**Migration Letters**

Volume: 20, No: 7, pp. 525-546

ISSN: 1741-8984 (Print) ISSN: 1741-8992 (Online)
www.migrationletters.com

# Unlocking Sustainable Agriculture: Assessing Readiness, Awareness, and Interventions in Indonesian Oil Palm Smallholders

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**Abstract**

*In pursuit of sustainable agriculture, this study examined the small farmers of Indonesian oil palms, focusing on their readiness, awareness of sustainability, and the impact of social interventions. Data collection involved structured interviews and employed a structure equation model for analysis. Data was collected from 154 respondents through interviews and observation with oil palm farmers using a structured questionnaire and analyzed using SmartPLS version 3.2.9. Before the analysis, seven out of 27 indicators had invalid values. After adjustments, all values met the discriminant validity criteria. Reliability tests confirmed the reliability of the questionnaire, with Cronbach's alpha > 0.7 for all variables. Discriminant validity requirements were also met. In the inner model analysis, exogenous constructs (smallholder readiness, sustainability awareness, social intervention) collectively explained 68.7% of smallholder sustainability status variance, while smallholder sustainability status was influenced by 55.3%. The relationships between smallholder readiness, sustainability awareness, social intervention and smallholder sustainability status were significant (0.02 ≥ f square < 0.35). Predictive relevance of smallholder readiness, sustainability status, and social intervention in smallholder sustainability status, and smallholder sustainability status in oil palm smallholder performance, was appropriate (Q square > 0.05). The bootstrapping analysis showed significant direct and indirect effects, confirming smallholder readiness, sustainability status, and social intervention as strong predictors of smallholder sustainability status and performance. In conclusion, this study underscores the importance of addressing smallholder readiness for sustainability as a crucial factor in achieving sustainable agriculture goals. More research is needed to explore long-term impacts, external factors, and innovative approaches to smallholder sustainability.*

***Keywords:*** *Smallholder radiness, Sustainability awareness, Oil palm smallholders, Sustainable agriculture, Indonesia.*

## INTRODUCTION

In general, the palm oil industry in Indonesia has had a significant economic impact, including being a source of foreign exchange, increasing farmer income,

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expanding employment opportunities, and improving people's lives and public health (Tandra et al., 2021);(Moreno-Peñaranda et al., 2015). This is supported by the significant strategic benefits of palm oil, which can produce various types of derivative products in the form of food and non-food materials, as well as bioenergy so that the demand for palm oil is expected to increase according to the growth of the world population (Tandra et al., 2021). The increase in demand also impacts the expansion of oil palm farming land so that the use of vacant land is attempted to increase the productivity of oil palm plantations. Palm oil production is influenced by several technical and social factors. Technical factors include:

- The area of land used
- The use of labor,
- The use of fertilizers (type and quantity), and
- The use of pesticides (type and amount of use).

Rural to urban migration has given rise to numerous social issues. These challenges encompass institutional bias caused by stringent household registration policies, societal labeling and bias in state-run job sectors and among city dwellers, as well as emotional distress and a sense of detachment (Qi, 2019). Social factors include the age and level of education of the farmer. In running a farm and avoiding migration, several things need to be considered: costs, revenues, and farm income. In addition, it is also necessary to review in more detail the issue of smallholder performance in oil palm plantations, the status of sustainability, the readiness of smallholders for oil palm, concern for sustainability, and social interventions, considering that external support is needed for the sustainability of oil palm plantations in Indonesia.

The performance of oil palm farmers is measured based on several criteria, including quality, quantity, knowledge of work, cooperation, initiative, creativity, awareness, and quality of human resources (Olavarrieta, 2022).. However, amid increasing public attention to environmental sustainability following the agreement on the Sustainable Development Goals (SDGs) platform by countries worldwide, the palm oil industry is in the spotlight. It is under pressure from various parties to impact the corporate and industrial industries positively and negatively. The biggest challenge for the Indonesian palm oil business is demonstrating to the world market that Indonesian palm oil is used responsibly and sustainably.

Independent oil palm smallholders currently face challenging sustainability and inclusion issues. This provides a boost to sustainable palm oil production due to concerns about deforestation (Goh, Wong, & Ng, 2016);(Bong et al., 2017), loss of biodiversity, land expansion, carbon dioxide emissions (Lee et al., 2014), illegal land use, violation of labor rights, marginalization of local communities, and land conversion, which are considered caused by the expansion of oil palm plantations (Kusters, 2018);(Suroso & Ramadhan, 2014);(Tey et al., 2020). Nongovernmental organizations (NGOs) have also increased pressure on the palm oil industry by encouraging consumers and companies to be aware of its adverse impacts on palm oil production. Increasing international consumer pressure has led to certification schemes for producing sustainable palm oil (Brandi et al., 2015);(Sahidan, 2021). Roundtable on Sustainable Palm Oil (RSPO) is one of the RSPOs (responsible for sustainable palm oil. RSPO is listed as a certification label to guarantee sustainable palm oil plantation practices. RSPO makes it difficult for smallholder plantations, which account for around 40% of global palm oil production, to achieve sustainability certification

due to a lack of information, costs, and weak farmer institutions (Tey et al., 2020). Meanwhile, for business entities, the obligation to comply with sustainability certification affects the company's profitability owing to increased operational costs for sustainable palm oil production (Azhar et al., 2015). This impacts the limited number of oil palm plantation companies that have RSPO certification in Indonesia, the world's leading exporter of palm oil.

The readiness of farmers is measured from several aspects, namely, the livelihood of independent oil palm farmers, the legality of the land for cultivation, and the clarity of the source of oil palm seeds (Apriyanto et al., 2019). It is estimated that the more dominant source of income from the oil palm plantation sector in the livelihood structure of the farmer's household, the better the readiness of oil palm smallholders to implement ISPO certification. The facts on the ground show that it is rare for independent smallholder households whose livelihoods are structured to rely solely on the support of a single source of palm oil plantation products. In developing countries, especially Indonesia, the source of income for rural farmers consists of three sources of income, namely, farm income, off-farm income, and non-farm income, which are used in such a way as to maintain their existence and respond to pressures or changes in surrounding conditions (Dharmawan et al., 2019;Euler et al., 2017;Aisyah et al., 2021). Apriyanto et al. (2019) classified three sources: oil palm plantations (oil palm), agriculture in general (agriculture), and non-farm activities (all livelihood activities outside the agricultural sector). The results show that the source of income from palm oil plantations needs to be more significant to say that economically smallholder palm oil plantations where ISPO certification can easily be implemented. Aspects of land legality in Apriyanto et al. (2019) stated that the agrarian structure of illegal oil palm plantations (Forest Cultivation Areas) is shallow compared to that of oil palm plantations on legal land (Non-Forest Cultivation Areas), which means that independent smallholders have no problems with the legality and status of cultivated land. Without the risk of agrarian conflict, degradation of environmental quality, or unsustainable development, the ISPO can be certified. However, the facts on the ground show that land certificates, one of the requirements for ISPO certification, still need to be fully met. The last aspect is clarity on the source of the oil palm seeds, where the facts in the field show that the origin of the oil palm seeds planted is from other oil palm farmers whose legality is unclear, or the oil palm seeds they use are the result of nurseries independently by the farmers themselves. The average use of certified seeds is at most 35% of the area of palm oil plantations.

