Andalasian International Journal of Agricultural and Natural Sciences (AIJANS)
ISSN: 2745-7885 (Online)
Available in : https://aijans.lppm.unand.ac.id/index.php/aijans



Article

The Role of Land Area as A Mediator in The Relationship between Palm Oil Price and Productivity on Farmers' Income in Bangko Pusako Rokan Hilir

Tsamara Afifah[1*], Heri Faisal Harahap[2], Silfia[3], Reza Mardiyah Amir[4]
[1,2,3]*Department of Business Agricultural, Politkenik Pertanian Negeri Payakumbuh , Indonesia*

DOI: https://doi.org/10.25077/aijans.v6.i01.26-36.2025

Submission Track
Received: May 21, 2025
Final Revision: June 16, 2025
Accepted: June 24, 2025
Available Online: June 27, 2025

Keywords
palm oil, land area, productivity, farmers' income

Correspondence
*E-mail: tsamaraafifah1@gmail.com

ABSTRACT

This study aims to analyze the mediation effect of land area on the relationship between price and productivity on oil palm farmers' income in Bangko Pusako District, Rokan Hilir Regency. A quantitative approach using Structural Equation Modeling-Partial Least Squares (SEM-PLS) method was employed to analyze data from 155 oil palm farmers selected through accidental sampling technique. The results show that palm oil prices and productivity do not have significant direct effects on farmers' income. However, land area proves to have a significant direct effect on farmers' income (T-statistic = 2.208, p-value = 0.028). Mediation analysis reveals that palm oil prices significantly affect income through land area mediation (T-statistic = 2.112, p-value = 0.035), while productivity does not significantly affect income through land area mediation (T-statistic = 1.611, p-value = 0.108). These findings confirm the important role of economies of scale in oil palm farming, where farmers with large land areas have comparative advantages in utilizing market price fluctuations. This research provides theoretical contributions to the development of farmer income analysis models and practical inputs for formulating more effective and targeted oil palm farmer empowerment policies.

INTRODUCTION

Indonesia is an agricultural country that has great potential in the development of the agricultural sector, especially the plantation sub-sector. Palm oil has become one of the leading plantation commodities that plays an important role in improving people's welfare, especially palm oil farmers. This commodity has a very large opportunity to be used as a mainstay of non-oil and gas exports, with a role as a provider of raw materials for the processing industry that creates added value and encourages the development of the palm oil industry [1]. Indonesia has become the largest palm oil producer in the world, with a total production reaching 51.3 million tons in 2023, reflecting Indonesia's strategic position in the global palm oil industry. Riau Province as one of the national palm oil production centers has a substantial contribution to Indonesia's total palm oil production, with a plantation area reaching 2.8 million hectares and contributing around 20% of total national production.

The global context shows that Indonesia competes with other major producers such as Malaysia and Nigeria. Malaysia, as the second largest producer, has a higher productivity per hectare than Indonesia, reaching 17-20 tons of FFB/ha/year, while Indonesia's average is still around 15-18 tons of FFB/ha/year. Nigeria, despite having large land potential, still faces productivity challenges with an average of 8-12 tons of FFB/ha/year and various constraints similar to smallholder farmers in Indonesia [2]. This

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comparison shows that there is still room for increasing Indonesian oil palm productivity, especially at the smallholder farmer level.

The development of oil palm plantations has been proven to have a positive impact on improving the welfare of rural communities. However, the income level of oil palm farmers is not always stable and is influenced by various complex factors, both internal and external. The price of oil palm is a crucial factor affecting farmers' income, where price fluctuations in the international market directly impact prices at the farmer level. According to Kabul Wijayanto (BPDPKS), although palm oil contributes the largest foreign exchange to Indonesia outside of oil and gas with exports reaching US$28.45 billion of the total US$242.87 billion of non-oil and gas exports in 2023, the volatility of CPO prices ranging from US$905-1,019/ton creates uncertainty for farmers in estimating income [3]. In addition to price factors, plantation productivity plays an important role in determining farmers' income levels. Studies in Malaysia show that appropriate technology and management can increase productivity by up to 17-20 tons of FFB/ha/year, providing a competitive advantage for farmers. In Nigeria, research by [2] found that various productivity constraints faced by smallholder farmers, such as limited access to technology and capital, have a significant impact on their income even though they face the same price fluctuations. However, achieving optimal productivity is not easy because it is influenced by various factors such as seed quality, fertilization, maintenance, and environmental conditions. Oil palm farmers face various obstacles both technically and institutionally, including poor seed quality and inappropriate plant care [4][5].

