetheless, smallholders often achieve lower yields compared to industrial plantations due to inefficient farm management practices (Lee et al., 2014). Since smallholders contribute approximately 40% of the Indonesian palm oil supply (Qaim et al., 2020), it becomes imperative for them to adopt production standards that enhance efficiency on existing land, while minimizing the environmental burden (Byerlee et al., 2017). Hence, the need arises for targeted interventions to support smallholders in their farm productivity.

The Roundtable on Sustainable Palm Oil (hereinafter "RSPO") certificate is the primary certification scheme available for palm oil producers, including both industrial and small-scale producers (Ponte and Cheyns, 2013; Santika et al., 2020). The RSPO certification requires adherence to various obligations, such as regulations on agrochemical usage, seedling quality, and fertilizer usage (Brandi et al., 2015). To comply with these requirements, smallholders need to invest in their farms by, for instance, purchasing high-quality seedlings or additional equipment. Furthermore, smallholders are asked to form a farmer group in order to operate under RSPO. As of 2022, out of approximately 2.7 million Indonesian smallholders cultivating oil palm, only 130,809 farmers operate under the RSPO certificate (RSPO, 2022). However, the majority of certified smallholders are the aforementioned scheme smallholders, meaning their participation is obligatory because the mill they are associated with is certified (Glasbergen, 2018). Hence, the current rate of certified smallholders does not mirror farmers' active choice of adopting a certificate but rather reflects farmers producing for a certified mill. Indeed, the majority of independent smallholders is unlikely to meet the current requirements for adopting a certificate (Watts et al., 2021).

The Indonesian government has introduced the Indonesian Sustainable Palm Oil certificate (ISPO), which imposes similar requirements to the RSPO certificate. Unlike RSPO, however, the ISPO certificate will be mandatory for smallholders in Indonesia (Astari and Lovett, 2019). However, this policy has been attributed to the government's aim to exert greater control over the domestic palm oil industry while the potential benefits and the practicalities remain opaque (Astari and Lovett, 2019).

Certification schemes play a crucial role in promoting higher efficiency on small-scale oil palm plantations by requiring smallholders to adhere to better farm management practices (Brandi et al., 2015). Therefore, they offer a pathway to optimize productivity and sustainability within the palm oil industry. Certificates not only promote environmentally sustainable practices, they have also been shown to reduce poverty among certified households and mitigate adverse environmental externalities (Santika et al., 2020). However, the direction

[1] Smallholders in Indonesia operate on 4 ha on average (Qaim et al., 2020). Furthermore, the Ministry of Agriculture Indonesia defines smallholder farms as units managed by communities or peasant families and not legally registered companies.

and magnitude of positive effects are not guaranteed and depend on the initial endowment of households as well as the degree to which they accommodate smallholders' realities and the local context (Carlson and Garrett, 2018; Ibnu et al., 2015; Morgans et al., 2018; Persch-Orth and Mwangi, 2016). From a smallholder's perspective, adopting a certificate can bring several benefits, including enhanced market access, price premiums, improved productivity, and efficiency (Asfaw et al., 2010; Gatto et al., 2015; Hope et al., 2008; Krishna et al., 2017). Smallholders also gain access to agronomic input factors such as technical support, training on the use of chemical inputs, and financial incentives (Glasbergen, 2018; Ruml et al., 2022). Additionally, certification can have positive social impacts and contribute to community development (Ibnu et al., 2015).

Nonetheless, there are substantial challenges and drawbacks acting as barriers to smallholder certification. These include high investment costs, market uncertainty, price volatility and perceived lack of economic benefits (Apriani et al., 2020; Asfaw et al., 2010; Hidayat et al., 2015; Loconto and Dankers, 2014). Limited financial resources further compound these challenges (Krishna et al., 2017). The opaque conditions for farm management practices further present barriers to smallholders' decision to adopt certification (Brandi et al., 2015; Gatto et al., 2015). The attributes included in our discrete choice experiment are drawn from the existing literature, highlighting the primary challenges currently encountered by Indonesian oil palm smallholders in the certification adoption process. In the following, we derive the hypotheses for our study based on the literature, drawing on the methodological approaches outlined by Block et al. (2024), Feisthauer et al. (2024), Nordmeyer & Muβhoff (2023). Our approach to the literature review is also presented in Fig. 1.

In light of these challenges, the literature argues that smallholders often associate certificates with uncertain monetary gains (Hidayat et al., 2015; Loconto and Dankers, 2014), which further perpetuates their hesitancy towards certification (Brandi et al., 2015; Glasbergen, 2018). A cash premium could provide a direct and measurable impact on farmers' welfare, particularly since smallholders are often cash-constrained (Cahyadi and Waibel, 2016; Glasbergen, 2018). A cash premium could cushion the costs of certification and thereby potentially increase profitability (Glasbergen, 2018; Hidayat et al., 2016). With these insights, we formulate our first hypothesis.

H1. Farmers' adoption decision is positively influenced by the introduction of a cash premium.

Studies have identified multi-stakeholder approaches as essential for integrating smallholders into certification schemes, particularly to address complex organizational demands (Garrett et al., 2016; Watts et al., 2021). Among these demands, issuing a cash premium is a potential mechanism to foster adoption, with various institutions capable of serving as issuers. In this study, we test how different institutions influence farmers' willingness to adopt a certificate. We hypothesize that cash premiums issued by the Indonesian Government positively influence smallholders' willingness to adopt as smallholders tend to place higher trust on national governments (Hendrawan and Musshoff, 2024a). Indeed, trust has been identified as a major driver of farmers' support for governmental interventions (Alkon and Urpelainen, 2018). We thus arrive at our second hypothesis.

H2. Farmers' adoption decision is positively influenced by the Indonesian Government as the issuer of cash premiums under a certification scheme.

Acquiring certification for the farm currently requires farmers to hold land titles and permits for oil palm cultivation issued by the government. However, most smallholders lack these documents which is a substantial obstacle to certification and further perpetuates the exclusion of smallholders (Apriani et al., 2020; Brandi et al., 2015; Watts et al., 2021). Access to and ownership of land rights has been shown to drive productivity (Ullah et al., 2024) and foster the uptake of sustainability practices among farmers (Adamie, 2021; Deininger, 2014). It is therefore worth considering whether and how smallholders could be provided with land titles for existing farmland during the certification process. Moreover, to ensure environmental sustainability, land titles should be linked to penalties for environmentally destructive behavior, which smallholders are often disproportionally associated with (Ibanez and Blackman, 2015). A similar approach has been implemented via the EU REDD facility, where tenure rights are linked to obligations concerning agroforestry (Vaudry, 2022). To address this, we focus on two main drivers of environmental destruction: illegal land openings, often through forest encroachment as well as opening land or removing old plantations through slash-and-burn (Brandi et al., 2015; Ibanez and Blackman, 2015; Morgans et al., 2018). We thus test if farmers would accept obligations to refrain from land openings and slash-and-burn practices in favor of land titles and permits for oil palm cultivation. We therefore arrive at the following third hypothesis.

H3. Farmers' adoption decision is positively influenced by the provision of land rights and production permits even under obligations to refrain from land openings and slash-and-burn techniques.