Farmers' readiness to face ISPO implementation was generally reported to be unprepared because the oil palm income source was not the primary income source and the legality of the land and seeds, which also contained conflicts and ambiguity (Dharmawan et al., 2019). The problems faced are related to smallholders' willingness to make individual and group changes to realize the sustainability of palm oil plantations. Further research is needed to determine the current sustainability status of oil palm smallholders. Given the complex challenges farmers face in implementing sustainability from various aspects of land management, seed and land legality, capital, level of knowledge and skills in agriculture, level of relationship with marketers, level of education, and so on. Therefore, this study aimed to analyze oil palm smallhodlers readiness, sustainability awareness, and social interventions on the sustainability status and performance of oil palm smallholders in Indonesia.

## METHOD

Research design

This study used a quantitative research design with interview and survey methods (online and offline questionnaires) through talkshow event about oil palm smallholder's issues to collect the information desired and relevant to this study in detail. The attributes used in this study include several variables consisting of smallholders' readiness (KP), sustainability awareness (KK), social intervention (IS), smallholders' sustainability status (SKP), and performance of oil palm smallholders (KPS) and some of the respondent's information consists of:1) gender; 2) age; 3) resident status; 4) employment status; 5) other work; 6) level of formal education; 7) family dependents; 8) oil palm land; 9) farming experience; and 10) land legality. Research was carried out to several provinces in Indonesia such as Bangka Belitung, West Kalimantan, Central Kalimantan, West Papua, Riau, and North Sumatra oil palm smallholders independent and group. We collected 154 respondents of oil palm farmers.

Variables and Data Distribution

The following in Table 1 is the distribution of the respondent data used in this study as information to explain the circumstances and conditions based on the data obtained and their relevance to support the development of an explanation of the sustainability status of oil palm smallholders in Indonesia. The respondent of oil palm smallholders was dominated from Riau Province as the biggest oil palm plantation, including smallholder farmers. Other respondences were only allowing to participate as a group or on behalf of farmer community to submit the questionnaire.

Table 1: Information of respondents characteristic.

| **Information** | | **Frequency** |
|---|---|---|
| Province | - Bangka Belitung | 3 |
| | - West Kalimantan | 1 |
| | - Central Kalimantan | 3 |
| | - West Papua | 1 |
| | - Riau | 143 |
| | - North Sumatra | 3 |
| Gender | - Man | 129 |
| | - Woman | 25 |
| Age | - >50 years | 35 |
| | - 41 – 50 years | 51 |
| | - 31 – 40 years | 50 |
| | - 21 – 30 years | 17 |
| | - 15 – 20 years | 1 |
| Resident status | - Comer | 36 |
| | - Native inhabitants | 118 |
| Marital status | - Not married yet | 9 |
| | - Divorced | 6 |
| | - Marry | 139 |
| Other jobs | - Midwife | 1 |
| | - Unloaders palm factory | 1 |
| | - Laborer | 2 |
| | - Housewife | 3 |
| | - Private sector employee | 22 |
| | - Student | 1 |
| | - Mechanics | 1 |
| | - Fisherman | 1 |
| | - Farmer | 23 |

| Information | | Frequency |
|---|---|---|
| | - Trader | 24 |
| | - Government employees | 3 |
| | - Cooperative management | 1 |
| | - KUD manager | 1 |
| | - POLRI | 1 |
| | - Office staff. | 1 |
| | - FFB transport car driver | 1 |
| | - Builder | 1 |
| | - Self-employed | 5 |
| | - Businessman | 1 |
| | - Other | 60 |
| Formal education. | - Elementary School | 20 |
| | - Junior High School | 39 |
| | - Senior High School | 51 |
| | - Diploma | 8 |
| | - Bachelor's degree | 20 |
| Family responsibility | - >3 | 25 |
| | - 0 | 11 |
| | - 1 | 20 |
| | - 2 | 33 |
| | - 3 | 65 |
| Oil palm area | - >3 ha | 50 |
| | - 3 ha | 1 |
| | - 2 – 3 ha | 42 |
| | - 1 – 2 ha | 50 |
| | - <1 ha | 11 |

Source: Authors, research data 2023.

The value of research variables can be measured in numbers so that they can be analyzed, and the results can be more accurate and communicative. There are various methods of measuring with a scale, namely, the Likert scale, Guttmann scale, differential semantic scale, and rating scale. The scale used in this study was a Likert scale with index numbers consisting of five levels: 5 (strongly agree), 4 (agree), 3 (quite agree), 2 (disagree), and 1 (strongly disagree). The following is a table of the assessment indicators used in this study.

Table 2: Variables and indicators of assessment in research

| Variable | Dimensions | Indicators |
|---|---|---|
| Smallholders readiness | 1. Legality of Land<br>2. Land Management<br>3. Environmental management and monitoring<br>4. Continuous business improvement | 1. Plantation legality, legality management, legality suitability.<br>2. Farmers' understanding of land, farmer's understanding of fertilization and harvest management.<br>3. Ownership of environmental permits, reporting of environmental monitoring, and records of environmental monitoring.<br>4. Records of garden management, recording of harvests seeking knowledge information. |

| Variable | Dimensions | Indicators |
|---|---|---|
| Sustainability awareness | 1. Sustainability practice awareness<br>2. Behavior and attitude awareness<br>3. Emotional awareness | 1. Discussions on environmental issues, waste management, and use of plastics; discussions with family members; and participation in environmental activities.<br>2. Following news related to environmental issues, respecting biodiversity, paying attention to vehicle pollution, sorting household waste, which ones can be recycled, saving electricity at home, and saving water use.<br>3. Paying attention to environmental problems at the place of residence, attitudes toward air pollution problems, attitudes towards river water pollution problems, and responsibility for protecting the environment. |
| Social intervention | Farmer's trust | Attitudes towards government policies, attitudes towards company programs, attitudes towards third parties in the effort, attitudes towards community programs, and attitudes towards farmer observers. |
| Smallholders sustainability status | 1. Economy<br>2. Social<br>3. Environment<br>4. Technology<br>5. Institutional | 1. Easy to access FFB sales, labor absorption from oil palm plantations is high, income from oil palm farming increases, and productivity from oil palm plantations increases.<br>2. Resolving conflicts between farmers can be resolved; I have an education diploma, participate in farmer empowerment activities, and teach family members to continue oil palm farming.<br>3. The land irrigation system is good, access to infrastructure is good, I plant other crops in addition to oil palm, and I pay attention to the environmental impact of my farming activities.<br>4. I use the criteria for ripe |