Previous studies have examined the relationship between palm oil prices and farmers' income, with several studies finding a positive correlation between price increases and increased farmer income. However, these studies generally focus on the direct relationship without considering the role of mediating variables. Studies on palm oil productivity have also been widely conducted, focusing on factors that influence productivity and its impact on income. Several researchers have found that increased productivity is not always directly proportional to increased income, indicating that there are other factors that need to be considered. The main gap identified is the lack of research examining the mediating role of land area in the relationship between price and productivity on oil palm farmers' income. Most previous studies ignore the complexity of the interactions between these variables, especially how land area can moderate the effects of price and productivity on income. A comparative study in Malaysia by [6] identified various challenges faced by smallholder farmers, including limited land area that affects the ability to adapt to market fluctuations. Meanwhile, research in Nigeria by [7] revealed that business scale and land area are important factors in determining the effectiveness of technology application to increase productivity and income of oil palm farmers. These findings indicate the importance of understanding the role of land area as a mediating variable in the relationship between production factors and farmer income.

This study uses the Structural Equation Modeling - Partial Least Squares (SEM-PLS) approach which is suitable for analyzing complex relationships between latent variables with relatively small samples. SEM-PLS was chosen because of its ability to test mediation effects and analyze complex structural models without strict normal distribution assumptions, and is suitable for exploratory research that develops new theories. The novelty of this study lies in the comprehensive approach in analyzing the relationship between price, productivity, and income by considering the mediating role of land area. This approach is expected to provide a deeper understanding of the dynamics of oil palm farmers' income, especially in Bangko Pusako District which has a fairly diverse diversity of farmer land areas, ranging from narrow to relatively large.

The purpose of this study was to analyze and test the mediation effect of land area on the relationship between price and productivity on the income of oil palm farmers in Bangko Pusako District, Rokan Hilir Regency. The results of the study are expected to provide theoretical contributions in the development of farmer income analysis models as well as practical input for the formulation of more effective and targeted oil palm farmer empowerment policies. Data from the Ministry of Agriculture (2023) shows

that the area of oil palm land in Indonesia reached 15,435.70 ha in 2023, with Riau Province having the largest land area of 2,869.30 ha. In Rokan Hilir Regency, Bangko Pusako District is the district with the largest land area of 22,570.00 ha, followed by Tanah Putih District (21,016.00 ha) and Tanjung Medan District (20,133.00 ha). The variation in land area owned by farmers in Bangko Pusako District provides a good opportunity to study how land area can mediate the effect of price and productivity on farmer income. Understanding the role of mediation is important for developing a model of empowering oil palm farmers that is more appropriate to local conditions and supports the sustainability of this sector amidst global challenges such as climate change and sustainability demands. This research is also relevant to the government's efforts in developing a sustainable oil palm sector, where a better understanding of the factors that influence farmers' incomes can help in formulating policies that support the sustainability of this sector.

METHODS

Sample and Data Collection Method

This study employs a quantitative approach, utilizing statistical data collection to facilitate calculations through the use of statistical data. The population of this study comprises all oil palm farmers in Bangko Pusako, Rokan Hilir, although the exact number remains unknown, making the population considered unidentified in detail [8]. Due to this constraint, the research employs accidental sampling, a non-probability sampling technique where respondents are selected based on ease of access and availability without considering overall population representation. While this method is practical, cost-effective, and suitable for exploratory research with time and resource limitations, it has inherent limitations regarding generalizability due to potential bias [9]. The collected data will be processed using structural equation modeling with the Smart PLS approach.