Capacity building and farm management trainings are essential in ensuring increased farm productivity, particularly since smallholders

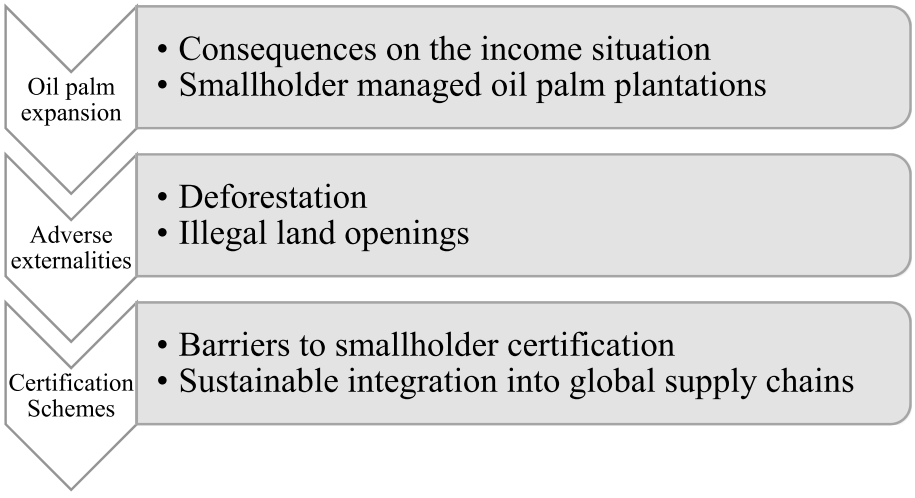

Fig. 1. Graphical presentation of the literature review.
Source: Own illustration

are associated with overfertilizing and lower harvest amounts which remain below the potential crop yield (Darras et al., 2019). Additionally, capacity building measures and trainings on the use of agronomic input factors largely impact the effectiveness of certificates on farmers' livelihoods (de Vos et al., 2023; Hidayat et al., 2015). The fourth hypotheses thus states.

H4. Farmers' adoption decision is positively influenced by the provision of farm management trainings.

The lack of organizational and financial capacities are among the primary hurdles of smallholder certification (Brandi et al., 2015; Watts et al., 2021). For instance, the costs of certification for smallholders largely depend on the prior endowment and management of the farm (Brandi et al., 2015; Glasbergen, 2018; Hidayat et al., 2016; Hutabarat et al., 2018). Unclear ways of obtaining certification further lowers the willingness of farmers to invest, particularly since economic benefits under a certificate remain opaque to most smallholders (Glasbergen, 2018). We thus state in hypothesis five.

H5. Farmers adoption decision is negatively influenced by the introduction of certification costs.

In addition to the previously discussed challenges hindering smallholders' certification, it's crucial to consider the potential influence of behavioral aspects on farmers' decisions to adopt certification schemes. The connection between one's risk attitude and the adoption of a certificate has been explored in studies such as Mohan (2020) and Ayuya et al., (2015) providing first, limited insights. Investigating the impact of these behavioral factors on adoption decisions not only helps us understand their role but also informs the development of policies aimed at reducing risk for smallholders and promoting certification. Moreover, we highlight the role of socioeconomic factors and farm characteristics in shaping farmers' decisions to adopt, providing a comprehensive perspective on the drivers of certification adoption.

We test the previously outlined hypotheses via a discrete choice experiment, explained in more detail in the following section. Discrete choice experiments are widely applied, particularly within agricultural economics to understand choice drivers for different forms of policy interventions (Block et al., 2024a,b; Caputo et al., 2023; Hendrawan and Musshoff, 2024b). Eliciting and highlighting smallholders' preferences enables an improved understanding of smallholders' needs, thereby ensuring participatory and inclusive policy designs (Meemken et al., 2017; Potts et al., 2014). We further strengthen our analysis through the estimation of willingness-to-pay measures, which provide valuable insights into how much farmers value a particular attribute.

3. Experimental design and data collection

Since currently certified smallholders typically operate under a certified mill, the current certification rate does not mirror farmers' active adoption decision. Hence, we cannot observe revealed preferences for certification schemes among smallholders and thus have to rely on a discrete choice experiment. Discrete choice experiments are particularly well established for ex-ante policy impact analysis and to thereby analyze stated preferences around non-market goods, particularly in environmental, agricultural economics and health economics (Buchholz et al., 2022; Chen et al., 2023; Luksameesate et al., 2023 ; Ward and Makhija, 2018).

3.1. Discrete choice experiment

The design of our choice experiment presented farmers with three options: two alternatives describing different certification schemes and a third option representing the choice to opt-out, indicating no certification scheme. Farmers were asked to decide among these alternatives during the experiment. Hence, each choice card consisted of two alternatives and the opt-out option. The opt-out option mirrored the voluntary nature of certification. Farmers are often unaware of the certificates available and the features which they entail (Glasbergen, 2018). By excluding names of certificates, we guide farmers' attention towards the attributes of each alternative, rather than being distracted by a certificate name.

The attributes in our choice experiment reflect the key barriers to smallholder certification as outlined in section 2. We address these challenges by deconstructing them into distinct attributes of hypothetical certificates in our choice experiment, and thereby identify which attributes drive smallholders' adoption decision. See Table 1 for an overview of the attributes and attribute levels.

The first attribute of the choice experiment describes the cash premium paid directly to the farmer, per certified hectare, per year. The attribute levels vary at 3 Mio. IDR, 5 Mio. IDR, and 7 Mio. IDR. We arrived at these values based on the existing literature.

We include a second attribute describing the issuer of the cash premium, providing three possibilities, namely, a certification agency, the Indonesian government, and a supranational organization, such as the European Union (EU) or the Association of Southeast Asian Nations (ASEAN). This attribute also enables us to investigate farmers' attitude towards these different governmental bodies and their role within the industry.

The provision of land titles and permits under obligations could be an effective approach to promote sustainability while discouraging harmful land management practices. The third attribute is thus described by the following attribute levels: oil palm permit + land rights; oil palm permit + land rights + no illegal land openings; oil palm permit + land rights + no slash & burn.

In order to foster capacity building on small-scale farms, we included the fourth attribute of farm management training with three different intensities: No training, a one-time training prior to certification, and yearly trainings as long as the farmer operates under a certificate.

As a fifth and final attribute we include the costs per certified hectare per year in the choice experiment. These costs typically represent additional expenses for yearly audits as well as the acquisition of different input factors to adhere to the production standards under a certificate, as outlined in the literature. We investigate the impact of certification costs on farmers' willingness to adopt a certificate through three different levels, namely 2.5 Mio. IDR, 5 Mio. IDR, and 7.5 Mio. IDR.

Farmers are typically certified as a farmer group, consisting of members from different, geographically close villages often based on mutual sympathy. Group access introduces valuable economies of scale e.g. regarding harvest management of the perishable fresh fruit bunches, yearly audit costs, trainings, and internal monitoring (Maertens and

Table 1
Attributes and their associated levels.