| Variable | Dimensions | Indicators |
|---|---|---|
| | | fruit at harvest; it is easy for me to market the harvested fruit, I can easily get information on the price of oil palm fruit, and the tools needed for gardening activities are easy to obtain.<br>5. I always receive training and counseling, loan funds from banks or cooperatives are easy to obtain, participate in cooperative membership, and participate in farmer group activities. |
| Performance of oil palm smallholders | 1. Quality<br>2. Quantity | 1. The oil palm fruit produced is in accordance with the quality desired by the factory.<br>2. The condition of my oil palm plant looks healthy and green.<br>3. The access to the garden is well maintained so it is easy to reach.<br>4. The yield of oil palm fruit is in accordance with the production target.<br>5. Revenue from sales of palm oil increased.<br>1. Revenue from the sale of other crops increased. |

Source: (Gómez-Limón & Riesgo, 2009);(Saifi & Drake, 2008);(Smith & McDonald, 1998);(Zhen & Routray, 2003); (Chen et al., 2022).

SmartPLS analysis

SmartPLS or Smart Partial Least Square is an analytical method used in this study to examine the relationships between variables. We used SmartPLS version 3.2.9. This study had five variables: KP, KK, IS, SKP, and KPS. The SmartPLS approach is powerful because it is not based on various assumptions. The analysis approach using smart-pls is caused by the small number of samples needed. It is highly recommended when it has a limited number of samples and does not have to have a normal distribution because it uses a bootstrapping method or random multiplication. Therefore, the assumption of normality was manageable. In the SEM analysis on SmartPLS, there are three simultaneous activities:

- Checking the validity and reliability of the instrument (confirmatory factor analysis)
- Testing relationship model between variables (path analysis)
- Obtaining a valuable model for prediction (structural model and regression analysis)

Three steps must be taken when processing quantitative research data using SmartPLS: the PLS Algorithm, Bootstrapping, and Blindfolding (Hair et al., 2019):

1. The PLS Algorithm, also known as the standard algorithm for calculating PLS components (factors), is a nonlinear iterative partial least squares (NIPALS). The fundamental essence of this algorithm is to estimate the parameters t and u using an iterative least-squares regression process. The results of the PLS Algorithm analysis include outer loading, which is used to measure whether the indicators truly represent the variables. Direct, indirect, and total effects, as well as R squared, determine the percentage of exogenous variables that can affect endogenous variables. In addition, an f-square was used to calculate the magnitude of the influence between variables on effect size and discriminant validity to display the Fornel-larker table. Discriminant validity was assessed using the cross-load method.

2. Bootstrapping was used to assess the significance level or probability of direct, indirect, and total effects. Bootstrapping also assesses the significance level of other values, including R square, adjusted R square, F square, outer loading, and outer weight. The indicator used to determine significance at this stage uses the statistics of t and the values of p.

3. Blindfolding analysis was used to assess the level of relevance of the predictions from the constructed model. This analysis process uses the Q square value; if Q square > 0.05, it can be concluded that the constructed model is relevant. That is, the exogenous variables used to predict the endogenous variables are correct.

## RESULTS

Outer model of the PLS Algorithm (Outer Loading and AVE) before and after handling

Based on the results of the PLS Algorithm analysis in Table 3, before handling the convergence validity of the outer loading and average variance extracted (AVE) values, it was found that seven of the 27 variables were invalid (the loading factor value was less than 0.7). The KK and IS variables in each indicator are considered valid (the load factor value is more significant than 0.7), indicating that these variables are reliable. The SKP and KPS variables each had two of the total indicators showing invalid values (<0.7), and the KK variables and three of the six indicators were invalid (<0.7). However, according to AVE, 4 out of 5 have met the discriminant validity requirement (a minimum value of 0.50 has been achieved)—KK variable, which had an AVE value of only 0.

Table 3: PLS Algorithm outer loading and AVE results before and after handling

| Variable | Indicator | | *Convergent Validity* | | | *Convergent Validity* | |
|---|---|---|---|---|---|---|---|
| | | | *Outer Loading* | AVE | | *Outer Loading* | *AVE* |
| Smallholders Readiness (KP) | KP1 | *Before handling* | 0.719 | 0.595 | *After handling* | 0.719 | 0.595 |
| | KP2 | | 0.706 | | | 0.706 | |
| | KP3 | | 0.772 | | | 0.772 | |
| | KP4 | | 0.797 | | | 0.797 | |
| | KP5 | | 0.854 | | | 0.854 | |
| Sustainability Awareness | KK1 | | 0.779 | 0.499 | | 0.787 | 0.565 |
| | KK2 | | 0.627 | | | 0.676 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| (KK) | KK3 | | 0.844 | | 0.858 | |
| | KK4 | | 0.675 | | 0.705 | |
| | KK5 | | 0.750 | | 0.719 | |
| | KK6 | | 0.514 | | deletion | |
| Social Intervention (IS) | IS1 | | 0.852 | | 0.852 | |
| | IS2 | | 0892 | | 0892 | |
| | IS3 | | 0.828 | 0.712 | 0.828 | 0.712 |
| | IS4 | | 0879 | | 0879 | |
| | IS5 | | 0.762 | | 0.762 | |
| Smallholders Sustainability Status(SKP) | SKP1 | | 0.805 | | 0.805 | |
| | SKP2 | | 0.799 | | 0.799 | |
| | SKP3 | | 0.637 | 0.521 | 0.637 | 0.521 |
| | SKP4 | | 0.777 | | 0.777 | |
| | SKP5 | | 0.554 | | 0.554 | |
| Performance of Oil Palm Smallholders (KPS) | KPS1 | | 0.624 | | 0.624 | |
| | KPS2 | | 0.866 | | 0.866 | |
| | KPS3 | | 0.797 | 0.616 | 0.797 | 0.616 |
| | KPS4 | | 0837 | | 0837 | |
| | KPS5 | | 0867 | | 0867 | |
| | KPS6 | | 0.685 | | 0.685 | |

Source: Authors, research data 2023.