Data Analysis Technique

This study employs Partial Least Squares (PLS) method for data analysis, a statistical technique used to simultaneously estimate structural and measurement models involving latent variables and indicators. PLS is particularly suitable for data with high multicollinearity and limited sample sizes, enabling it to handle complex inter-variable relationships [10]. The analysis encompasses both outer model (measurement model) evaluation, which examines the relationships between latent variables (palm oil price, productivity, land area, and income) and their reflective indicators, and inner model (structural model) analysis, which tests the direct and indirect relationships among latent variables. Key evaluation metrics include R-square for explanatory power (0.67 substantial, 0.33 moderate, 0.19 weak), effect size (f-square) for practical significance (0.02 small, 0.15 medium, 0.35 large), and predictive relevance (Q-square) for model prediction capability [11] [12].

Hypothesis testing is conducted using t-statistics with a significance threshold of 1.96 ($\alpha = 5\%$), where hypotheses are accepted when t-statistic > 1.96 or p-value < 0.05 [13]. The mediation effect testing follows a three-stage process as outlined by [14]: first, establishing significant direct effects between independent and dependent variables; second, confirming significant relationships between independent variables and the mediator; and third, conducting simultaneous testing of main effects and mediating variable effects on the dependent variable. Full mediation (fully mediating) is established when the direct effect becomes non-significant while the indirect effect through the mediator remains significant, demonstrating that the mediating variable successfully explains the relationship between independent and dependent variables.

RESULTS AND DISCUSSION

Bangko Pusako District is strategically located between 101°14'-101°34' East Longitude and 0°25'-0°45' North Latitude, characterized by a tropical climate with average temperatures ranging from 27°-35°Celsius. The

district encompasses a total area of approximately 948.85 km² within Rokan Hilir Regency, featuring diverse topographical characteristics including highland and lowland terrain that supports various land utilization patterns including agricultural land, plantation areas, residential settlements, and public facilities. This geographical setting provides an optimal environment for oil palm cultivation, which serves as the primary economic activity for the local population of 64,332 inhabitants, comprising 33,023 males and 31,309 females [5]. The demographic composition and substantial population size necessitate comprehensive regional development planning that encompasses agricultural sector development, educational infrastructure, and public service provision to ensure optimal fulfillment of community needs through data-driven development approaches.

Descriptive Analysis

Data description is a description of the data used in a study. In testing this data description, the researcher tries to find out the description or condition of the respondents who are the samples in this study. From the collection of questionnaire data from respondents' answers, with a sample size of 155 people who have oil palm land in Bangko Pusako Rokan Hilir, this test was carried out using the assistance of the Partial Least Squares Structural Equation Modeling (PLS-SEM) 3.0 program.

Based on the frequency analysis of questionnaire data from respondents, the characteristics of the sample in this study include educational background, gender, age, occupation, land area, monthly palm oil income, and farming experience. The results of data processing using frequency analysis conducted by the researcher are presented in the following tables:

Table 1. Frequency Analysis Results Based on Educational Background

No.	Educational Level	Frequency (People)	Percentage
1.	Junior High School	15	9.7%
2.	Senior High School/Vocational	133	72.9%
3.	Diploma III	7	4.5%
4.	Bachelor's Degree	20	12.9%
	Total	**155**	**100.0%**

Table 1 presents the frequency analysis results indicating that respondent characteristics based on educational background show that 20 respondents hold bachelor's degrees, 7 respondents have diploma degrees, 133 respondents completed senior high school education, and 15 respondents finished junior high school. The analysis concludes that respondent characteristics in this study are dominated by those with senior high school education, totaling 133 respondents or individuals who own palm oil plantations in Bangko Pusako, Rokan Hilir, from the total sample of 155 respondents.

