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Research Article

DETERMINANTS OF ECONOMIC AND ENVIRONMENTAL FACTORS ON THE INCOME OF COCONUT FARMERS IN SIMEULUE REGENCY

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Abstract
This study aims to examine the economic and environmental determinants of coconut farmers' income in Simeulue Regency by analyzing land area, selling price, labor, and damaged trees as independent variables, and farmers' income as the dependent variable. This study employs a quantitative approach using multiple linear regression analysis of primary data collected through questionnaires and interviews with 97 coconut farmers. The results indicate that all variables are simultaneously associated with farmers' income; however, when analyzed individually, land area ($\beta = 0.012$, $p < 0.001$) and labor ($\beta = 0.049$, $p = 0.015$) exhibit positive and significant relationships. Meanwhile, selling price showed a positive but insignificant correlation ($\beta = 0.093$, $p = 0.811$), and damaged trees were negatively but insignificantly correlated with income levels ($\beta = -0.001$, $p = 0.429$). These findings indicate that larger landholdings and greater labor utilization are correlated with higher income levels, whereas pest-damaged trees remain a productivity challenge. Therefore, strategies focused on improving land management, optimizing labor, maintaining price stability, and implementing sustainable pest control have the potential to enhance the welfare of coconut farmers in Simeulue Regency. This study has limitations related to the relatively small sample size.

Keywords: Farmer income, land area, prices, labor, damaged trees

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INTRODUCTION

Income is a critical metric for evaluating a community's well-being, particularly for households reliant on the agricultural sector. In the field of development economics, income is defined as the capacity of individuals or households to satisfy their fundamental and social needs (Chen, 2026; Sudomo et al., 2023; Kimkong et al., 2023). In the agricultural context, farmers' income is defined as the difference between total revenue and total production costs incurred during the farming process (Mahmud et al. 2025). Consequently, the level of farmers' income emerges as a pivotal factor in determining the sustainability of farming operations and the well-being of farming households.

The plantation sector, which is a component of the agricultural sector, fulfills a pivotal function in the economic well-being of rural communities. Among the plantation commodities with high economic value is the coconut. The coconut plant is recognized as a versatile commodity, offering numerous benefits as both a food source and an industrial raw material. The financial well-being of coconut farmers is significantly impacted by the productivity of their crops and the prevailing market prices, thereby underscoring the pivotal role of this commodity in sustaining coastal and island communities as their primary means of subsistence (Rani et al., 2024; Agus et al., 2025; Nabillah et al., 2025; Zainol et al., 2023).

Simeulue Regency, a district within Aceh Province, exhibits considerable promise for the cultivation of coconut plantations. The majority of the local population relies on this sector for their livelihoods. According to data from BPS (2026) , the area of coconut plantations in Simeulue Regency during the 2021–2025 period is shown in the following Table 1.

Table 1. Area of Coconut Plantations in Simeulue Regency, 2021–2025

No	Years	Land Area (ha)
1	2021	8.186,90
2	2022	8.187,00
3	2023	8.187,00
4	2024	8.237,00
5	2025	8.298,00

Source: (BPS, 2026)

As illustrated in Table 1, there was a consistent and gradual increase in the area dedicated to coconut plantations from 2021 to 2025. In 2021, the area dedicated to coconut plantations was documented at 8,186.90 hectares, which subsequently increased to 8,187.00 hectares in both 2022 and 2023. Subsequently, in 2024, the area increased to 8,237.00 ha, and in 2025, the area of coconut plantations increased again to 8,298.00 ha. The aforementioned conditions indicate that coconut remains one of the most significant and continuously growing plantation commodities in Simeulue Regency. This increase also suggests that the public is interested in maintaining and expanding coconut plantation businesses as a source of economic income. According to the latest available BPS (2026) the following table presents the coconut production figures for Simeulue Regency from 2021 to 2025.