After handling as being provided in Table 3, the results showed that all AVE values met the criteria above 0.5, and the outer loading value was above 0.4. This indicates that eliminating the KK06 indicator as an indicator of the sustainability concern (KK) variable with the smallest outer loading can increase the AVE value (before handling).

Table 4: PLS Algorithm internal consistency reliability results before and after handling

| **Variable** | **Cronbach's∝** | ***ρA*** | ***Composite Reliability*** |
|---|---|---|---|
| | *Before handling* | | |
| Smallholders Readiness (KP) | 0.831 | 0.847 | 0.880 |
| Sustainability Awareness (KK) | 0.793 | 0.828 | 0.854 |
| Social Intervention (IS) | 0898 | 0.903 | 0.925 |
| Smallholders Sustainability Status(SKP) | 0.764 | 0.787 | 0.842 |
| Performance of Oil Palm Smallholders (KPS) | 0.871 | 0.876 | 0.905 |
| | *After handling* | | |
| Smallholders Readiness (KP) | 0.831 | 0.847 | 0.880 |
| Sustainability Awareness (KK) | 0.809 | 0839 | 0.866 |
| Social Intervention (IS) | 0898 | 0.903 | 0.925 |
| Smallholders Sustainability Status (SKP) | 0.764 | 0.787 | 0.842 |
| Performance of Oil Palm Smallholders (KPS) | 0.871 | 0.876 | 0.905 |

Source: Authors, research data 2023.

This study's reliability test of PLS used Cronbach's and composite reliability methods. The results in Table 4 show that the results before and after handling all variables have good reliability and are declared reliable because the Cronbach's value is > 0.7, which means the questionnaire's question items are reliable. The insignificant changes reached <0.99 on the Sustainability Concern (KK) indicator. This indicates that all research variables have met composite reliability and high reliability because the composite reliability is > 0.7. Reliability tests were conducted to prove the instrument's accuracy, consistency, and precision in measuring constructs, and the value of composite reliability and Cronbach's α must be greater than 0.7 (Chin, 1998). The complete modeling results of the handling SmartPLS analysis are shown in Figure 2.

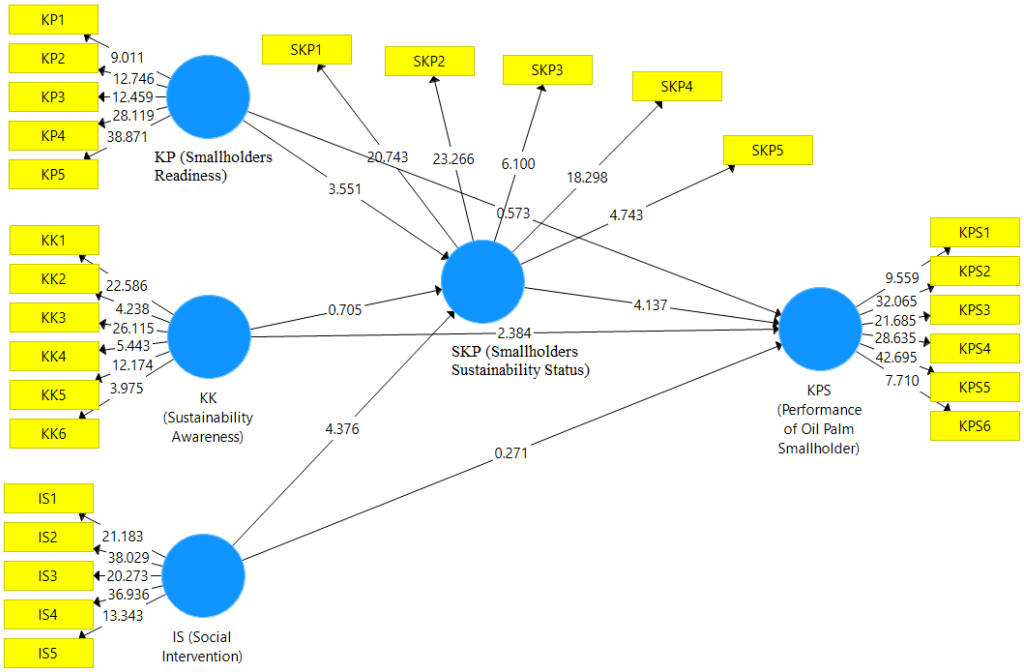


Figure 1: Pre-treated SmartPLS models (Source: Authors, research data 2023).

PLS Algorithm Discriminant Validity (Cross Loading)

The cross-loading value of each construct was evaluated to ensure that its correlation with the measurement items was greater than that of the other constructs. The expected cross-loading value was greater than 0.7 (Hair et al., 2019). Discriminant validity was assessed using the cross-load method. Discriminant validity tests the extent to which the latent construct differs from other constructs. A high value of discriminant validity indicates that a construct is unique and capable of explaining the measured phenomenon. From the table above, it can be explained that all loading indicators on the construct are greater than the cross-loading. As an example of the KK1 indicator, the loading value is 0.787 greater than the cross-loading of other constructs, namely 0.563 for IS, 0.655 for KP, 0.537 for KPS, and 0.619 for SKP. Similarly, with all other indicators, the value of loading to construct > cross-loading to other constructs.