Attributes	Levels
Cash premium per certified hectare per year	3 Mio. IDR 5 Mio. IDR 7 Mio. IDR
Issuer of the cash premium	Certification agency Indonesian Government Supranational organization (EU, ASEAN)
Land rights & oil palm permits with and without obligations	Land rights + oil palm permits Land rights + oil palm permits + no illegal land openings Land rights + oil palm permits + no slash-and-burn
Farm management training	No training One-time training Yearly trainings
Costs per certified hectare per year	2.5 Mio. IDR 5 Mio. IDR 7.5 Mio. IDR

Exchange Rate: 1 USD = 14,205 IDR (October 2021).

Swinnen, 2008; Mausch et al., 2009; Narrod et al., 2009; Sellare et al., 2020). However, employing a group-decision making processes can introduce substantial noise and bias due to social influence, power dynamics or dominant group members. Therefore, we elicit farmers' preferences at the individual level. This enables a more nuanced understanding of effective certification designs that accommodate smallholders' needs.

3.2. Experimental implementation and data collection

Respondents were confronted with twelve choice cards in an unlabeled choice experiment. Table 2 displays an exemplary choice card. Prior to answering the twelve choice cards, respondents were asked to complete a practice choice set in order to familiarize themselves with the experiment. Within this practice choice set one alternative was clearly superior, with the highest level of cash premiums and the lowest level of costs. The inferior choice set was chosen by 16 respondents, which did not result in their exclusion during the main choice experiment (Lancsar and Louviere, 2006; Miguel et al., 2005; Ryan et al., 2009). To ensure informed choices throughout the experiment, we provided printed documents with descriptions of the attributes and levels. We also addressed the issue of hypothetical bias by continuously reminding respondents of the opt-out option (Lancsar et al., 2007). Following Hensher et al. (2015), we used the results obtained from the pretest as priors for calculating the choice cards following a d-efficient, fractional factorial design in Ngene. Each alternative, reflecting a potential certification scheme, was described by five attributes with varying attribute levels, as displayed in Table 1. We further checked for attribute-level balance, orthogonality across the attributes, minimal overlap and utility balance for all choice sets (Hensher et al., 2015; Louviere et al., 2010).

The main data collection took place from October until December 2021, following a pre-test which ran in September 2021. The study was approved by the ethical commission of the Indonesian Government and participation was voluntary and could be withdrawn at any point during the questionnaire. Data was collected across the province of Jambi – allowing us to work with a broad geographical sample (see Fig. 2 for a map of Jambi province). As Jambi is the second largest province in Indonesia in terms of smallholder-managed oil palm plantations, wherein 40% of oil palm plantations are smallholder-managed (Apriani et al., 2020; Euler et al., 2016; Krishna et al., 2017), it stands out as the ideal location for this study. Additionally, Jambi province is a well-established hub of oil palm plantations in Indonesia, with livelihoods heavily reliant on its cultivation (Jelsma et al., 2019; Qaim et al., 2020; Santika et al., 2020). Within the province of Jambi, as in the rest of Indonesia, the certificate issued by RSPO is currently the dominant one (Ponte and Cheyns, 2013).

We built our sample following a multi-stage sampling procedure and therefore firstly identified the five biggest oil palm cultivating regencies within the province of Jambi (Krishna et al., 2017). Based on the five regencies, we randomly selected four districts per regency. Lastly, we randomly selected two villages per district. Within each village, a team of enumerators randomly approached farmers. In order to control for neighborhood effects and wherever possible, no more than two smallholders were interviewed within the same street. Respondents with a total acreage of more than 20 ha and those who were primarily cultivating crops other than oil palms were excluded from the study. Furthermore, we excluded plantation caretakers from our sample as we argue that the adoption of a certification scheme is a decision usually made by the plot owner, since the additional costs required for adherence to a certificate can be seen as an investment into the farm. Should respondents be taking care of other plots beyond the ones they own, we asked them to only consider their own plots in their answers.

The household survey was conducted by a team of trained enumerators who interviewed the farmers at their respective homes. Furthermore, as is common in psychology and within discrete choice experiments, we did not directly monetarily incentivize our experiment (Madsen and Stenheim, 2015). Following insights gained during the pre-test we moved the experiment to the first part of the questionnaire to avoid tiring effects among respondents. The final structure of the questionnaire was thus as follows: Respondents first participated in the choice experiment. Afterwards, survey participants answered questions on their socioeconomic aspects such as age, household size and education as well as behavioral questions, e.g. self-assessing one's risk attitude or the respondents' locus of control, both measured on scales from 0 to 10. The overall sample consists of 251 oil palm smallholders. The data was anonymized.

Table 2
Example choice card.

Alternative 1	Alternative 2	No choice
Cash premium per certified hectare per year	3 Mio. IDR	7 Mio. IDR
Issuer of the cash premium	Certification agency	Supranational organization (EU, ASEAN, …)
Land rights & permits with and without obligations	Land rights + Oil palm permits + no slash and burn	Land rights + Oil palm permits
Farm management training	One-time training	Yearly trainings
Costs per certified hectare per year	5 Mio. IDR	2.5 Mio. IDR

Exchange Rate: 1 USD = 14,205 IDR (October 2021).

4. Methodology

According to the random utility theory of Lancaster (1966), which was then further developed by McFadden, individuals make choices based on the utility they derive from different alternatives (McFadden, 1973). These alternatives are described by attributes and their associated levels which vary with each choice set (Louviere et al., 2000).

In our case, farmers $i \in \{1, \ldots, I\}$ maximize their utility U based on alternative $j \in \{1, \ldots, J\}$ within each choice situation $k \in \{1, \ldots, K\}$. The utility function can thus be modelled as the following equation:

$$U_{ijk} = \beta_i x_{ijk} + \varepsilon_{ijk} \quad (1)$$

Here, x_{ijk} describes the attributes of certification scheme j in choice set k as chosen by farmer i. The farmers' utility, denoted by U_{ijk}, captures their individual preferences, while ε_{ijk} represents the unobserved error component that accounts for idiosyncratic factors and unobserved influences. By estimating parameters β_i we can quantify the impact of different attributes on smallholders' utility and determine their preferences towards specific certification schemes. Following utility theory, we assume homogeneous preferences among all respondents for higher cash premiums and lower certification costs. Hence, the cash premium, as well as the cost attribute are set as non-random in our estimation. All other attributes were set as random since preferences are assumed to be heterogeneous across respondents. In equations (2)–(5) *Premium* denotes the cash premium paid per certified hectare per year, while *Issuer* refers to the body issuing the cash premium. *Rights* refers to the provision of land rights and oil palm permits, with and without obligations to refer from land clearing and slash-and-burn techniques. *Training* denotes farm management trainings and *Costs* refers to certification costs per hectare per year. Our models include an alternative specific constant (ASC). The ASC is a dummy variable, coded 1 for each of the certification alternatives and 0 for the opt-out option. Therefore, the ASC represents farmers' general attitude towards certificates, without considering the presented attributes, which also allows us to accommodate concerns over omitted variable biases. Thereby the ASC captures any utility the smallholders might derive from certificates, which were not represented in the attributes.

Fig. 2. Map of the research location Jambi province.
Source: Own illustration.

We therefore estimate the following base model:

$$Y_{ijk} = \beta_0 ASC + \beta_1 Premium_{ijk} + \beta_2 Issuer_{ijk} + \beta_3 Rights_{ijk} + \beta_4 Training_{ijk} + \beta_5 Costs_{ijk} + e_{ijk} \quad (2)$$

Y describes farmers i binary decision for alternative j in choice set k.