Table 2. Frequency Analysis Results Based on Respondent Gender

No.	Gender	Frequency (People)	Percentage
1.	Male	123	79.4%
2.	Female	32	20.6%
	Total	155	100.0%

Table 2 shows the frequency analysis of respondent data indicating that respondent characteristics based on gender in this study are dominated by males, totaling 123 individuals, while female respondents total 32 individuals who own palm oil plantations in Bangko Pusako, Rokan Hilir, from the total sample of 155 respondents.

Table 3. Characteristic Analysis Results Based on Respondent Age

No.	Age Range	Frequency (People)	Percentage
1.	20-30 years	41	26.5%
2.	31-40 years	74	48.4%
3.	41-50 years	35	23.2%
4.	51-60 years and above	5	1.8%
	Total	155	100.0%

Table 3 presents frequency analysis results showing respondent characteristics based on age, with 41 respondents aged 20-30 years, 74 respondents aged 31-40 years, 35 respondents aged 41-50 years, and 5 respondents aged 51-60 years. The analysis concludes that respondent characteristics based on age are dominated by those aged 31-40 years, totaling 74 respondents who own palm oil plantations in Bangko Pusako, Rokan Hilir, from the total sample of 155 respondents.

Table 4. Characteristic Analysis Results Based on Respondent Occupation

No.	Occupation	Frequency (People)	Percentage
1.	Student	10	6.5%
2.	Entrepreneur	62	40.0%
3.	Farmer	69	44.5%
4.	Civil Servant	14	9.0%
	Total	155	100.0%

Table 4 presents frequency analysis results showing respondent characteristic descriptions based on occupation: 10 students, 62 entrepreneurs, 69 farmers, and 14 civil servants who own palm oil plantations in Bangko Pusako, Rokan Hilir, from the total sample of 155 respondents.

Table 5. Characteristic Analysis Results Based on Respondent Land Area

No.	Land Area	Frequency (People)	Percentage
1.	1-5 hectares	122	78.7%
2.	5-10 hectares	27	17.4%
3.	11+ hectares	6	3.9%
	Total	155	100.0%

Table 5 presents frequency analysis results showing respondent characteristic descriptions based on land area: 122 respondents own 1-5 hectares, 27 respondents own 5-10 hectares, and 6 respondents own 11 hectares or more of palm oil plantations in Bangko Pusako, Rokan Hilir, from the total sample of 155 respondents.

Table 6. Frequency Analysis Results Based on Monthly Income

No.	Monthly Income (IDR)	Frequency (People)	Percentage
1.	500,000 - 1,000,000	12	7.7%
2.	1,500,000 - 2,500,000	71	45.8%
3.	3,000,000 - 5,000,000	48	31.0%
4.	6,000,000+	24	15.5%
	Total	155	100.0%

Table 6 presents questionnaire data analysis results showing respondent characteristic descriptions based on monthly income: 12 respondents earn IDR 500,000-1,000,000, 71 respondents earn IDR 1,500,000-2,500,000, 48 respondents earn IDR 3,000,000-5,000,000, and 24 respondents earn IDR 6,000,000 or more who own palm oil plantations in Bangko Pusako, Rokan Hilir, from the total sample of 155 respondents.

Table 7. Frequency Analysis Results Based on Farming Experience

No.	Farming Experience	Frequency (People)	Percentage
1.	1-5 years	92	59.4%
2.	6-10 years	44	28.4%
3.	10-15 years	19	12.3%
	Total	155	100.0%

Table 7 presents questionnaire data analysis results showing respondent characteristic descriptions based on farming experience: 92 respondents have 1-5 years of experience, 44 respondents have 6-10 years of experience, and 19 respondents have 10-15 years of farming experience in palm oil cultivation in Bangko Pusako, Rokan Hilir, from the total sample of 155 respondents.