Table 5: PLS Algorithm Cross-Loading Discriminant Validity Results Handling

| Indicator | Social Intervention (IS) | Sustainability Concern (KK) | Farmer Readiness (KP) | Oil Palm Smallholder Performance (KPS) | Farmer Sustainability Status (SKP) |
|---|---|---|---|---|---|
| IS1 | **0.852** | 0.486 | 0.650 | 0.483 | 0.712 |
| IS2 | **0892** | 0.548 | 0.649 | 0.509 | 0.649 |
| IS3 | **0.828** | 0.512 | 0.571 | 0.488 | 0.642 |
| IS4 | **0879** | 0.493 | 0.592 | 0.493 | 0.662 |
| IS5 | **0.762** | 0.434 | 0.453 | 0.447 | 0.532 |
| KK1 | 0.563 | **0.787** | 0.655 | 0.537 | 0.619 |
| KK2 | 0.317 | **0.676** | 0.370 | 0.346 | 0.349 |
| KK3 | 0.531 | **0.858** | 0.692 | 0.510 | 0.581 |
| KK4 | 0.244 | **0.705** | 0.343 | 0.409 | 0.257 |
| KK5 | 0.448 | **0.719** | 0.538 | 0.401 | 0.433 |
| KP1 | 0.395 | 0.396 | **0.719** | 0.369 | 0.436 |
| KP2 | 0.392 | 0.502 | **0.706** | 0.505 | 0.508 |
| KP3 | 0.458 | 0.439 | **0.772** | 0.466 | 0.532 |
| KP4 | 0.619 | 0.634 | **0.797** | 0.537 | 0.693 |
| KP5 | 0.734 | 0.737 | **0.854** | 0.566 | 0.727 |
| KPS1 | 0.563 | 0.392 | 0.467 | **0.624** | 0.550 |
| KPS2 | 0.511 | 0.495 | 0.557 | **0.866** | 0.627 |
| KPS3 | 0.418 | 0.429 | 0.479 | **0.796** | 0.598 |
| KPS4 | 0.317 | 0.404 | 0.460 | **0.836** | 0.521 |
| KPS5 | 0.447 | 0.535 | 0.544 | **0867** | 0.587 |
| KPS6 | 0.430 | 0.541 | 0.498 | **0.687** | 0.520 |
| SKP1 | 0.656 | 0.511 | 0.664 | 0.523 | **0.805** |
| SKP2 | 0.759 | 0.614 | 0.658 | 0.538 | **0.800** |
| SKP3 | 0.342 | 0.427 | 0.443 | 0.653 | **0.638** |
| SKP4 | 0.540 | 0.383 | 0.593 | 0.521 | **0.776** |
| SKP5 | 0.367 | 0.260 | 0.350 | 0.379 | **0.553** |

Source: Authors, research data 2023.

PLS Algorithm Inner Model (R square and f square)

The coefficient of determination (R-square) is a way to assess how much an exogenous construct can explain an endogenous construct. The coefficient of determination (R square) is expected to be between 0 and 1. The R square values are categorized into three categories, namely, strong, moderate, and weak, with R square values of 0.75, 0.50, and 0.25, respectively (Hair et al., 2017), while other opinions state that the criteria for R square values of 0.67, 0.33, and 0.19 are classified as strong, moderate, and weak. The adjusted R-squared value was corrected based on the standard error value. The adjusted value of R-squares provides a more substantial picture than R-square in assessing the ability of an exogenous construct to explain an endogenous construct. Based on the analysis of the coefficient of determination, it can be explained that all exogenous constructs (that IS, KP, and KK) simultaneously affect SKP by 0.687 or 68.7%, and SKP is influenced by 0.553 or 55.3% by SKP. Each is classified as moderate to strong in explaining how the construct affects the other constructs.

Table 6: Results of PLS Algorithm R Square Inner Model handling

| | ***R Square*** | ***R Square Adjusted*** |
|---|---|---|
| Performance of Oil Palm Smallhodlers (KPS) | 0.565 | 0.553 |
| Smallholders Sustainability Status (SKP) | 0.693 | 0.687 |

Source: Authors, research data 2023.

An analysis determining the f-square, or effect size needs to be performed to assess whether there is a significant relationship between variables. Based on the table above, the results of the inner model f-square are divided into three categories of effects, namely, 0.02 ≥ f < 0.15, classified as small effect; 0.15≥ f < 0.35, classified as medium effect; and f 0.35, classified as significant effect (Hair et al., 2019). Thus, based on the results in the table of the value of the f square above, a large effect size is absent with the criterion f 0.35, a moderate effect size with the criterium 0.15 ≥ f < 0.35 is an indicator of IS against SKP and KP against SKP and SKP against KPS. A small effect size with the criterion 0.02 ≥ f < 0.15 indicates KK to KPS. Meanwhile, the effect is ignored in the Indicator of KPS, KP on KPS, and KK on SKP because it has an f-squared value <0.02, which means that the f-squared value does not affect the other constructs.

Table 7: Results of PLS Algorithm f Square Inner Model handling

| | **Social Intervention (IS)** | **Sustainability Concern (KK)** | **Farmer Readiness (KP)** | **Oil Palm Smallholder Performance (KPS)** | **Farmer Sustainability Status (SKP)** |
|---|---|---|---|---|---|
| Social Intervention (IS) | | | | **0.001** | 0.297 |
| Sustainability Awareness (KK) | | | | 0.043 | **0.009** |
| Smallholders Readiness (KP) | | | | **0.006** | 0.208 |
| Performance of Oil Palm Smallholders (KPS) | | | | | |
| Smallholders Sustainability Status (SKP) | | | | 0.214 | |

Source: Authors, research data 2023.

Blindfolding (Q-square)

Blindfolding is used to assess the level of relevance of predictions from a constructed model. The analysis used a square Q value. If Q square > 0.05, it can be concluded that the constructed model is relevant, which means that the exogenous variables used to predict endogenous variables are appropriate. The relevance of the predictions of IS, KK, and KP to SKP and SKP to KPS is based on the square Q value of 0.329 and 0.322 > 0.05 respectively, so accept H0 which means that the exogenous variables IS, KK, and KP are appropriate or relevant if used as predictors of the SKP construct as an endogenous variable, as well as the IS, KK, KP, and SKP constructs for KPS.

Table 8: Q Square blindfolding results treatment

| | **SSO** | **SSE** | $\mathbf{Q^2(1-SSE/SSO)}$ |
|---|---|---|---|
| Social Intervention (IS) | 770,000 | 770,000 | |
| Sustainability Awareness (KK) | 770,000 | 770,000 | |
| Smallholders Readiness (KP) | 770,000 | 770,000 | |
| Performance of Oil Palm Smallholders (KPS) | 924,000 | 626,184 | 0.322 |
| Smallholders Sustainability Status (SKP) | 770,000 | 516,533 | 0.329 |

Source: Authors, research data 2023.

Bootstrapping (Direct Significance Test and Specific Indirect Effect)

Direct effects are the direct effects of a construct or an exogenous latent variable on endogenous latent variables. Based on the table above, the results of SmartPLS bootstrapping on direct effects illustrate that the hypothesis that the states the influence of IS on SKP, KK on KPS, KP on SKP, and SKP on KPS results in an acceptable evaluation. The p-values are 0.000, 0.024, and 0.000, respectively, and 0.000, respectively. The respective values of the T statistics are 4.505, 2.262, 3.902, and 4.416, which indicates that this hypothesis has a positive and significant value, and the cutoff value that gives the limits of the accepted hypothesis must be a p-value <0.05, and T statistics > 1.96. Additionally, the hypothesis that states the effect of IS on KPS, KK on SKP, and KP on KPS results in rejecting the evaluation because of a p-value of > 0.