We further explore the heterogeneity among smallholders by including interaction terms into the base model described in equation (2). Including interaction terms between the ASC and different farm and respondents' characteristics allows us further insights into the drivers of farmers' preferences. In a first step we are interested in socioeconomic variables, such as age, education and the previously discussed background in transmigration and their potential impact on farmers' preferences. In order to understand possible relationships, we estimate the following extended equation:

$$Y_{ijk} = \beta_0 ASC + \beta_1 Premium_{ijk} + \beta_2 Issuer_{ijk} + \beta_3 Rights_{ijk} + \beta_4 Training_{ijk} + \beta_5 Costs_{ijk} + \beta_6 (ASC \times age) + \beta_7 (ASC \times education) + \beta_8 (ASC \times transmigration) + e_{ijk} \quad (3)$$

Additionally, we expect behavioral aspects such as the individuals risk attitude, and farmers' personalities to influence their adoption decisions. Farmers personalities, reflected in their locus of control and perceived control as farmers, have been shown to influence their adoption decision e.g. regarding new technology or farm management practices (Abay et al., 2017; Wuepper et al., 2020). Locus of control and the perceived control as farmers refer to an individual's perception of the extent to which they have control over the events that affect their lives. In this context, it means they perceive themselves as having a greater ability to control and manage their farm operations, including the implementation of new production standards required for certification. These factors are represented as follows:

$$Y_{ijk} = \beta_0 ASC + \beta_1 Premium_{ijk} + \beta_2 Issuer_{ijk} + \beta_3 Rights_{ijk} + \beta_4 Training_{ijk} + \beta_5 Costs_{ijk} + \beta_6 (ASC \times age) + \beta_7 (ASC \times education) + \beta_8 \Big(ASC \times transmigration + \beta_9 (ASC \times locus\ of\ control) + \beta_{10} (ASC \times risk\ attitude) + \beta_{11} (ASC \times farm\ success\ dependent\ on\ skills) + e_{ijk} \quad (4)$$

Lastly, we investigate the role of farm characteristics and previous experience with certificates on preference heterogeneity. Initial farm characteristics are shown to be associated with higher profitability under a certificate and thus might positively influence the adoption of certification (Hidayat et al., 2016). We therefore estimate the following equation:

$$Y_{ijk} = \beta_0 ASC + \beta_1 Premium_{ijk} + \beta_2 Issuer_{ijk} + \beta_3 Rights_{ijk} + \beta_4 Training_{ijk} + \beta_5 Costs_{ijk} + \beta_6 (ASC \times age) + \beta_7 (ASC \times education) + \beta_8 \Big(ASC \times transmigration + \beta_9 (ASC \times locus\ of\ control) + \beta_{10} (ASC \times risk\ attitude) + \beta_{11} (ASC \times farm\ success\ dependent\ on\ skills) + \beta_{12} (ASC \times farm\ size) + \beta_{13} (ASC \times experience\ with\ certification) + \beta_{14} (ASC \times farm\ succession) + e_{ijk} \quad (5)$$

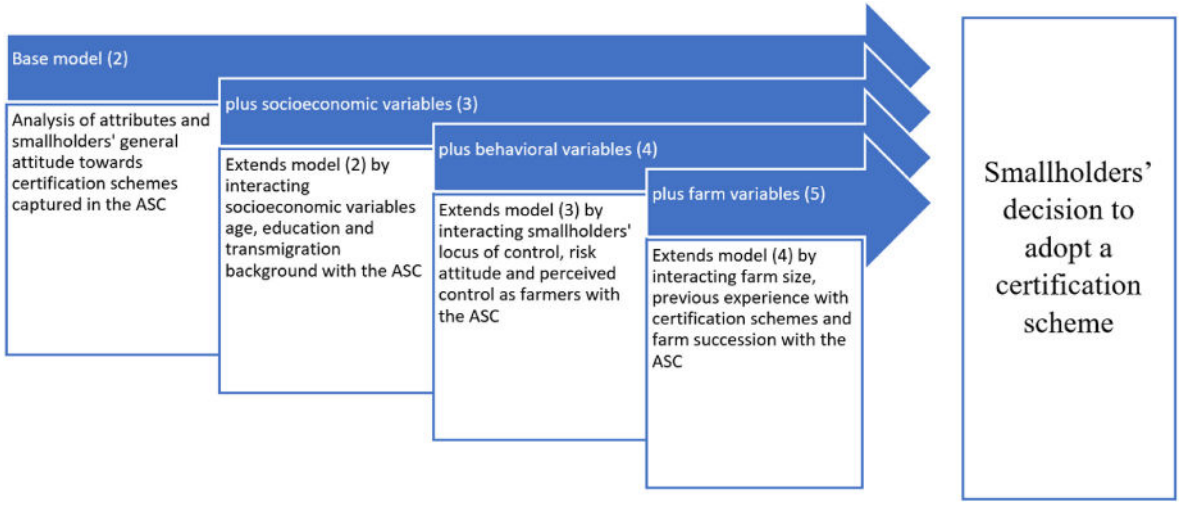

Fig. 3. Graphical display of the methodological approach.
Source: Own illustration.

Table 3
Descriptive statistics of respondents (n = 251).

Variable	Unit	Mean/ Percentage	Standard deviation
Socioeconomic variables			
Age	Years	41.9	10.08
Education	Years	9.8	3.65
Gender (male)	1/0	.93	–
Married (yes)	1/0	.92	–
Transmigration background (yes)	1/0	.31	–
Behavioral Variables			
Control over Farm Productivity[a]	Number	8.1	1.79
Locus of Control[a]	Number	7.1	2.12
Risk attitude[a]	Number	5.6	2.74
Farm Data			
Certification (yes)	1/0	.11	
Farm succession (yes)	1/0	.86	–
Land size	Hectare	3.4	3.05
Main income from oil palm plantation (yes)	1/0	.84	–
Member of farmer group (yes)	1/0	.40	–
Permit for oil palm cultivation (yes)	1/0	.12	–
Monthly on-farm income in IDR			
Below 1,500,000	1/0	.18	–
1,500,001–3,000,000	1/0	.23	–
3,000,001–4,500,000	1/0	.15	–
4,500,001–6,000,000	1/0	14.8	–
6,000,001–7,500,000	1/0	.07	–
7,500,001–9,000,000	1/0	.06	–
9,000,001–10,500,000	1/0	.02	–
10,500,001–12,000,000	1/0	.02	–
Above 12,000,000,001	1/0	.09	–

[a] Measured on a scale from 0 to 10.

Equations (2)–(5) can also be represented in a graphical format as displayed in Fig. 3, which shows the sequential extension of equation (2) through the addition of variables capturing potential influencing variables on smallholders' adoption decision.

We estimate equations (2)–(5) via a maximum likelihood simulation with a mixed logit model in Stata 17 (Train, 2009). This approach accommodates preference heterogeneity across individuals as well as random taste variation. As common in choice modelling, we test the robustness of our estimation results through increased Halton draws – the results reported in section 5 are obtained using the usual 1000 Halton draws (Train, 2000). The attribute levels are dummy-coded (Hu et al., 2022). We utilize the Wald test to assess the statistical significance of the estimated coefficients in our mixed logit models (Hensher et al., 2015; Train, 2009).

