Preferences for replanting subsidy programs among Indonesian oil palm smallholders

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Abstract

Indonesia, the largest global oil palm producer, has 40% of its oil palm plantations managed by smallholders. However, smallholders only account for 33.6% of the total production. One of the main reasons for this large gap in productivity is the decreasing productivity of old oil palms, hence, replanting is required. Smallholders have limited capitals and capabilities to conduct replanting. Subsidy programs could help increase the current low rate of replanting for smallholders, therefore potentially increasing future production and decreasing the risk of more deforestation. However, so far it is not known how such subsidy program should look like in detail. Therefore, this study aims to determine smallholders' preferences in replanting subsidy programs. A discrete choice experiment involving a sample of 249 oil palm smallholders was conducted in the five largest oil palm producing regencies in Jambi Province, Indonesia. Latent class analysis based on sustainable livelihood framework revealed four unique profiles of the smallholders. Preferences for replanting subsidy programs identified with mixed logit model shows different preferences for different profiles of smallholders. The results of this study are of interest for policy makers and is expected to contribute to the future development of replanting subsidy programs.

Keywords: Oil palm, smallholders, replanting, sustainable livelihood framework, subsidy

1. Introduction

There is no doubt that oil palm is one of the most important oil crops, reflected in a huge body of literature showing that it produces palm oil, which is the most versatile vegetable oil that can be used as basic ingredient for food products, cosmetics, biofuel and daily cleansing agents (Casson et al., 2014). Oil palm can produce 1.9-4.8 t ha^{-1} of vegetable oil, that is more vegetable oil per unit of farm land than any other crop such as soybean (0.4-0.8 t ha^{-1}), rapeseed (0.7-1.8 t ha^{-1}), coconut (0.4-2.4 t ha^{-1}), sunflower (0.5-0.9 t ha^{-1}), and olive (0.3-2.9 t ha^{-1}) (Meijaard et al., 2020). Yet, oil palms grow best in tropical areas, where the tropical rainforests are, emitting a huge amount of greenhouse gas emission and threatening a huge body of biodiversity (Meijaard et al., 2020) (Qaim et al., 2020).

Indonesia is the current largest producer of oil palm. The cultivation area of oil palm has boomed due to the increasing global demand of vegetable oil, from merely 0.1 Mha at the end of the 1970s to almost 15 Mha in 2019 (Statista, 2021) (Wicke et al., 2011). This extensively transformed the tropical landscapes. Mostly transformed between the year 2005 to 2015, currently, around 59% of the plantation area in Indonesia are managed by oil palm companies and 41% by smallholders (Qaim et al., 2020).

Despite managing almost half of the oil palm plantation area in the country, smallholders only produce one third of all palm oil in Indonesia (Herdiansyah et al., 2020)(Statista, 2021). The relative yield gap of smallholder managed plantation compared to company manage plantations are mainly caused by the ageing of the plantations, lower quality seedling, and poor farming management (Soliman et al., 2016; Teuscher et al., 2015). The cultivation of smallholder oil palm expanded widely in the middle of the 1990s (Naylor et al., 2019) so now, many plantations are currently over 25 years old. The productive cycle of oil palms ends after approximately 25 years, after that the palm produces less fruits and harvesting becomes more expensive due to the height of the palms (Corley & Tinker, 2016). It is estimated that around 2.4 million hectares of the plantations managed by smallholders will need replanting within the next few years (Glenday & Paoli, 2015) (Ompusunggu & Gunawan, 2018).

Replanting the oil palm plantation is a huge decision-making moment that will be faced by every smallholder. First, the cost that is required to replant is expensive (Nurfatriani et al., 2019). Second, there is a production gap for the first few years after replanting: oil palm can only produce fruit bunches once they are mature (Corley & Tinker, 2016). To respond to this problem, the Indonesian government have allocated funds to support oil palm smallholders to replant their plantations. However, the rate of replanting remains low. One of the reasons is due to the low participation in the replanting subsidy program (Nurfatriani et al., 2019). If replanting does not take place, the continuous increasing demand of vegetable oil, especially palm oil, might pose a grave existential threat to tropical rainforests.