Table 9: Results of the Significance of Direct Effect and Specific Indirect Effect Bootstrapping Handling

| | ***Original Sample*(O)** | ***Sample Means*(M)** | ***Standard Deviations* (STDEV)** | **T statistics (\|O/STDEV\|)** | ***p-values*** |
|---|---|---|---|---|---|
| ***Direct Effects*** | | | | | |
| Social Intervention (IS)→Performance of Oil Palm Smallholders (KPS) | -0.029 | -0.046 | 0.118 | 0.249 | 0.804 |
| Social Intervention (IS)→Smallholders Sustainability Status (SKP) | 0.426 | 0.424 | 0.095 | 4,505 | **0.000** |
| Sustainability Awareness (KK)→ Performance of Oil Palm Smallholders (KPS) | 0.202 | 0.212 | 0.089 | 2,262 | **0.024** |
| Sustainability Awareness (KK)→ Smallholders Sustainability Status (SKP) | 0.075 | 0.080 | 0.094 | 0.801 | 0.424 |
| Smallholders Readiness (KP)→ Performance of Oil Palm Smallholders (KPS) | 0.093 | 0.082 | 0.123 | 0.754 | 0.451 |
| Smallholders Readiness (KP)→ Smallholders Sustainability Status (SKP) | 0.418 | 0.420 | 0.107 | 3,902 | **0.000** |
| Smallholders Sustainability Status (SKP)→ Performance of Oil Palm Smallholders (KPS) | 0.552 | 0.572 | 0.125 | 4,416 | **0.000** |
| ***Specific Indirect Effects*** | | | | | |
| Social Intervention (IS)→ Smallholders Sustainability Status (SKP)→ Performance of Oil Palm Smallholders (KPS) | 0.235 | 0.243 | 0.079 | 2,969 | **0.003** |

| | | | | | |
|---|---|---|---|---|---|
| Sustainability Concern (KK)→ Smallholders Sustainability Status (SKP)→ Performance of Oil Palm Smallholders (KPS) | 0.041 | 0.042 | 0.052 | 0.790 | 0.430 |
| Smallholders Readiness (KP)→ Smallholders Sustainability Status (SKP)→ Performance of Oil Palm Smallholders (KPS) | 0.231 | 0.244 | 0.093 | 2,488 | **0.013** |

Source: Authors, research data 2023.

Indirect effects are the indirect effects of a construct or exogenous latent variable on endogenous latent variables through an intermediary variable. The output generated by SmartPLS analyzes the expected results, as shown in the table above. The results of SmartPLS bootstrapping on specific indirect effects illustrate that the hypothesis that the states the influence of IS on KPS through the intervening variable SKP results in an acceptable evaluation because the p-value is 0.003 and the T-statistic value of 2,969 concluded in this hypothesis is positive and significant. The same is true for the construct of KP to KPS through the intervening variable SKP, resulting in an acceptable evaluation because the p-value is 0.013 and the T-statistic value is 2.488; it is also concluded that this hypothesis has a positive and significant value. The two cutoff values that provide the accepted hypothesis limits must be T statistics > 1.96 and p-value < 0.05. The hypothesis states that the effect of KK on KPS through the SKP-intervening variable results in the evaluation being rejected. Because the p-value is 0.430 and the T-statistic value is 0.790, it can be concluded that this hypothesis is positive and not significant because the cutoff value for T-statistics is <1.96, and the p-value is > 0.05.

## DISCUSSION

Performance is a work achievement, both in quality and quantity, that is carried out by an individual as an effort to carry out his responsibilities according to the tasks that the company has given because the higher the level of employee performance, the quality and productivity in a company can increase and develop to optimal (Marini et al., 2021). According to the study, factors that affect performance include individuals' abilities, mental and physical skills, family background, age, and gender. Organizations include resources, leadership, rewards, work procedures, and teamwork. Psychology includes perception, attitudes, personality, motivations, and commitment. Moreover, the factors that influence organizational performance are ability and motivation (Risman, 2022). When focusing on the quality and quantity of performance of oil palm farmers, replanting is needed for plants between 20 and 25 years of age. Replanting was performed so that oil palm plantation production did not decrease drastically. The annual rejuvenation program accounts for approximately 4% of the total plantation area, so that the immature plantation area (TBM) does not exceed 12% of the total plantation area. This is done so that fresh fruit bunches (FFBs) processed by the palm oil mill (PKS) remain stable. Rejuvenation is carried out according to procedures related to occupational safety and health (K3) of employees, as well as the prevention and mitigation of environmental pollution by implementing the concept of zero-burning.

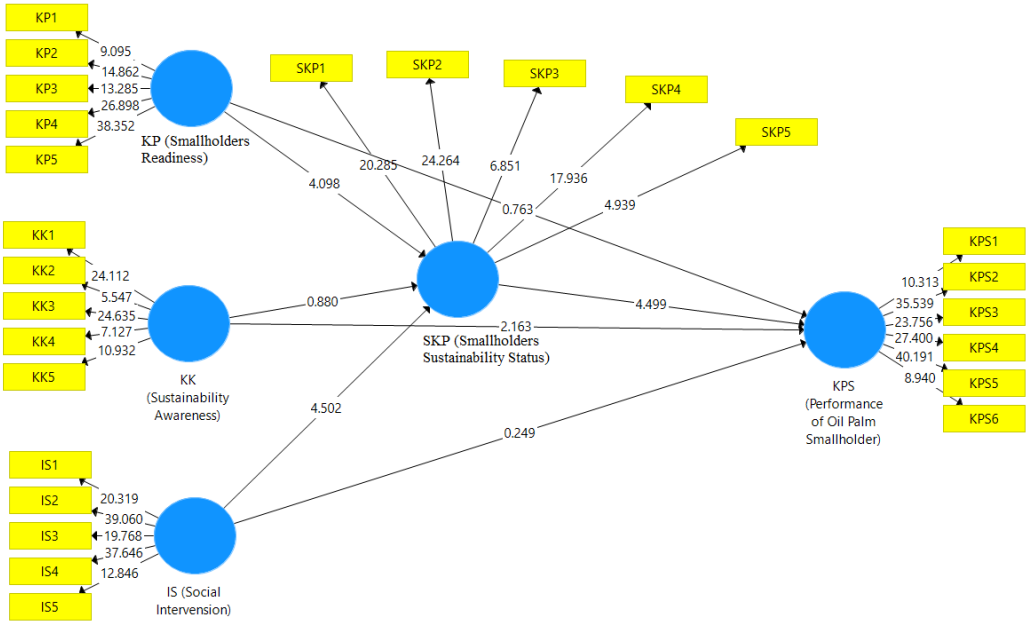


Figure 2: SmartPLS model handling (Source: Authors, research data analysis, 2023).