Table 2. Total Coconut Production in 2021-2025

No	Years	Total Coconut Production (Tons)
1	2021	3.798
2	2022	3.827
3	2023	4.139
4	2024	4.139
5	2025	3.996

Source: (BPS, 2026)

As illustrated in Table 2, coconut production exhibits annual variability. Coconut production rose from 3,798 tons in 2021 to 4,139 tons in 2023 and 2024, but subsequently declined to 3,996 tons in 2025. A contradiction emerges between the increase in the area of coconut plantations and the inverse relationship with coconut production in Simeulue Regency, as evidenced by data presented in Tables 1 and 2. Moreover, according to extant research, a discrepancy exists between the potential of available resources and the actual production realised in terms of farmers' income. For instance, Rombon et al. (2025) posit that land area is a determining factor in production capacity, suggesting that greater land area results in higher potential yield. Price fluctuations have been shown to affect farmers' incomes directly, underscoring the importance of price-stabilisation policies to ensure economic security for agricultural communities. Moreover, labor plays a pivotal role in facilitating the seamless operation of production processes and enhancing the efficacy of farm management. These findings suggest that coconut farmers have yet to attain optimal economic benefits from their agricultural operations. This situation underscores the importance of conducting in-depth research on the economic and environmental factors affecting coconut farmers' income. Conducting such research would allow for the identification of the causes of low income and the formulation of appropriate measures to improve farmers' welfare while supporting the sustainability of the coconut industry in Simeulue Regency.

In addition to economic factors, environmental factors such as tree damage caused by pest infestations particularly Oryctes rhinoceros also have a significant impact on the decline in coconut productivity and farmers' income. As demonstrated in previous studies, such factors as land area, selling price, and labor costs have been found to exert a significant influence on income (Apriliana et al., 2023). The economic well-being of agricultural households, particularly in rural areas with a high dependence on the agricultural sector, is significantly influenced by farmers' income, which serves as a pivotal indicator in such assessments. Farm income is defined as the difference between total revenue generated from product sales and total production costs incurred during the production process (Zuhdi, 2021). Furthermore, income is influenced by the ownership and utilization of production factors such as land, labor, and capital, which determine the magnitude of the output obtained by farmers. Consequently, the level of farmers' income is indicative of not only production output but also efficiency in farm management.

In the domain of production economics, the land area is identified as the predominant factor in determining production capacity. It has been demonstrated that the magnitude of the managed land area is directly correlated with the potential yield, thereby resulting in augmented farmer income. This assertion is further substantiated by extant research, which has demonstrated a positive and significant correlation between land area and farmer income, underscoring the direct relationship between land size and agricultural output. Furthermore, fluctuations in selling prices have been demonstrated to directly impact farmers' revenue, underscoring their pivotal role in the economic well-being of agricultural communities. A substantial body of research suggests that an increase in coconut selling prices can lead to a considerable augmentation in farmers' income. However, farmers frequently encounter price volatility in the market.

Income is a critical determinant of household well-being, particularly for those reliant on agricultural activities. In the context of coconut farming in Simeulue Regency, economic factors such as labour availability and efficiency directly influence productivity and income, while environmental challenges, including pest infestations, can reduce yield and quality. Optimal labour utilisation enhances land management and crop quality, whereas crop damage from pests like the longhorn beetle imposes additional costs and lowers harvest output. Despite existing research highlighting these factors, the integrated impact of both economic and environmental variables on farmers' income in this region remains underexplored (Wagiman

et al., 2020). This study aims to address this gap by examining how land area, labour, selling price, and crop damage collectively shape the income of coconut farmers in Simeulue Regency.

Agricultural income not only reflects farmers' capacity to meet household needs but also indicates the sustainability of farming practices. In the case of Simeulue Regency's coconut farms, labour efficiency positively impacts crop production, while environmental factors such as pest infestations negatively influence harvest outcomes. Crop damage from pests like the longhorn beetle reduces yield and quality, thereby limiting potential income gains. Current literature often treats economic and environmental variables separately, creating a gap in understanding their joint effect on farmers' financial performance (Vowell et al., 2023; Mansfield et al., 2023; Khopade et al., 2025; Parré et al., 2024; Chiarella et al., 2023; Primov et al., 2025). This study seeks to bridge that gap by examining how labour, land area, selling price, and damaged trees collectively affect coconut farmers' income in Simeulue Regency.