For most smallholders, oil palm is their main source of livelihood. Livelihood revolves around the availability of resources that may provide goods and services for their daily life (Scoones, 2009). Resources can be regarded as capitals or capabilities, which are components for building a livelihood and adapt to hardships (Bebbington, 1999). Capabilities allow human to go through different sets of alternatives when faced with stresses and shocks (Ellis, 2000). In this study, we are implementing the sustainable livelihood framework developed by the DFID (Scoones, 1998) to measure capabilities and determine the characteristics of smallholders. The objective of this paper is to understand the behavior of Indonesian oil palm smallholders towards prospective replanting subsidy programs. To our knowledge there is still no empirical evidence on how smallholders will choose to proceed once the plantations have reached maturity and are decreasing in productivity. If they choose to replant, how are they going to fund it, what kind feature do they prefer in a subsidy program, and would the preferences of different types of farmer be different? This paper has two-fold purposes to 1.) reveal the unique profiles of smallholders based on their capabilities and 2.) determine the preferences of different characteristics of smallholders for a subsidy program using a Discrete Choice Experiment (DCE). To our knowledge, we are the first to conduct a DCE of a replanting subsidy program for oil palm smallholders in Indonesia. It is important to understand the characteristics of the smallholders to design an efficient subsidy program in the future to increase the participation in subsidy programs. We posit that different profiles of smallholders have different preferences for subsidy programs.

2. Oil Palm Replanting and the Costs

Oil palm replanting is the process of replacing old palms with new oil palm seedlings (Novra et al., 2021). The oil palm is a perennial crop which has around 25-year-cycle of productivity (Corley & Tinker, 2016). When newly replanted, new seedlings have three years of unproductive phase (year 0 – year 3), which is later followed by a rapid increase phase (year 4 – year 8), where the production grows substantially until it reaches the prime production phase (year 9 - year 17). Then the production might start to decline slowly (Murphy et al., 2021). During this phase, the trees would already be very tall, reaching 10 meters high, making it even harder and more expensive to harvest. To replant, old palms should first be cleared. This can be done by felling and chipping by using heavy machinery or chainsaw. Smallholders mostly use chainsaw, accompanied by prior poisoning to the palm to weaken the palm trunk. In addition to clearing by felling and chipping, the technique of underplanting, which is planting the new seeds underneath the old palms while gradually clearing the old trees is also an option.

The cost of replanting per hectare might range from 3200 – 3800€. To lighten the load, the Indonesian Government through BPDPKS have initiated PSR funding, a replanting subsidy program for smallholders. PSR allows farmer to receive 1600€ per hectare and capped to 6400€. (Nurfatriani et al., 2019). The PSR program was initiated in 2017, but so far, the targeted replanting area has not been reached and a big part of the fund has yet to be disbursed. Smallholders need to pay for the cost through savings or loans. Hence, replanting is both a challenge and opportunity. In spite of the costs, utilizing replanting as a momentum to introduce better seedling and redesigning the plantation might close the current yield gap between company managed and smallholder plantation, increasing the productivity of the plantation, therefore enhancing the well-being of the smallholders.

3. Sustainable livelihood approach

A multi-disciplinary approach is required to understand smallholders' preferences of replanting subsidy programs. The Institute of Development Studies (IDS) developed The Five Capitals Framework, a guide for sustainable livelihood analysis. This framework incorporates multiple outlooks namely natural, human, social, physical, and financial capitals, where they constitute assets or resources that measure human capabilities to act and build a livelihood (Bebbington, 1999; Scoones, 2009). The set of these capitals provides various disciplinary perspectives for building livelihoods, allowing diverse alternatives to achieving resilience (Nelson et al., 2010b). As an approach, this framework is regarded as an asset-based approach in which changes or magnitudes of each capital is viewed as an appropriate metric to measure resilience (Donovan, 2012). This framework also enables the identification of available or scarce capitals of different types and how they affect human livelihood (Emmanuel-Yusuf et al., 2017). Conversely, livelihood strategies depend highly on the capability of humans in allocating and managing capitals (Ellis, 2000).