Farmers success is closely related to their ability to increase production and farm management. Competence is reflected in the social and economic characteristics of farmers. In general, the social characteristics of farmers (age, education level, farming experience, and number of family dependents) are not optimal, coupled with economic characteristics (land area, labor, capital), which still need to be more efficient. The low competence of farmers is partly due to the lack of participation of farmers in the participation of farmer groups, inaccurate information, farmers feeling they are not involved in decision-making, and agricultural technology needing to be understood (Kurniati & Gamal, 2018). Kurniati (2018) stated that qualitative and quantitative analyses show that the social characteristics of farmers include an average age of 49.1 years, elementary school graduation, average business experience of 20.62 years, and three dominant family members of 3 people. Economic characteristics include an average land area of 0.3 ha, labor generally coming from the family, and relatively little use of farming capital (Kurniati & Gamal, 2018). In this study, the social characteristics of oil palm farmers were an average age of 40 to 50 years, high school education level, a dominant number of family members of 3, an average land area of 3 ha, and most oil palm plantations were only a sideline.

The KP indicator (farmer readiness) has a significant influence on the SKP indicator (farmer sustainability status), indicating that farmer readiness plays an essential role in achieving sustainability (Table 9). The readiness of farmers in the replanting aspect to face sustainable agriculture can be seen from various aspects, including input aspect, financial aspect, market aspect, technological aspect, institutional aspect, and income aspect. The input aspect is one of the most important aspects of palm oil plantation cultivation. The input aspect is everything included in the production process. From the input aspect, it is easy for farmers to obtain input to develop their plantation businesses. The business of developing the garden is, for example, to rejuvenate plants when they are no longer productive. For example, the input to which Askes refers is access to farmers to obtain seeds, fertilizers, herbicides, and pesticides. Knowledge of farmers' perceptions regarding readiness for replanting is a financial aspect, including farmers' readiness regarding sources of funds for replanting costs. The

source of the funds in question is personal funds or loan assistance programs from cooperatives, banks, or other financial institutions. The financial aspect is seen through farmers' access to financial assistance. Financial assistance can be obtained from the government and financial institutions, such as banks, credit institutions, cooperatives, and intermediaries. This financial aspect can be seen in farmers' ease of obtaining loans from related parties. The market aspect refers to farmers selling and marketing their crops (FFB). From a market perspective, the points we want to examine are the access of farmers to sell FFB and the suitability of prices for the quality of FFB for farmers. When conducting an oil palm plantation business, farmers must ensure a market accommodating farmers' harvests (FFB). Market access (market information) is a weapon farmers must master when facing economic globalization.

The market aspect is vital because if farmers do not know the market, the yield (FFB) will be in vain because FFB cannot be marketed like other crop yields. Farmers' perceptions of the technological aspects are the benefits of rejuvenation as a technology for developing and maintaining the sustainability of the oil palm plantation business. From a technological perspective, farmers' perceptions of the benefits of future rejuvenation of smallholder palm oil plantations can be identified. The technological aspects include the benefits of general rejuvenation.

The role of institutions in the assistance planned for revitalizing oil palm farmers is crucial (Raharja et al., 2020). The institutions in question are governments, companies, cooperatives, banking companies, and other people's credit institutions. Apart from that, we also want to examine farmers' access to assistance in the institutional aspect. Lastly, income is one of the most important aspects because income is the income received by farmers from farming carried out by farmers. The income aspect is variable because rejuvenating oil palms will improve quality, production, and productivity, automatically increasing independent smallholders' income (Susanti et al., 2020). A high income is one of the reasons why farmers cultivate palm oil. Lastly, the income aspect is one of the most important because income is the income received by farmers from farming carried out by farmers. The income aspect is variable because rejuvenating oil palms will improve quality, production, and productivity, automatically increasing independent smallholders' income. High income is one reason for farmers to cultivate oil palms. Lastly, the income aspect is one of the most important because income is the income received by farmers from farming carried out by farmers. The income aspect is variable because rejuvenating oil palms will improve quality, production, and productivity, automatically increasing independent smallholders' income. High income is one reason for farmers to cultivate oil palms.

These six aspects are used as guides to determine the readiness of farmers to face this rejuvenation for the benefit of sustainable agriculture. Every farmer member of the Association of Independent Oil Palm Farmers has the advantage that other independent smallholders do not. The Amanah Association has received RSPO certification, giving each member farmer greater access to various production factors. RSPO-certified smallholders are required to comply with every RSPO standard to have legal land certificates that provide guarantees to financial institutions to provide loans for replanting. However, long-term planning in the RSPO standard also encourages farmers to prepare for replanting costs earlier by setting aside a portion of the proceeds from the sale of FFB (Susanti et al., 2020).

The constraints faced by farmers before rejuvenation are their decreased income due to a natural decline in FFB production and the waiting period before new

plants produce fruit (Soebirin et al., 2021). This problem can be overcome by preparing before rejuvenation, such as performing side activities to earn additional income. These side activities should be related to palm oil plantation activities, so they do not interfere with managing palm oil plantations. Farmers can plan a rejuvenation system by considering alternative replanting models such as total replanting, gradual replanting, underplanting, and new planting with short-term intercropping (Dhandapani et al., 2020;Ernawati et al., 2019). However, Dharmawan et al. (2019) stated that the readiness of farmers who still needed to be ISPO certified was measured based on ISPO parameters: land legality, seed legality, and farmers' knowledge of environmental management. The results of this study indicate that the three research locations showed that the farmers needed more time to be ready to perform ISPO certification.

Furthermore, independent smallholders and plasma partners (> 90%) respond positively to the approval of certified palm oil farmers (PKS), as well as plasma partner farmers. Small oil palm plantation businesses exhibit different levels of readiness among smallholders. Plasma partner farmers are more prepared than independent smallholders, and the level of GAP implementation at the plantation level differs between independent smallholders and plasma partners. Plasma partner farmers who apply GAP practices and have GAP implementation document records account for more (±30%) than independent smallholders (±10%) . Thus, the risk of expansion of palm oil plantations on natural resources and the environment will remain a significant challenge in the future.