Hypotesis Testing

This study examines eight hypotheses to test the significance of the effects of selling price (X1) and productivity (X2) on income (Y) through the mediating variable of land area (Z), using a two-tailed hypothesis test to analyze both direct and indirect relationships between exogenous and endogenous latent constructs. The hypotheses aim to address the research problem by evaluating specific causal pathways, including the role of the intervening variable. Structural Equation Modeling with a Partial Least Squares approach (SEM-PLS) was employed for analysis, with hypothesis testing based on t-statistics and p-values. A hypothesis is considered significant if it meets the Rule of Thumb criteria: a p-value below 0.05 and a t-statistic above 1.96 (significance level = 5%) for a two-tailed test (or 1.65 for a one-tailed test at 5% significance). Accordingly, the decision rule for accepting or rejecting hypotheses is that Ha is accepted and H0 is rejected if the t-statistic exceeds 1.96. Alternatively, using probability criteria, Ha is accepted if the p-value is less than 0.05. The structural model results, presented in the figure below, demonstrate the path coefficients and their significance levels, providing empirical evidence for the hypothesized relationships. This analytical approach ensures robust validation of both direct and mediated effects within the proposed framework. The findings contribute to understanding the interplay between pricing, productivity, and land area in shaping income outcomes. The subsequent discussion interprets these results in the context of existing theoretical and empirical literature.

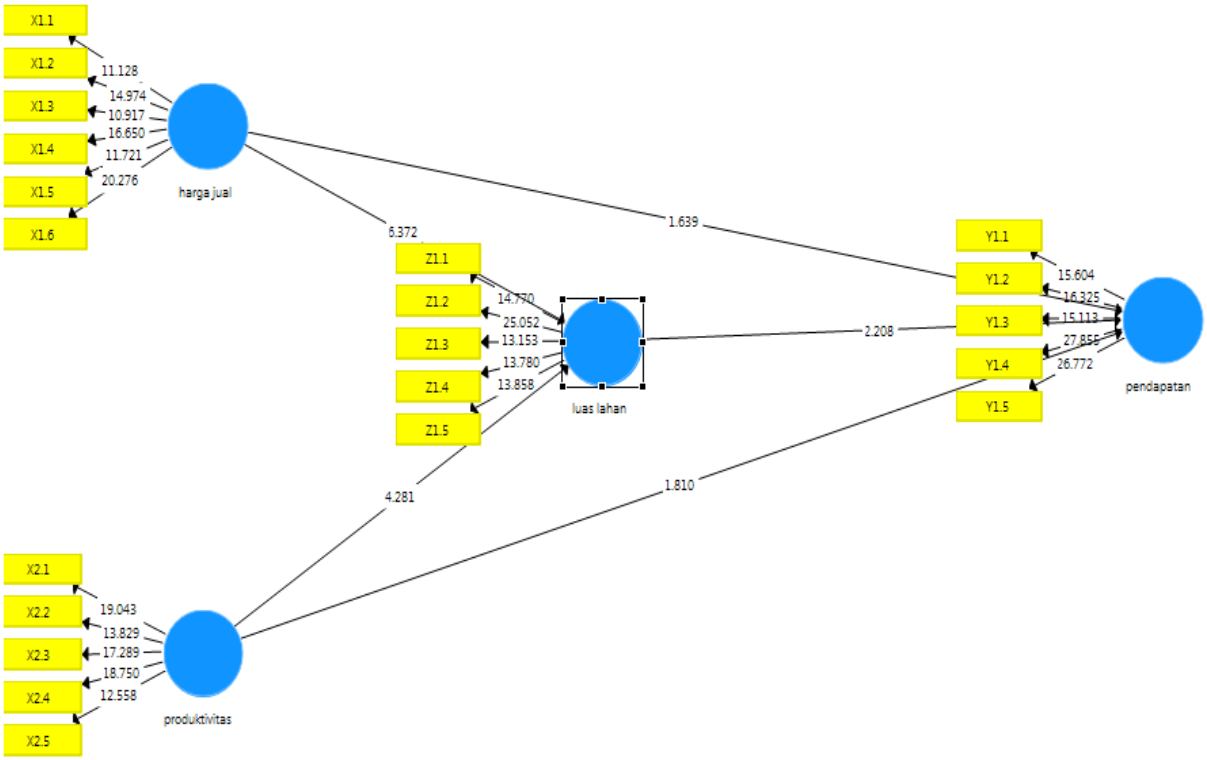


Figure 1. Boostraping Results

The structural model results presented in the figure are summarized in tabular form as shown in the table below:

Table 8. Direct Effect Hypothesis Testing

Variable	Original Sample	T Statistic	P Value
Selling Price → Land Area	0.498	6.372	0.000
Selling Price → Income	0.211	0.639	0.102
Land Area → Income	0.317	2.208	0.028
Productivity → Land Area	0.380	4.281	0.000
Productivity → Income	0.219	1.810	0.071

The SmartPLS testing results in Table 8 present the research hypothesis testing outcomes, beginning with the first hypothesis through to the hypotheses examining the direct effects of selling price and productivity on income, followed by the effects of the land area construct or variable on income.

Based on the hypothesis testing results presented in Table 24, the following conclusions can be drawn:

- **Selling price has a significant positive effect on land area**, as evidenced by the T-statistic value (6.372) > critical T-statistic value (1.96) with a P-value of 0.000 < 0.05. Therefore, Ha3 is accepted and Ho3 is rejected.
- **Selling price does not have a significant positive effect on income**, as evidenced by the T-statistic value (0.639) < critical T-statistic value (1.96) with a P-value of 0.102 > 0.05. Therefore, Ho1 is accepted and Ha1 is rejected.
- **Land area as a mediating variable has a significant positive effect on income**, as evidenced by the T-statistic value (2.939) > critical T-statistic value (1.96) with a P-value of 0.003 < 0.05. Therefore, Ha4 is accepted and Ho4 is rejected.
- **Productivity has a significant positive effect on income**, as evidenced by the T-statistic value (2.813) > critical T-statistic value (1.96) with a P-value of 0.005 < 0.05. Therefore, Ha2 is accepted and Ho2 is rejected.

The indirect effect hypothesis testing demonstrates the relationships between independent variables and dependent variables through mediating variables. Mediation effect testing involves not only analyzing the direct effects of independent variables on dependent variables but also examining the reciprocal relationships that occur through mediating variables. The purpose of mediation testing is to determine whether the mediating variable plays a role in bridging the influence of independent variables on dependent variables. The following table presents the results of mediation effect testing using the SmartPLS 3.0 program.

Table 9. Indirect Effect Hypothesis Testing (Mediating Variable Effects)

Construct	Original Sample	T Statistic	P Value
Selling Price → Land Area → Income	0.158	2.112	0.035
Productivity → Land Area → Income	0.120	1.611	0.108

The table above shows the t-statistic or t-calculated values used to assess whether hypotheses are accepted or rejected by comparing the t-statistic values with the t-table value of 1.96 and p-value < 0.05 (significance level = 5%). Based on the indirect hypothesis testing results or mediating variable effects in Table 25, the following conclusions can be drawn:

- **Selling price has a significant effect on income through land area as a mediating variable**, as the T-statistic or T-calculated value of 2.112 > 1.96 with a P-value of 0.035 < 0.05 (significance level). Therefore, Ha3 is accepted and Ho3 is rejected.
- **Productivity has a significant effect on income through land area as a mediating variable**, as the T-statistic or T-calculated value of 1.611 < 1.96 with a P-value of 0.108 > 0.05 (significance level). Therefore, Ho2 is accepted and Ha2 is rejected.

DISCUSSION

Effect of Palm Oil Price on Palm Oil Farmers' Income

The test results show a significance level of 0.102 which is greater than the alpha value of 0.05, indicating that the null hypothesis (Ho_1) is accepted. With a T-statistic value of 0.639 which is smaller than 1.96, this study proves that palm oil prices do not have a significant direct effect on the income of

palm oil farmers. This finding contradicts the research of [15] which found a positive and significant effect of palm oil prices on the income of palm oil farmers, where an increase in palm oil prices with stable sales results can increase farmers' income.