Natural capital can be defined as stocks of natural resources, such as air, water, soil, and genetic resources, which flow to produce ecosystem services as the product that can be useful for livelihoods (Jansson, 1994; Scoones, 2009). Natural capital can be enhanced and regulated under human control (Braat and Groot, 2012). Therefore it depends highly on human activity and management (Ellis, 2000). For smallholder farmers, natural capital provides ecosystem services such as soil health, water supply, water regulation, climate regulation, food production, biodiversity, and raw materials such as plant biomass and animal biomass (Altieri et al., 2012; Bebbington, 1999; Costanza et al., 1997). Human capital is described as skills, knowledge, the ability of labor, good health, nutrition, and labor power that is available within a person (Braun et al., 2009; Scoones, 2009). Social capital can be defined as goodwill engendered by the fabric of social relations, which can be mobilized to facilitate action (Adler and Kwon, 2002). Components of social capital are equally important for achieving goals that could not be achieved individually (Donovan, 2012). A prominent theory coined by (Portes, 1998) posited four sources of social capital namely value, solidarity, reciprocity, and trust. Relationships in a social group provides privileges and advantages from any activity within the group and may then reduce vulnerability in livelihood, it also provides broader source of information, enhance information quality, relevance and timeliness. Social ties form trust between people or household within the community to strengthen reciprocity, which might be beneficial as means of support diversification. Nurturing and maintaining reciprocity with networks are believed to be investments for countering change and securing the livelihood of rural households (Ellis, 2000) (Aldrich and Meyer, 2015). Financial capital is measured in monetary terms that can be accessed by a household. In livelihood, financial capitals are owned in the physical form of cash, savings, and access to bank account or credits. Financial capital may be diminished to build up other types of capital, for example, to pay for school fees to increase human capital and to provide physical capital such as housing and transportation (Quandt, 2018). Physical capital is human-made capital or infrastructure which facilitates people's activities (Scoones, 2009).

The five capitals framework can be quantified and modelled for broader analysis of multifunctional agricultural resiliency. Previous empirical research that applied this framework have acknowledged the multidimensional nature of this framework as a good approach for capturing assets and capabilities of human (Bebbington, 1999; Nelson et al., 2010). (Nelson et al., 2010a), analyzed the vulnerability of rural livelihoods through a geospatial analysis by constructing a composite index map of adaptive capacity by using farm survey data. (Quandt, 2018) introduced Household Livelihood Resilience

Approach (HLRA) composite indexes based on the sustainable livelihood framework to measure livelihood resilience and effectiveness of agroforestry in building livelihoods for smallholders in Kenya.

For our study, we selected relevant quantitative indicators (Table 1.) as a composite asset building blocks for each capital. Since we are focusing on smallholder farmers, we mainly base our indicator choices on the previous study of Quandt(2018) which we then modify based on the context of oil palm smallholders in Indonesia.

Table 1. Quantitative indicators for each capital used in this study

Capitals	**Quantitative Indicator**
Financial capital	Salaried job (yes or no)
	Access to a bank account (yes or no)
	Income from oil palm (categories*)
	Income from other sources (categories*)
Human capital	Education (level of education of respondents)
	General health (healthy or have problems)
	Experience in oil palm farming (categories^)
Natural capital	Total farm area (hectares)
	Local climate perception (scale of good to bad)
	Average oil palm productivity (scale of unproductive to very productive)
	Livestock (number of livestock)
Physical capital	Vehicle ownership (none, motorbike only, motorbike and car)
	Phone ownership (none, simple phone, phone with internet, smartphone)
Social capital	Political influence in the village (yes or no)
	Participation in farmer groups (yes or no)
	Transmigration history (yes or no)

Notes: * divided into 9 categories: 1=less than Rp 1.500.000, 2=Rp 1.500.001 - Rp 3.000.000 ,3=Rp 3.000.001 - Rp 4.500.000, 4=Rp 4.500.001 - Rp 6.000.000, 5=Rp 6.000.001 - Rp 7.500.000, 6=Rp 7.500.001 - Rp 9.000.000, 7=Rp 9.000.001 - Rp 10.500.000, 8=Rp 10.500.001 - Rp 12.000.000, 9=more than Rp 12.000.000. ^ divided into 6 categories= 1=0-5 years, 2=6-10 years, 3=11-15 years, 4=16-20 years, 5=21-25years, 6= more than 25 years