The KK indicator (concern about sustainability) has a significant influence on the KPS indicator (oil smallholder performance), indicating that awareness/awareness plays an essential role in the implementation of sustainability (Table 9). Perception is the process of receiving information or stimuli from the environment and transforming them into psychological awareness (Luke et al., 2020). Some perceive something as having good, positive, or negative perceptions that affect visible or real human actions. The perceptions in this study are the views or responses and opinions of self-supporting oil palm smallholders, which contain elements of smallholder assessment of the aspects of RSPO certification. Sustainable palm oil plantations can only be produced if management always considers social, environmental, and economic aspects (people, planet, and profit). The human aspect is not only for workers but also for the broader interests of society. The environmental aspect is taking advantage of natural resources and taking advantage of them as much as possible without harming or damaging the environment. The economic aspect is not only the benefits obtained by farmers but also includes broader benefits, namely, the benefits that the ecological and social environment can feel. The level of application of the principles and criteria of RSPO by independent oil palm smallholders is still far from the certification standard, that is, only 57.17% (included in the well-implemented category). This is because of the high cost of RSPO certification, and farmers still need help adapting to the cultivation standards required by the RSPO. For example, work safety procedures, such as helmets, goggles, boots, and other safety equipment, are part of Personal Protective Equipment (PPE).

Sustainability awareness can also be seen through the Theory of Planned Behavior (TPB) and past behavior. It is used as a theoretical basis to examine the influence of attitudes towards sustainability, subjective norms, perceptions of behavioral control, and past behavior on the intentions of independent smallholders and plasma smallholders to implement sustainable palm oil production practices (Yutika et al., 2019). The results of his research show that attitudes towards sustainability, subjective norms, perceptions of behavioral

control, and past behavior significantly affect plasma smallholders' intention to adopt sustainable palm oil production practices. For independent smallholders, subjective norm variables did not influence farmers' intentions to implement sustainable palm oil production practices. The application of sustainable agricultural practices in smallholder palm oil plantations can be increased by collaborating with various parties, such as large state companies, large private companies, extension programs, and government support. Oil palm companies can become normative references for the implementation of sustainability practices. The government can support smallholder farmers, especially independent smallholders, increase prices, strengthen downstream industries, and subsidize smallholder oil palm rejuvenation programs to increase the productivity of smallholder oil palm plantations.

Furthermore, establishing farmer groups and the KUD (The village unit cooperation) should improve the institutional farming system. Informal education programs such as counseling are urgently needed by smallholder farmers, especially independent farmers, to increase their awareness of and ability to carry out sustainable practices, produce organic fertilizers, and assist farmers in pest control programs in an integrated manner. Improve the institutional farming system by forming farmer groups and KUD. Informal education programs such as counseling are urgently needed by smallholder farmers, especially independent farmers, to increase their awareness and ability to carry out sustainable practices, produce organic fertilizers, and assist farmers in pest control programs in an integrated manner.

Farmers are the main actors in agricultural production activities and a part of Indonesian society that needs to improve their welfare and intelligence. One effort to increase intelligence is through extension activities. With extension agents, it is hoped that all the agricultural information that develops can be absorbed and accepted by farmers; the more information they use, the more influential the counseling will be. Including individuals from various cultural backgrounds, introducing diversity to mainstream communities, and acknowledging the unique requirements of different groups are essential for establishing trust and mutual respect between the majority and minority populations. Equal recognition of diversity and respect for diverse viewpoints among all citizens, regardless of their socio-cultural, economic, or political backgrounds, are crucial for maintaining the social fabric and fostering trust among both local residents and newcomers. The various needs of different community groups play a vital role in sustaining societal cohesion and promoting trust among both native and immigrant populations (Yeasmin et al., 2023).

The subjects of agricultural development are farmers, farming communities in general, and farming groups in particular. As a component of the agribusiness system, the role of farmer groups significantly determines the success of the extension (Marbun et al., 2019). Although extension workers have made efforts with farmers/farm groups to conduct development in the agricultural sector, government policies that favor extension workers are still needed. The intervention of agricultural extension workers and the government is essential in increasing farmers' awareness and optimism in implementing sustainability. Theoretically, the development of farmer groups is carried out by raising farmers' awareness of the existence of farmer groups. Extension agents can influence goals through their role as educators, innovators, facilitators, consultants, supervisors, monitors, evaluators, and advisors to farmers according to the characteristics of farmers, including the potential of the area (Marbun et al., 2019). To increase the effectiveness of extension activities and to grow and

develop the participation of farmers in agricultural development, it is necessary to guide the formed farmer groups so that they will be able to grow and develop with adequate economic strength and will then be able to support their members' welfare. Farmer group development is a series of activity processes that enable and empower farmers' group members to achieve a common goal. A farmer group is said to be developing if it has the following characteristics:

1. Know each other, be familiar, and trust each other among members.
2. Has the same views and interests in farming.
3. Has similarities in tradition or settlement, business gap, and type of business istrict-level patents and institutions.

In presidential regulation number 154 of 2014, extension institutions, agriculture, fisheries, and forests were government agencies responsible for agriculture. Field Agricultural Counseling is tasked with encouraging farmers so that they want to change their way of thinking, way of working, and way of life to be more in line with the times and development of more advanced agricultural technology. Thus, an agricultural extension agent has three roles in carrying out his duties:

1. Acting as an educator, providing knowledge or new ways of cultivating plants so that farmers are more focused on their farming business, increasing yields, and overcoming failures in their farming business.
2. Acting as a leader who can guide and motivate farmers so that they want to change their way of thinking about how they work so that there is openness, and they are willing to accept new farming methods that are more efficient and successful so that their standard of living is more prosperous.
3. Acts as an advisor who can serve, provide instruction, and help farmers through demonstrations or working examples in farming to solve all their problems.

## CONCLUSION

Smallholder readiness (KP), sustainability awareness (KK), and social intervention (IS) play essential roles in implementing sustainability (SKP) and improving the performance of oil palm smallholders (KPS). Farmers' readiness to take on input, financial, market, technological, institutional, and income aspects must be improved to implement ISPO sustainability. Implementing sustainable palm oil plantations in their management must consider social, environmental, and economic aspects. External roles of agricultural, extension, governence and farmers' awareness are needed to achieve sustainability goals. Further research need to expand the other variables and indicators that meet with the improvement of their productivities and performances for sustainable oil palm smalholders that can be contributed to global oil palm production.

Data Availability

The dataset is accessible to the corresponding author upon request.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Funding Statement

The authors declare that no funding received for conducting this study.

Acknowledgments

The authors would like to thank ANJ Research Center Library and Faculty of Business and Management, Universitas Mercu Buana, for technical support during the research work.

Author's contributions

All authors contributed to the study's conception and design. J.S. and Dj. coordinated the writing process and wrote the general parts of the manuscript (Abstract, Introduction, Materials and Methods, Conclusion); Supervision, writing review and editing, J.S. and A.B.S; supervision, literature review, editing, J.S., and D.K.; Literature review, revision, J.S.

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