The insignificant direct effect of palm oil prices on income can be explained by several interrelated structural factors. Increases in palm oil prices are often accompanied by increases in production costs such as fertilizer, labor, and transportation costs, so that when production costs increase faster than selling prices, farmers' profit margins can actually decrease. High market price fluctuations make farmers unable to rely on prices as a stable source of income, because price increases in one period do not guarantee sustainable income if prices fall drastically in the next period. In addition, production efficiency varies between farmers, causing not all farmers to be able to take advantage of high prices optimally, especially if productivity is low or production efficiency is poor so that income remains low even though prices are high. This condition shows that to increase farmer income sustainably, it is not enough to rely only on high palm oil prices, but it is necessary to pay attention to all other production factors.

Effect of Productivity on Income

The test shows a significance level of 0.071 which is greater than alpha 0.05, so the null hypothesis (Ho_2) is accepted and shows that productivity does not have a significant direct effect on the income of oil palm farmers. This result is not in line with the research of [16] which found a positive and significant effect of work productivity on farmer welfare, where the better the level of farmer work productivity, the more farmer welfare will increase through increased work quantity, work quality, and punctuality in working.

The insignificant direct effect of productivity on income can be explained by the complexity of the relationship between production output and net income realization. Although farmers are able to produce a lot of Fresh Fruit Bunches (FFB), if the selling price is low or production costs increase, the net income received can remain small or even lose money. In reality in the field, not all farmers are able to manage their harvest optimally due to limited access to good markets, limited transportation facilities, or do not have the power to determine prices which are usually influenced by market fluctuations. The scale factor also plays an important role, where if productivity is high but the land area is small, the total yield remains limited compared to farmers whose land is large even though the productivity is standard but can still earn large incomes. This shows that productivity is important, but not the only determinant of income, so to achieve optimal income increases, farmers also need to pay attention to the efficiency of using production inputs, managing operational costs, and other factors that affect crop yields.

Direct Effect of Land Area on Farmer Income

The test results show a significance value of 0.003 which is smaller than 0.05, so the alternative hypothesis (Ha_3) is accepted and proves that land area has a significant direct effect on oil palm farmers' income. This finding is consistent with agricultural economic theory which emphasizes the importance of business scale in determining income, where the size of the farmer's land area will affect the amount of production produced.

The significant effect of land area on income can be explained through the mechanism of economic scale which allows farmers with large land to achieve higher production efficiency through more optimal use of inputs and more efficient distribution of fixed costs. The area of farmers' land which is the area of land that is planted and has produced allows farmers to produce a larger amount of output, so that with the increase in land area, the farmer's ability to produce production will also increase. This larger production capacity allows farmers to produce a significant volume of output, so that total income increases even though productivity per hectare is the same as farmers with small land. In addition, farmers with large land areas have greater management flexibility to diversify crops or implement more sophisticated technologies, although this effect may vary depending on other factors such as productivity, processing

efficiency, and local conditions.

Indirect Effect of Palm Oil Prices on Income Through Land Area Mediation

The test results show a significance level of 0.006 which is smaller than the alpha value of 0.05, so the null hypothesis (Ho_4) is rejected and the alternative hypothesis (Ha_4) is accepted. This finding indicates that palm oil prices through the mediation variable of land area have a positive and significant effect on the income of oil palm farmers, indicating that the effect of palm oil prices on income is strengthened through the scale of the business owned by farmers.

The mediation mechanism of land area on the relationship between palm oil prices and income can be explained through several interrelated aspects. From the perspective of economic scale, farmers with large land can take advantage of increases in palm oil prices optimally because of their large production volume, so that when prices rise, farmers with large land gain proportionally greater profits than farmers with small land. Resource efficiency also plays an important role, where large land allows farmers to allocate resources more efficiently, so that when prices are profitable, they can maximize output without increasing production costs proportionally. In addition, farmers with large production have a stronger bargaining position in price negotiations, so they can take advantage of market price fluctuations better. Research in Pasir Tuntung Village, Kota Pinang District, also shows that both selling prices and land area partially have a positive and significant effect on the income of oil palm farmers, confirming that an increase in selling prices will have a greater impact on the income of farmers who have larger land areas because larger production volumes allow them to take advantage of high prices optimally.