4. Materials and methods

4.1 Study Area

We collected data from smallholders in Jambi Province, one of the most productive oil palm producing provinces in Indonesia. The Jambi Province is located on the east coast of Central Sumatra. It covers a total area of 50.165 km^2 that consists of highlands and lowland rainforest, which has been largely transformed to agricultural lands, mainly oil palm and rubber (Clough et al., 2016). In the last decade, rubber plantations have been increasingly converted to oil palm due to the low and unstable rubber prices. Oil palm farmers in Jambi includes mixtures of scheme smallholders, former plasma smallholders, independent smallholders, and smallholders in farmer groups (RAHARJA). Historically, scheme smallholders came on to the scene in around 1980s, when the transmigration program started (Petri, 2022). Here, households from Java and other densely populated islands were resettled to less-developed places, including Jambi, where they are supported in the cultivation of cash crops, particularly oil palm (Feintrenie and Levang, 2009). In the mid-1990s, due to the decentralization in Indonesia, smallholders began cultivation independently (Bazzi et al., 2016). In addition to oil palm many farmers also cultivate rubber (*Hevea brasiliensis*) (Schwarze, 2015) .

We selected five oil palm high producing regencies, namely Merangin, Muaro Jambi, Muaro Bungo, Batanghari, and Tanjung Jabung Barat to keep the overarching socio-ecological landscape homogeneous. Applying stratified random sampling method, two random sub-regencies were chosen from each regency, and then two random villages were chosen from each sub-regency. Around 11 to 13 random smallholders from each village were asked to participate.

4.2 Survey design and data collection

The data for this cross-sectional study was collected from October to December 2021 involving 249 randomly-stratified selected oil palm smallholders, ignoring whether they are scheme smallholders, former plasma smallholders, independent smallholders, and smallholders in farmer groups since these grouping can overlap. The interviews consisted of four sections and were conducted in person on one-on-one sessions. The first section consisted of basic personal data and control questions to make sure that the randomly selected respondents are relevant to the study. Section two consisted of Likert-scale questions on perceptions, knowledge, and attitudes towards replanting and subsidy programs. Section three is a discrete choice experiment (DCE), which was designed based on extensive literature review and expert opinions. The amount of subsidy attribute offers respondents to register for the subsidy individually or together in a group. The money given for the subsidy can come from International aids (for example USAID or EU), the Indonesian Government, or under Islamic Banking. The replanting method attribute is a prerequisite, it can be done in one time for the whole plantation or gradually. Another prerequisite is the number of trees that need to be planted. Planting a tree within an oil palm plantation is ecologically beneficial to enhance ecosystem services, but it might take some space in the plantation. The unlabeled DCE consisted of five attributes with two to four levels each (Table.2). The DCE design followed a D-efficient design which was generated by the software Ngene. Respondents faced 12 choice sets, with three options (Subsidy A, Subsidy B, or opt-out) in each set (Table 3.). Before making the choices, the respondents were asked to think of a situation in a hypothetical scenario where their current oil palm plantation is 25 years old and the known cost for replanting is approximately 35 million IDR. For the opt-out option, at the end of the experiment, the respondents were asked what was their reason for opting out (e.g. prefer to replant without subsidy, selling the plantation, giving the plantation to their children, etc). Finally, section four consisted of questions on financial and sociodemographic information.

Table 2. Attributes and their levels in the discrete choice experiment

Attribute	Level
Amount of subsidy*	25 million IDR, 30 million IDR, 35 million IDR, 40 million IDR
Subsidy registration	Individual, Group-based
Source of funding	International funding, Indonesian government, Islamic Bank
Replanting method	Gradual, Whole plantation
Tree that must be planted*	0,5,10,15

Note: * per hectare

Table 3. Example of a choice set

	Subsidy A	Subsidy B	Opt-out
Subsidy registration	Group-based	Individual	
Source of funding	The government	International funding	
Replanting method	Whole plantation	Whole plantation	
Amount of subsidy	40 million IDR	25 million IDR	
Trees that must be planted	0	15	
I choose	O	O	O