5. Results & discussion

5.1. Descriptive results

Table 3 shows the descriptive statistics of our sample. Our respondents are on average 42 years old, the majority is male (92.8%) and married (93.2%). The gender ratio of our sample reflects the male-dominated nature of the palm oil industry (Chrisendo et al., 2020; Mehraban et al., 2022). Respondents report on average 9.8 years of schooling. Approximately 31.3% of respondents have a transmigration background - either through themselves or their parents' participation in the transmigration program. Respondents were asked to assess their willingness to take on risks on a scale from 0 to 10 (Dohmen et al., 2011), where 0 indicated no willingness to take on risk and 10 meant an individual is fully prepared to take on risk. The average willingness to take on risk was 5.6. Respondents were asked to rate their perceived control over various aspects on a scale from 0 to 10, where 0 indicated no control and 10 represented full control. The average score for locus of control, reflecting the perceived control over life events, was 7.1. For farm productivity, respondents indicated a slightly higher average score of 8.1, suggesting a greater perceived level of control.

Regarding the farm data, respondents cultivate an average of 3.4 ha, with 12% being experienced with certification. Most, 86% of respondents, report they hope for their children to continue their farms. Many, 40% of the sample, are members of a farmer group, which is currently a prerequisite for adopting a certificate such as RSPO (Brandi et al., 2015). Most, 85% of respondents, obtain their primary income from oil palm cultivation, for which only 13% hold the necessary official permits. The majority of respondents, 57%, generates below 4.5 Mio. IDR on-farm income per month from oil palm cultivation (4.5 Mio. IDR correspond to approximately 316.79 USD as of October 2021).

In order to support the estimation results obtained from the choice experiment, we also investigate farmers' general attitude towards certification schemes measured on a five-point Likert-scale. We furthermore included the option to choose "I don't know" within the Likert-scale questions. Including the option to choose "I don't know" provides an additional layer of credibility to the farmers' choices. By including this option, farmers are given the opportunity to express their uncertainty or lack of knowledge regarding the statement or question being presented. This acknowledges that farmers may have genuine limitations in their understanding or awareness of certain aspects, allowing for

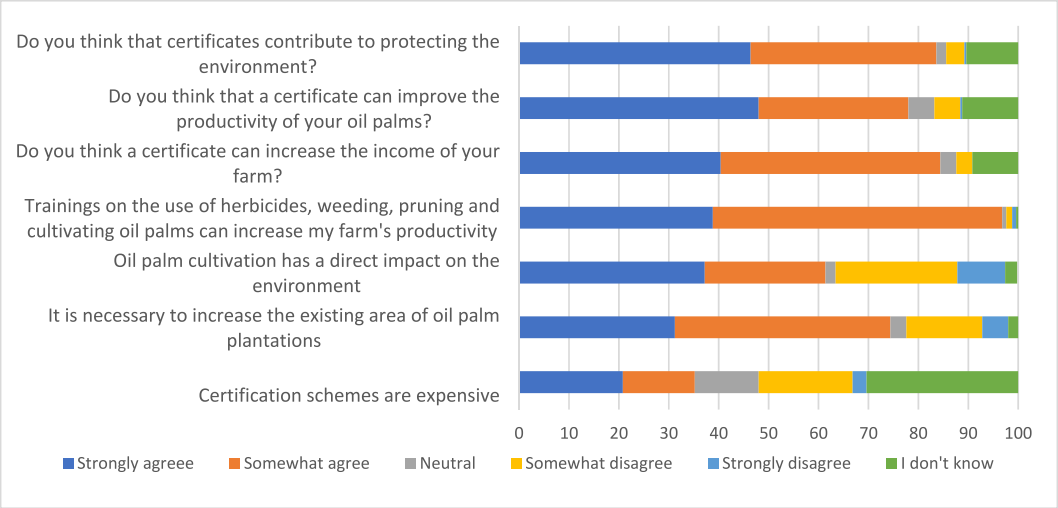

Fig. 4. Descriptive statistics on Likert-scale statements & questions (in percentage, n = 251).
Source: own illustration based on survey data.

a more accurate reflection of their responses. The results are displayed in Fig. 4.

As certificates aim to mitigate adverse impacts of oil palm cultivation on the environment, farmers' attitude towards environmental topics and their perceived impact of oil palm cultivation on its surroundings are driving factors in the decision-making processes regarding the adoption of a certificate. Regarding the costs, 35% of respondents strongly or somewhat agree to certificates being expensive, while another 30% indicate that they do not actually know if certification schemes are expensive, suggesting a potential low information level or uncertainty regarding the expenses involved. Interestingly, despite potential low information levels among smallholders, 84% of respondents either strongly or somewhat agree that being certified would have a considerable positive impact on their income. While 61% either strongly agree or somewhat agree to the direct environmental impact of oil palm cultivation, it is interesting to note that 74% strongly or somewhat agree that increasing the existing area of oil palm cultivation is necessary. Moreover, 78% strongly or somewhat believe that their farms' productivity would be improved under a certification scheme. In line with these findings, 84% of respondents strongly or somewhat recognize the potential of certification schemes in contributing to environmental protection. Additionally, a substantial 95% of respondents strongly or somewhat agree to the positive impact of farm management training, specifically in areas such as pruning, fertilizer usage, herbicides, and weeding, on improving their yield. These answers suggest a general positive attitude towards certificates and a general openness towards learning and capacity building.

5.2. *Estimation results on farmers preferences towards certification schemes*

This section discusses the results of the mixed logit models, as previously outlined in equations (2)–(5). Regarding the goodness of fit, all 4 models show statistical significance, as indicated by the chi squared measure in Table 4. A positive coefficient of the attribute level indicates a higher probability of a farmer choosing a certificate with this specific attribute level.

Regarding the estimation results of model I, the general openness and positive attitude of farmers for certificates as indicated in the descriptive results in Table 3, are supported by the positive and statistically significant coefficient for the ASC. Furthermore, all attributes presented in the choice experiment influence smallholders' utility, as indicated by their respective statistical significance levels. Preference heterogeneity across the sample is indicated by the statistically significant standard deviations shown in the lower part of model I in Table 4. See also Fig. 5 for a graphical presentation of model I results.

The coefficients for the cash premium per certified hectare per year in model I is positive and statistically significant, indicating farmers are more likely to choose a certificate which includes a cash premium. Thus, we cannot reject H_1 as farmers' decision to adopt a certification scheme is positively influenced by the introduction of a cash premium.

Regarding the providing institution, the coefficient of the level representing the Indonesian government is positively and statistically significant, indicating smallholders' preferences for a domestic institution. Hence, we cannot reject H_2 as the empirical results indicate that the issuing institution influences farmers' adoption decision.