Indirect Effect of Productivity on Income Through Land Area Mediation

The test results show a significance level of 0.108 which is greater than the alpha value of 0.05, so the null hypothesis (Ho_5) is accepted and the alternative hypothesis (Ha_5) is rejected. This finding indicates that productivity through the mediation variable of land area does not have a positive and significant effect on the income of oil palm farmers. This result is contrary to the research of [18] which used the Cobb-Douglas method to analyze the effect of land area and productivity on oil palm production results at PTPN V, Pekanbaru, where the results of the study showed that land area and productivity simultaneously had a significant effect on production results with a contribution of 99.6% to the dependent variable.

The insignificant effect of productivity on income through land area mediation can be explained by several interacting factors. Limited business scale is the main factor, where increasing productivity for farmers with narrow land does not result in a significant impact on income because the total output remains limited, so that high productivity per hectare cannot compensate for the limitations of the business scale. Land management efficiency also plays an important role, where farmers with large areas of land are not always able to manage the entire area with a consistent level of productivity due to limited labor and capital, so that productivity per hectare decreases as the land area increases. The phenomenon of diminishing returns also occurs, where there is an optimal limit to the land area where productivity begins to decline due to the limitations of farmers' managerial abilities in managing areas that are too large. This condition shows that the role of land area as a mediating variable between productivity and farmer income is contextual, where in some cases land area can strengthen the positive influence of productivity on income, while in other cases factors such as efficiency and managerial ability are more dominant in determining farmer income.

CONCLUSION

This study shows that in the context of oil palm farmers, land area is a key factor that determines income both directly and as a mediator of the influence of palm oil prices on income. Conversely, palm oil prices and productivity do not directly affect income, but palm oil prices can influence through the mediation of land area while productivity cannot be mediated by land area in influencing income. This

finding underlines the importance of the role of economies of scale in oil palm farming, where farmers with large land areas have a comparative advantage in taking advantage of market price fluctuations and achieving more optimal production efficiency. Based on the research findings that show the importance of land area in determining farmer income, a comprehensive policy is needed to address structural problems in oil palm farming. Land reform and consolidation programs are a top priority, where the government needs to facilitate the merger of small plots of land through partnership or cooperative schemes to achieve optimal economies of scale, redistribute unproductive land to farmers with small land areas to increase their business scale, and accelerate land certification programs to provide legal certainty that supports farmers' access to credit and investment. Given that high productivity does not automatically result in high incomes for smallholder farmers, a special support mechanism is needed that includes a core-plasma partnership program to integrate smallholder farmers with large companies to obtain better market and technology access, provision of production input subsidies, especially fertilizers and pesticides for productive smallholder farmers, and provision of access to appropriate technology that can increase the added value of production.

To overcome the instability of palm oil prices that do not directly affect income, it is necessary to establish a price stabilization institution that can guarantee minimum prices for farmers and encourage the development of palm oil derivative products to reduce dependence on Fresh Fruit Bunch prices. This study also acknowledges several limitations related to confounding variables that can explain income variations but are not included in the research model, such as access to production inputs that can affect farmer productivity and income, the quality and intensity of agricultural extension services that significantly affect the adoption of technology and good cultivation practices, transportation infrastructure that is a crucial factor in influencing production costs and ease of market access, availability of working capital and access to investment credit that affects farmers' ability to optimize production, and the quality of human resources reflected in the level of education and experience of farmers in influencing managerial ability and adoption of innovation.

For further research, it is recommended to include these confounding variables in the model to obtain a more comprehensive picture of the factors that influence the income of oil palm farmers, use a longitudinal approach to capture the dynamics of changes in farmer income in the long term, and conduct segmentation analysis based on farmer characteristics such as business scale and location to obtain more specific insights into income-increasing strategies that are appropriate to the conditions of each farmer group. Thus, efforts to increase the income of oil palm farmers in a sustainable manner can be carried out through a holistic approach that does not only focus on one production factor, but considers all aspects that influence the dynamics of oil palm farming.

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