4.3 The Latent Class Analysis

As highlighted in the introduction, this paper relies on the sustainable livelihood framework followed by a latent class analysis to determine the characteristics of smallholders. We created a simple composite asset index, following the method of Quandt (2018). For each indicator questions (Table 1.), we convert the answer choices to a scale of 0 for the least desirable response to 1 for the most desirable response. For binary response questions, for example participation in farmer groups, response "no" receives a score of 0 and "yes" receives a score of 1. For questions with multiple answers, for example farm productivity, answers were assigned of values within a range of 0 to 1 (for example 0, 0.25, 0.50, 0.75,1) With regards to this, we assume that higher scores indicate higher levels of capabilities. Converting the indicator questions into the scale of 0 to 1 allows them to be averaged together. To calculate the composite indexes of each livelihood capital, every indicator within the capital was given equal weight and averaged.

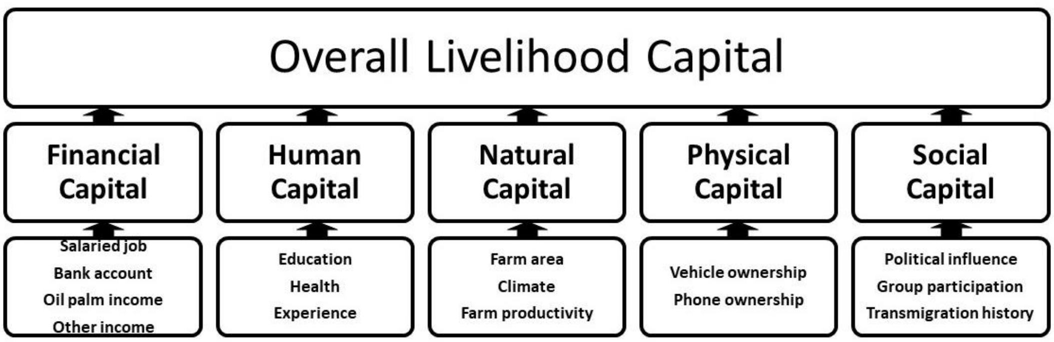

***Figure 1**. Livelihood capital composite index*

After all five of the livelihood capital composite indexes were calculated for all respondents, we run a latent class analysis to reveal the hidden unique profiles of smallholders. A latent-class model is based on the Random Utility Theory (McFadden, 1974), where person i's random utility for alternative j and choice situation t is given by

$$U_{ijt} = x\frac{T}{ijt}\beta_i + \varepsilon_{ijt,}$$

Where $i=1,\ldots, N; j=1,\ldots J$ and $t=1, \ldots, T_i$

The latent class model can be expressed as

$$Pi_1, i_2, \ldots i_n = \sum_{c=1}^{C} p_t \prod_{n}^{N} p_{i_n,t}^{n}$$

where C is the number of latent classes, $(N=1,2,\ldots N)$ are livelihood asset and p_t are recruitment or unconditional probabilities that should sum to one. $p_{i_n,t}^{n}$ are the marginal or conditional probabilities.

4.4 Determining smallholders' preferences of replanting subsidy programs

The econometric analysis is based on mixed logit models that are estimated using maximum simulated likelihood (Train, 2009). We created five models, one for the whole sample and four for each of the classes to determine the influence of capabilities on preferences of a subsidy program. With regards to the opt-out option in each choice set, our models include an alternative specific constant (ASC) to account for this status-quo option (0=choose a subsidy program, 1=opt-out). The amount of subsidy attribute was specified as continuous in all models. All other attributes except for the amount of subsidy were specified as having a random component, assuming that farmers have a homogeneous preference for higher amounts of subsidies. All model coefficients were assumed to be normally distributed.

The model is expressed as:

$$Y_{ijk} = \beta_0 ASC + \beta_1 R_{ijk} + \beta_1 F_{ijk} + \beta_1 M_{ijk} + \beta_1 S_{ijk} + \beta_1 T_{ijk} + \epsilon_{ijk}$$

Where Y marks the binary decision made by farmer i for alternative j and choice set k. R (method of registration), F (source of funding), M (replanting method), S (amount of subsidy), and T (number of trees that must be planted) represents the attributes. To increase the confidence in the estimation results, each model was repeatedly estimated for 500 times.