Turning to the provision of land rights and permits under obligations, only the level of obtaining land rights + oil palm permit with the obligation of no illegal land openings shows statistical significance. As expected, the negative coefficient implies that the requirement to avoid illegal land openings is negatively linked to certificate adoption. Additionally, this result suggests that respondents grasp the nuances of the choice experiment, discerning between different requirements and their practical implications. Given that this attribute was included to explore mechanisms for a potential freeze-in of the status quo by discouraging further illegal land openings, these results hold particular importance. Notably, the combination of land titles and permits with the obligation of no slash and burn does not exhibit statistical significance in relation to certificate adoption. Thus, we reject H_3 as farmers' adoption decision is shown to be negatively influenced by the provision of land rights and permits under the obligation to refrain from illegal land openings.

Both levels of the attribute on farm management trainings are positive and highly statistically significant. This signals a strong preference for certification schemes which offer any form of farm management training, particularly continuous trainings. Including farm management trainings can enhance certification schemes attractiveness and improve productivity and efficiency on smallholder farms. The estimation results align with the descriptive results, providing robust evidence that supports the validity of our study. Thus, we cannot reject H_4 as farmers' adoption decision is positively influenced by the provision of one-time as well as continuous farm management trainings.

The coefficient for costs per certified hectare per year is negative and statistically significant. Hence, smallholders are less likely to choose a certificate as costs increase. Therefore, we cannot reject H_5 as farmers' adoption decision is negatively influenced by certification costs.

Table 4
Estimation results of the mixed logit models (n = 251).

Mean parameters (standard errors)	*(I)*	*(II)*
ASC	4.844 *** (.708)	3.963 (2.131)
Cash premium	.015 *** (.002)	.015 *** (.002)
Issuer Indonesian government (dummy)[b]	.755 *** (.107)	.755 *** (.107)
Issuer supranational agency (dummy)[b]	−.014 (.079)	−.014 (.079)
Land rights + permits + no illegal land opening[c]	−.143 * (.072)	−.144 * (.072)
Land rights + permits + no slash & burn[c]	.212 (.111)	.215 * (.111)
Yearly farm management training[d]	1.211 *** (.208)	1.207 *** (.208)
One-time farm management training[d]	.994 *** (.219)	.991 *** (.219)
Costs	−.017 *** (.001)	−.017 *** (.001)
ASC interaction terms		
ASC *x* age		−.034 (.851)
ASC *x* education		.274 ** (.106)
ASC *x* transmigration		−1.040 (.851)
ASC *x* farm success dependent on skills		
ASC *x* locus of control		
ASC *x* risk attitude		
ASC *x* experience with certification		
ASC *x* farm size		
ASC *x* farm succession		
Standard deviation parameters		
ASC	5.588 *** (.704)	5.314 *** (.626)
Documentation + no illegal land opening	−.209 (.159)	−.208 (.167)
Documentation + no slash & burn	−.473 *** (.102)	.472 *** (.104)
Issuer Indonesian government (dummy)	−.412 *** (.112)	−.404 *** (.114)
Issuer supranational agency (dummy)	−.567 *** (.079)	−.559 *** (.097)
Training continuous	−.561 *** (.009)	−.553 *** (.100)
Training once	−.313 ** (.162)	−.355 ** (.143)
Goodness of fit measures		
Log likelihood	−2229.683	−2225.063
Chi squared	1138.81 ***	1079.490 ***

Mean parameters (standard errors)	*(III)*	*(IV)*
ASC	.837 (2.917)	−1.630 (3.124)
Cash premium	.015 *** (.002)	.016 *** (.003)
Issuer Indonesian government (dummy)b	.761 *** (.108)	.804 *** (.116)
Issuer supranational agency (dummy)[b]	−.013 (.079)	−.014 (.084)
Land rights + permits + no illegal land opening[c]	−.144 * (.072)	−.152 (.078)
Land rights + permits + no slash & burn[c]	.212 (.112)	.249 * (.112)
Yearly farm management trainings[d]	1.208 *** (.209)	1.183 *** (.221)
One-time training[d]	.996 *** (.220)	1.043 *** (.235)
Costs	−.017 *** (.001)	−.018 *** (.002)
ASC interaction terms		
ASC *x* age	−.038 (.041)	.037 (.036)
ASC *x* education	.235 (.148)	.343 (.133)
ASC *x* transmigration	−.802 (.740)	−.776 (.834)
ASC *x* farm success dependent on skills[e]	−.123 (.123)	−.104 (.112)
ASC *x* locus of control[e]	.285 (.171)	.206 (.160)
ASC *x* risk attitude[e]	.436 *** (.127)	.521 *** (.129)
ASC *x* experience with certification		−1.559 (1.080)
ASC *x* farm size		−.279 * (.119)
ASC *x* farm succession *x*		−.306 (1.003)
Standard deviation parameters		
ASC	5.001 *** (.109)	5.373 *** (.713)
Documentation + no illegal land opening	.192 (.181)	−.193 (.189)
Documentation + no slash & burn	.485 *** (.104)	.469 *** (.104)
Issuer Indonesian government (dummy)	.437 *** (.109)	−.422 *** (.111)
Issuer supranational agency (dummy)	.563 *** (.097)	.561 *** (.097)
Training continuous	.565 *** (.102)	−.556 *** (.103)
Training once	−.379 ** (.135)	−.346 * (.144)
Goodness of fit measures		
Log likelihood	−2219.434	−1992.030
Chi squared	999.57 ***	933.01 ***

Single, double and triple asterisks (*, **, ***) indicate statistical significance at the 5%, 1% and .1% level.
Halton draws = 1000.
Reference category is issuer being a certification agency.
Reference category is documentation without obligations.
Reference category is no farm management training.
Measured on a scale from 0 to 10.

5.3. Preference heterogeneity

The standard deviation parameter for the ASC is positive and statistically significant, which hints at heterogeneity within the sample (see Table 4). Therefore, we now explore drivers for preference heterogeneity by cumulatively extending base model I, allowing for a more detailed analysis. Here, we look at different characteristics of farmers and their individual background, which might drive farmers'

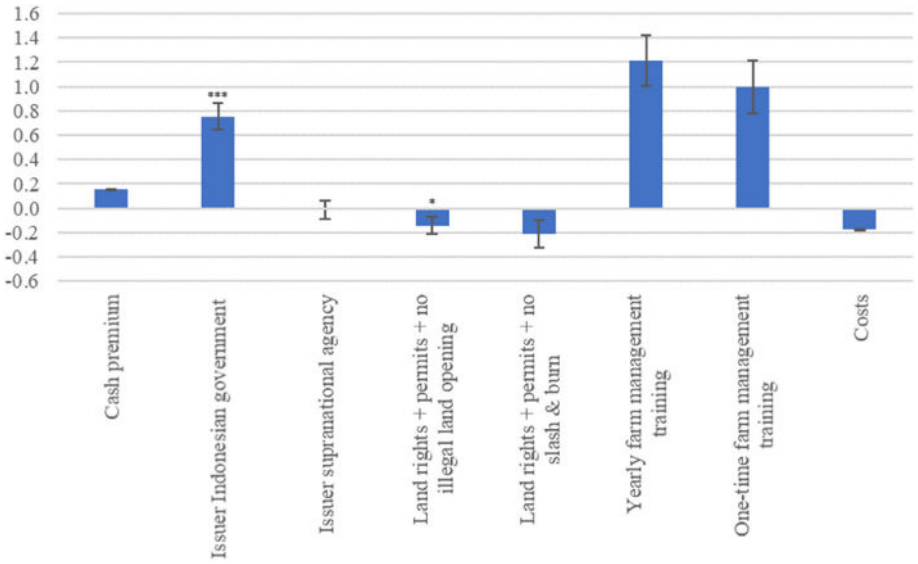

Fig. 5. Graphical presentation of model I results.
Estimated coefficients of model I with errors bars representing standard errors. Single, double, and triple asterisk (*, **, ***) indicate statistical significance at the 5%, 1% and .1% level. Source: Own illustration.