5. Results and discussion

In our sample, 15.6% of the smallholders are female, the mean age was 45.3 years, with an average year of schooling of years. The average oil palm plantation are was 3.41 hectares. Our respondents consist of smallholders who cultivates productive oil palm plantation and old oil palm plantation. A large representation of respondents (78, 31.3%) have no funding to conduct replanting and only a small representation (16, 6.4%) have sufficient funds to conduct replanting (Figure 2.). As mentioned in the previous section, however, our DCE included a hypothetical situation where all respondents were asked to think if their plantation already requires replanting since this situation will most likely be faced by all smallholders.

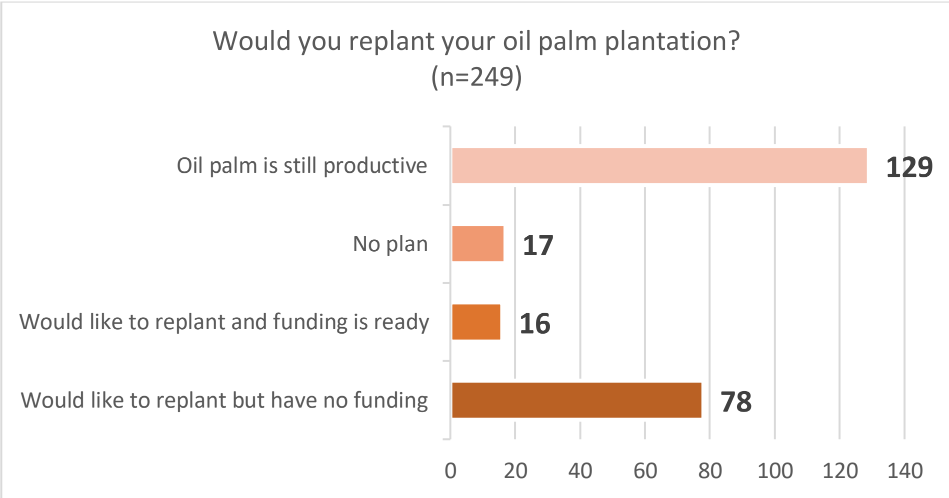

Figure 2. Respondents necessity and funding availability to conduct replant

The indicator questions from Table 1. were used for the latent class analysis. The calculated internal reliability was acceptable (Cronbachs Alpha = 0.6722) (Ursachi et al., 2015). The number of classes were then determined. The Bayesian Information Criterion (BIC), suggested a model with 4 classes since the BIC value for a 4-classes model (-694.53) is lower than the BIC values for 3-classes (-688.70) and 5-classes model (-690.72). Each respondent wsd assigned to the class in which their probability of membership is the largest. Class 1 is characterized by low social, human, and financial capital. Class 2 is characterized by low social and financial capital. Class 3 is characterized by high social but lower human capital. Class 4 is characterized by high human capital and well-rounded other capitals. We interpret these results to define four profiles: *vulnerable smallholders (class 1), self-reliant smallholders (class 2), social smallholders (class 3), and established smallholders (class 4)* (Figure 3.).

Figure 3. Livelihood capabilities for the revealed latent classes

Accounting all respondents, smallholders have a statistically significant positive preference for joining a subsidy program with either funding from Government or Islamic banking rather than International aids, under a group-based registration scheme instead of individual registration. The amount of subsidy is found to be statistically significant, the larger the amount is the more likely a subsidy program is preferred. Surprisingly, the requirement to plant trees are found to be not statistically significant. Although not statistically significant, it is interesting to see that smallholders have positive preference for planting a small number of trees rather than no tree at all. More amounts of trees were negatively preferred. This fact is relevant for designing future subsidy programs with tree planting requirement. Smallholders are in general willing to join a subsidy program and replant with the support from the subsidy money, although they are required to plant some trees in their plantations in exchange.

Table 4. Mixed-logit model results

Variables	All		Class 1		Class 2		Class 3		Class 4	
Mean parameters										
ASC§	-.06	(.35)	-0.07	(.79)	-.71	(.54)	3.31***	(1.18)	-.50	(.75)
Amount of subsidy	.04***	(.00)	.06***	(.02)	.02	(.01)	.10***	(.03)	.04**	(.02)
Tree number = 5&	.11	(.20)	-.02	(.47)	.26	(.30)	-.79	(.61)	.099	(.45)
Tree number = 10&	.04	(.19)	.16	(.43)	.11	(.29)	-.10	(.50)	-.26	(.43)
Tree number = 15&	-.15	(.11)	-.26	(.24)	-.05	(.18)	.04	(.35)	-.27	(.21)
Replanting gradually^	.07	(.16)	.25	(.33)	.10	(.24)	-.60	(.49)	-.22	(.37)
Funding from Government°	.91***	(.18)	.12	(.42)	.94***	(.30)	2.30***	(.60)	1.37***	(.46)
Funding from Islamic Banking°	.94***	(.13)	.51*	(.26)	.96***	(.21)	1.36***	(.38)	1.25***	(.29)
Group-based registration#	.28**	(.11)	-.08	(.23)	.13	(.18)	1.70***	(.47)	.43*	(.24)
SD parameters										
Tree number = 5&	1.03***	(.16)	.54	(.53)	-.99***	(.28)	-.61	(.51)	.84***	(.31)
Tree number = 10&	-.92***	(.15)	-.56	(.55)	1.08***	(.24)	-.55	(.53)	-1.00***	(.34)
Tree number = 15&	1.08***	(.12)	1.25***	(.27)	1.27***	(.20)	-.80*	(.41)	.98***	(.27)
Replanting gradually^	1.44***	(.12)	1.25***	(.35)	1.31***	(.17)	.98***	(.32)	1.63***	(.26)
Funding from Government°	-1.1***	(.16)	1.06***	(.38)	-1.33***	(.24)	.72	(.58)	1.69***	(.41)
Funding from Islamic Banking°	1.52***	(.13)	1.35***	(.28)	1.58***	(.20)	-.61*	(.36)	1.69***	(.28)
Group-based registration#	1.27***	(.11)	1.30***	(.23)	1.25***	(.18)	1.55***	(.47)	1.40***	(.23)
Log likelihood	-2359.58		-528.13		-994.61		-192.08		-598.53	
Chi squared	565.44		102.10		265.11		36.06		172.78	
Observations	8964		2052		3744		684		2484	
Class shares	100%		23%		40%		9%		28%	

Notes: Standard errors in parentheses. §Alternative specific constant. &Reference category is tree number = 15. ^Reference category is whole replanting. °Reference category is international funding.#Reference category is individual registration. *p<.05, **p<.01, ***p<.001.

Individuals who belong to class 1 statistically significantly prefer a replanting subsidy program with a higher amount of subsidy money. They also statistically significantly prefer replanting subsidy programs that are funded by Islamic banking rather that the Indonesian government or International aids. All other parameters are not statistically significant. Class 1 individuals are the most vulnerable group since the financial, human, and social capabilities are the lowest of all groups. On average, they have an average overall livelihood capital index of 1.79. With the low level of financial capability in hand, the amount of subsidy is almost the only thing that significantly matters for them. The higher the amount of the subsidy offered, the more likely they are to join the subsidy program. The low level of human capability reflects low level of education, experience, and general health. The low level of social capability reflects low political influence, social participation, and low advantages from having a transmigration history. These farmers are possibly local non-transmigrant individuals who are new to oil palm cultivation. Class 1 has a predicted share of 23% in the sample.

Individuals in Class 2 are the only group with an insignificant preference for the amount of subsidy money. The only statistically significant attribute is the source of funding, where they statistically significantly strongly prefer funding from government or Islamic banking to international aids. Similar to class 1, these individuals have low financial and social capability, but in contrast they have a much higher level of human capability. They are characterized as self-reliant, but might not yet be self-sufficient since they are still struggling financially, relevant to the other groups. On average, class 2 individuals have an average overall livelihood capital index of 2.25. The preferences for the funding schemes and the high level of human capability might reflect that class 2 individuals have a high trust in the national system, due to the combination of education, experience, and health. In addition to the current general health, these individuals might have benefited from the national education system and government support programs for farmers. The more farming experience a farmer has, the more familiar they are to government schemes and the more exposure they might have from government support programs. Class 2 has the largest predicted share of respondents in the sample (40%).