Table 5
Willingness to pay estimates in IDR (n = 251).

Attribute	*WTP*	*95% Confidence Interval*	
Land rights + permits + no illegal land opening -	8,483,511	−17,469,50	−172,796
Land rights + permits + no slash & burn	12,627,355	−093,058	24,807,543
Issuer Indonesian government	44,331,994	32,556,573	57,185,696
Issuer supranational agency	−845,532	−10,216,104	8,358,998
Yearly farm management trainings	71,062,876	50,416,644	94,846,726
One-time farm management training	58,328,327	36,255,441	80,669,807

Exchange Rate: 1 EUR = 14,205 IDR (October 2021).

preferences for certificates.

Firstly, we investigate the impact of age, education and transmigration background on smallholders' preferences, see equation (3). Model II in Table 4 extends the base model I by interaction terms for age, education and transmigration background. Notably the estimates for cash premium, the issuing body and farm management trainings remain stable, suggesting that the model specification is appropriate and captures the main effects effectively. While increasing age is negatively associated with certificate adoption, it is not a statistically significant driver of farmers' choices. Similarly, transmigration background does not statistically significantly influence farmers' preferences. However, the positive and statistically significant coefficient for education suggests that farmers with higher levels of education are more likely to adopt certification schemes. This result aligns with the understanding that obtaining certification requires substantial management effort and knowledge, which might be easier handled by more educated farmers. Thus, this result also underlines the urgency for comprehensive and targeted support mechanisms to ensure an all-encompassing inclusion of smallholders.

Further, we explore the role of behavioral variables on farmers' adoption uptake. Model III in the continued Table 4, displays a cumulative extension of the base model I by the interaction terms of locus of control, risk attitude and the perceived control over the farm's productivity. The self-assessed risk attitude positively and statistically significantly influences the decision to obtain certification. As previously outlined, particularly the costs associated with a certificate can be seen as a form of investment into one's farm. This can be argued to require a willingness to take on risks as well as an openness towards new technologies and innovations. We can thus state that less risk averse farmers are more likely to adopt a certification scheme. Hence designing certification schemes which notably lower the risk on the smallholder side can potentially contribute to higher adoption rates. In contrast, the positive coefficient for locus of control does not reach statistical significance, indicating that the individual's perceived locus of control is not reliably linked to the decision to adopt a certificate. Despite the lack of statistical significance, the positive coefficient suggests a potential trend: Individuals with a higher sense of control over their lives may exhibit greater confidence in adapting to new regulations, potentially fostering a more open attitude toward innovation and entrepreneurial endeavors on their farms (Knapp et al., 2021).

In Model IV, we delve into the impact of farm size, prior certificate experience, and farm succession on farmers' decision-making. Notably, the interaction term with farm size is both statistically significant and negative. This suggests that as the size of respondents' farms increases, there is a reduced likelihood of adopting a certificate. This finding implies that larger-scale farmers may weigh the associated rising costs more prominently, potentially diminishing their utility and dissuading them from certificate adoption. In contrast, factors such as farm succession and previous experience with certification do not exhibit statistically significant effects on farmers' choices.

Based on these results we can state that smallholders would more likely adopt a certificate if it includes transparent economic benefits, such as a cash premium issued by the Indonesian Government, per certified hectare, per year, and continuous farm management trainings. In contrast, smallholders are less likely to adopt a certificate as costs increase and if the provision of land rights and permits were tied to the obligation of no illegal land openings. The results of model I remain consistent when controlling for uncertified farmers, underscoring the robustness of our findings.

5.4. Farmers willingness to pay for certification schemes

Table 5 displays the willingness to pay estimates and their corresponding confidence intervals, which were obtained from the estimates of the base mixed logit model. Following the delta method and estimating willingness to pay measures in preference space, we divide each attribute by the negative of the cost coefficient. Positive coefficients indicate that farmers value certain attribute levels more, while negative

estimates indicate that compensation payments are expected for certain design attributes.

Consistent with the estimation results, farmers placed higher value on continuous and one-time farm management trainings, with the highest willingness to pay for continuous trainings. Further, farmers value the Indonesian government as the premium's issuer higher compared to a supranational agency. The requirement of no slash & burn displayed a positive willingness to pay, while the requirement of no illegal land openings resulted in a negative willingness to pay estimate, likely due to farmers' awareness of the difficulty surrounding additional land acquisitions for oil palm smallholders. The expected compensation payment therefore seems reasonable from the smallholders' perspective. Similarly, the positive estimate regarding farmers' willingness to pay for the requirement of no slash & burn could result from the negative externalities associated with fire usage for land clearings and thus reflect farmers' wishes for external regulation.

5.5. Discussion of results

Oil palm cultivation has been a major driver of rural development, providing income and livelihood opportunities for smallholder farmers, particularly in Jambi, Indonesia. However, the expansion of oil palm has come at high environmental costs, including deforestation and biodiversity loss (Qaim et al., 2020). In order to internalize these adverse externalities, certification schemes have emerged as promising tools, particularly in tropical agricultural goods such as coffee or cocoa (Gather and Wollni, 2022). Yet, oil palm smallholders face barriers in the adoption of certification schemes, reflected in a low adoption rate. Barriers identified in the literature range from high investment costs, uncertain monetary pay-offs and complex requirements paired with limited support structures. These barriers hinder efforts to achieve sustainable practices in oil palm cultivation, raising critical concerns about the environmental and social sustainability of smallholder-managed oil palm plantations. However, the contribution of oil palm cultivation to rural development, combined with the proven efficiency of certification schemes in fostering sustainable agricultural practices, underscores the need to identify pathways for supporting smallholder certification.

We address these challenges in a choice experimental approach among 251 farmers in Jambi province. Employing a discrete choice experiment allows us to elicit farmers' preferences for certification schemes. Furthermore, the use of a discrete choice experiment analyzed via mixed logit models offers a robust framework for understanding preference heterogeneity. By eliciting smallholders' preferences for certification schemes, we can identify actionable pathways for fostering sustainability within the palm oil industry – a vital contributor to rural development particularly in Jambi (Qaim et al., 2020).

Our study shows that the adoption rate of certification schemes among oil palm smallholders can be increased as smallholders are generally willing to adopt a certificate. In particular, the provision of annual cash payouts per certified hectare has emerged as a statistically significant adoption driver. Policymakers and certification providers should therefore prioritize financial mechanisms such as subsidies and cash premiums to make certification schemes more accessible to smallholder farmers. This result aligns with previous studies, indicating the necessity of economic support to shoulder high investment costs associated with the adoption and compliance with sustainability standards (Asfaw et al., 2010; Hope et al., 2008). Given that smallholders are often cash-constrained, any additional costs on the farmers' side can pose a burden which is difficult to handle (Brandi et al., 2015; Glasbergen, 2018). Besides economic incentives, farm management trainings have emerged as a strong adoption driver in our study. Investing into knowledge can further driver sustainability practices and contribute to improved environmental quality (Zhang et al., 2022).

Our study also explored the inclusion of land titles and permits for oil palm cultivation for certified farmers. While these aspects can promote secure land tenure and potentially discourage further land openings, they also introduce obligations that may deter some farmers. For instance, the requirement prohibiting further land openings is negatively associated with smallholders' adoption decision. While this underscores the importance of designing certificates that balance environmental obligations with practicalities, it might also reflect the challenges faced by small-scale farmers in obtaining land legally, often due to resource constraints (de Vos et al., 2023; Watts et al., 2021). Providing land tenure on certified land can therefore help build collateral to legally obtain additional land. However, enforcing such regulations requires a strong regulatory framework and close monitoring as well as enforcement – which remains a challenge for certification providers within the palm oil industry (Morgans et al., 2018; Pye, 2019). Yet, the demonstrated effectiveness of combining financial support with robust environmental rules for improved environmental outcomes (Fatima et al., 2025) shows how certification schemes can adopt a similar approach by providing incentives and enforcing land-use regulations to ensure sustainable practices.

Our study further highlights the role of psychological factors such as risk attitudes and locus of control and their influence on smallholders' adoption decision. Including behavioral aspects and their influence on farmers' decision making adds an additional nuance to understanding the barriers to certification adoption and is an important theoretical contribution. While locus of control did not statistically significantly influence smallholders' decision to adopt a certificate in our study, Abay et al. (2017) show the influence of Ethiopian farmers' locus of control in their decision to adopt new technologies. Our results indicate that farmers with lower willingness to take on risks are less likely to adopt a certification scheme. This result contrasts with previous results from e.g. Mohan (2020) who showed that Nepali small-scale tea farmers with a higher risk aversion were more likely to get certified. In our context, the finding that more risk-loving farmers are more willing to adopt a certificate likely underscores the perception of certification as a risky endeavor. This highlights the need to improve the transparency of certification schemes to reduce perceived risks and make them more accessible to smallholders. Reduced risks can be achieved not only through cash premiums per certified hectare, but also through education and capacity building, which, in the context of our study, has been shown to be a major driver of smallholders' adoption decisions.

By addressing both economic and behavioral barriers, this study provides actionable recommendations for policymakers and certification bodies to enhance smallholder adoption of certification schemes within the palm oil industry. Smallholder-managed oil palm plantations have been shown to hold particular importance for reaching the 2030 Agenda (Fosch et al., 2023). Certification schemes are key for smallholders' sustainable integration into global supply chains in general, which in turn can foster social equity and inclusive rural development. Our findings thereby directly contribute to reaching the SDGs by offering actionable insights for the design of integrative certification schemes. Knowing which attributes foster smallholders' willingness to adopt a certificate directly contributes to the ability to design certification schemes reflecting smallholders' preferences. In line with studies such as Agarwal et al. (2023), Dagar et al. (2021), this helps create an environment that enables smallholders to get certified, increase productivity, and foster sustainability. Promoting and investing into certification schemes encourages sustainability and beneficial agricultural practices (Ramzan et al., 2023) in environmental contexts and also in societal contexts, i.e. through reduced extractive farming practices and lower deforestation rates. This in turn benefits not only oil palm smallholders, but also society at large.

6. Concluding remarks

This study utilized a discrete choice experiment among 251 Indonesian oil palm smallholders to highlight how certification schemes should be better tailored to meet their needs. The rising global demand for palm oil (Qaim et al., 2020) necessitates increased oil palm yields for

existing smallholder-managed oil palm plantations to be reached in efficient, yet environmentally friendly ways. Certifying smallholder managed oil palm plantations is crucial for increasing productivity and internalizing negative externalities. Oil palm cultivation's contribution to rural development, particularly in Indonesia, shows the importance of striving for balance between ecological and economic sustainability. By such means, we can move towards sustainable palm oil which not only sustains small-scale farms, but also the environment in which they operate.

Employing a mixed logit model, we are able to answer our initial research questions. For research question one we can state the following: Our results show that oil palm smallholders are generally willing to adopt a certification scheme. The provision of a cash premium is a statistically significant driver of farmers' adoption decision, while increasing costs perpetuate farmers' willingness to adopt a certificate. Furthermore, we explore farmers' preferences for the provision of land titles and oil palm permits on existing smallholder managed plantations under obligations to refrain from illegal land openings and slash-and-burn-techniques as possible new requirements for certificates. The provision of land titles and oil palm permits, which entail certain obligations, could contribute to the achievement of sustaining the status-quo of current plantation areas and discourage further encroachment into tropical forests as well as illegal land openings.

In due course, we can answer research questions two, and three as follows: Smallholders prefer certification schemes which entail continuous farm management training, an Indonesian governmental issuer, and a cash premium. The provision of land titles and permits under the obligation of no illegal land openings lowers farmers willingness to adopt a certificate. These results offer valuable insights into the trade-offs one has to consider in designing certification schemes.

Regarding research question four, our study highlighted critical psychological influences shaping farmers' behaviors. Our findings underscore the importance of understanding farmers' individual perspectives and inclinations when designing effective and targeted certificates. The interplay between risk and certification underscores the imperative for designing certification schemes that actively mitigate risks for smallholders. This can be achieved through initiatives like providing cash premiums per certified hectare annually, offering farm management trainings, and by further fostering capacity building to enhance farm management.

Based on our results, we are able to formulate actionable policy recommendations. Designing certification schemes led by trusted entities, such as governmental agencies can help build farmers' confidence in the certification process. The provision of cash premiums and low certification costs helps to reduce the risk for smallholders and addresses their concerns about adopting a certificate. Continuous farm management trainings foster skills development and capacity building, thereby enhancing farm productivity and compliance with sustainability standards. Furthermore, the provision of land titles and permits for certified oil palm cultivation can create secure land tenure supporting smallholders' livelihoods, while strengthened monitoring frameworks ensure compliance.

Finally, our study is not only relevant in the context of Indonesian oil palm smallholders, but also contributes to a broader understanding as we globally strive to balance economic growth and environmental protection (Alvarado et al., 2021). Our findings provide critical insights into the role of financial incentives, farm management trainings and behavioral factors shaping sustainable agricultural practices. Our findings can also be of relevance in the context of newly developing oil palm plantations in Africa and South America, where policymakers and stakeholders aim to balance economic benefits with environmental protection (Ruml et al., 2022). Our results underscore the necessity of collaboration between policymakers, certification entities and private sector stakeholders to design interventions that promote smallholder-managed, sustainable oil palm plantations. An interesting avenue for future research remains in the exploration of how variations in cultural, economic and institutional contexts shapes the preferences for certification schemes among smallholders.

CRediT authorship contribution statement

Charlotte Reich: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Oliver Musshoff:** Writing – review & editing, Project administration, Funding acquisition, Conceptualization.

Ethical statement

This study was approved by the ethical commission of the Indonesian National Research and Innovation Agency (BRIN, Badan Riset dan Inovasi Nasional).

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Oliver Musshoff reports financial support was provided by German Research Foundation. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

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