Individuals in class 3 statistically significantly prefer to join subsidy schemes. They statistically significantly prefer a subsidy program which are funded by either the Indonesian government or Islamic bank with a group-based registration scheme. Another statistically significant attribute is the amount of subsidy offered: the higher the amount of subsidy offered, the more likely they are to join a subsidy program. Class 3 individuals have an average of total livelihood index of 2.77. They are characterized by higher levels of social capability and physical capabilities. Their main strength relative to other groups is their social capability, which means that they might be more influential in their society, active in farmer groups, and has advantages from their transmigration history. The combination of strong preferences for group-based subsidy program as well as joining the subsidy program might reflect the importance of collective action and peer-effect for this class. They might rely higher on the society, to make decisions, in this case to join a subsidy program. Class 3 has the lowest predicted share of respondents in the sample (9%).

Similar with individuals who belong to class 3, individuals in class 4 statistically significantly prefer a subsidy program which are funded by either the Indonesian government or Islamic bank with a group-based registration scheme. The amount of subsidy attribute is also positively statistically significant, which means that they are more likely to join subsidy programs when the amount of subsidy offered is higher. In contrast with individuals in class 3, however, the opt-out attribute is not statistically significant. Class 4 individuals have the highest average of overall livelihood capital of 3.07. They have the highest level of human, natural, and physical capability relative to other groups. They are the most established out of all the groups. The lower social power that they possess differentiate them with class 3 individuals in terms of joining subsidy program. Although they have the most well-rounded capabilities, they might not be socially confident enough to opt-out when offered to join a subsidy program. Class 4 has a predicted share of respondents of 28%.

From the results above, we can conclude three things. First, there is a latent heterogeneity in livelihood capabilities of the smallholders. Oil palm smallholder farmers are generally defined as farmers who cultivate less than 20 hectares of oil palm plantation. Size of plantation is one of the indicators for natural capability. In our study, latent class analysis results show that all four classes have similar levels of natural capabilities, meaning they are homogeneous when counting for the natural capability only. The heterogeneity comes from other capabilities (financial, human, social, and physical). This means that oil palm smallholder farmers can be classified and redefined based on these classifications. Second, this latent heterogeneity determines different preferences for replanting subsidy programs. Hence, understanding the characteristics of farmers is useful to deeper understand the preferences for replanting subsidy programs since different types of farmers might have different preferences. Third, based on the results we can see that instead of the total livelihood capabilities, social capabilities increase the chances of a respondent to prefer joining a subsidy program.

Conclusion

Replanting is a big decision to make for smallholders because of the costs. However, it is necessary for maintaining the palm oil production from the current plantations, so that no deforestation or land cover change is required. It is also economically beneficial for smallholders for maintaining their income through good production Replanting can potentially improve smallholders' income if they use this replanting momentum to plant higher quality seedlings or cultivate with a better plantation layout. This study focuses on a design of replanting subsidy programs. The main goal is to understand smallholders' preferences in a replanting subsidy program, to support the improvement of their participation in replanting subsidy programs. By utilizing the sustainable livelihood approach, we were able to reveal the livelihood capabilities heterogeneity of smallholder farmers. Using a DCE with relevant subsidy attributes, we are able to provide empirical insights and observe which attributes are preferred by different typologies of farmers. The main finding of this study is that different set of livelihood capabilities have different preference pattern on a replanting subsidy program. There is, one improvement that we suggest for future studies. Although commonly used for empirical analyses, the composite asset index created based on the sustainable livelihood approach only provides a glimpse of livelihood resilience and some indicators might be more important than others but this was not accounted for in this study. Weighing the indicators could result in an improvement in this method.

Our results have broader implications. From the policy perspective, it shows that understanding the characteristics of smallholders, especially the livelihood capabilities might be beneficial for designing a subsidy program, or any kind of intervention in the future. Programs or interventions can be designed tailored to the characteristics of the smallholders. From the smallholders' perspective, it shows that a certain subsidy program might not be interesting for everyone. It might be hard for the government, or any provider to develop different schemes of subsidy programs therefore it will be difficult to satisfy all types of farmers.

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