Based on previous research, it can be concluded that a range of interrelated economic and environmental factors influences farmers' income. Land area, selling price, and labour have been shown to have a significant impact on farmers' income, while environmental factors such as crop damage act as barriers to increased productivity. Therefore, a study integrating both aspects is crucial to provide a more comprehensive understanding of the factors affecting coconut farmers' income, particularly in Simeulue Regency. Based on the above explanation, the research questions are formulated as follows: first, how do economic factors comprising land area, price, and labour affect coconut farmers' income in Simeulue Regency? and second, how do environmental factors specifically damaged trees due to pests affect coconut farmers' income in Simeulue Regency? Studies integrating both economic and environmental factors remain limited, particularly regarding the coconut commodity in Simeulue Regency. Therefore, this study aims to comprehensively analyse the influence of these factors to support the formulation of appropriate policies for sustainably improving the productivity and welfare of coconut farmers.

RESEARCH METHOD

Research Design

The present study employs a quantitative approach to analyse the influence of economic and environmental factors on the income of coconut farmers in Simeulue Regency. This approach was selected because it provides objectively measurable results and allows for the testing of relationships between variables through statistical analysis. The present study was conducted in Simeulue Regency, Aceh Province, a region identified as having considerable potential for coconut cultivation. The Simeulue Regency is one of the island regions in Aceh Province, located in the western part of Sumatra Island and surrounded by the Indian Ocean. The geographical isolation of this region from mainland Aceh has shaped its distinct coastal characteristics. The community's economic reliance on the primary sector, particularly agriculture and plantations, is a salient feature of this coastal region (BPS, 2026). The research was conducted from December 2025 to January 2026. This timeframe was selected because it aligns with the period of high agricultural activity and post-harvest evaluation in the region, allowing for the collection of the most recent and accurate income data."

Research Target/Subject

The population under study comprises all coconut farmers in Simeulue Regency, amounting to 3,736 individuals (BPS, 2026). The sample size was determined using the Slovin formula with a 10% margin of error (Santoso, 2023). The formula is as follows:

$$n = \frac{N}{1 + N\,(e)^2}$$

Notes:
N = Total Number of Coconut Farmers
e = 0,10 (10% margin of error)

$$n = \frac{3.736}{1 + 3.736\ (0{,}10\%)^2}\ 97 \text{ respondents.}$$

Consequently, a total of 97 respondents were obtained. The sample was selected purposively in three subdistricts, namely Salang, Alafan, and Teupah Selatan, considering that these areas have a high concentration of coconut farmers. The purposive sampling criteria required respondents to be active coconut farmers who manage their own land, have been running their farming business for at least the last three years, and have experienced the impacts of pest infestations. These criteria ensured that the data collected accurately reflected both economic variables and environmental challenges.

Research Procedure

This study employs a quantitative approach to analyse the influence of economic and environmental factors on coconut farmers' income, using a sample of 97 respondents selected from a total population of 3,736 coconut farmers in Simeulue Regency, specifically in the districts of Salang, Alafan, and Teupah Selatan. The primary data collection phase was conducted directly through Likert-scale questionnaires and structured interviews with respondents. After the data were obtained to measure the interaction between variables, the data were analysed using multiple linear regression. Before hypothesis testing was conducted via partial tests (t-tests) and simultaneous tests (F-tests), and the evaluation of the coefficient of determination (R^2), the entire dataset had to pass classical assumption tests, including tests for normality, multicollinearity, heteroscedasticity, and autocorrelation. This series of prerequisite tests is conducted to ensure that the resulting regression model is robust and meets the Best Linear Unbiased Estimator (BLUE) criteria. Subsequently, the regression results are interpreted and discussed in depth, leading to the research conclusions and implications.

Instruments, and Data Collection Techniques

The data utilised in this study encompasses both primary and secondary sources. Primary data were collected through the distribution of questionnaires and structured interviews. In contrast, secondary data were obtained from relevant agencies, such as the Central Statistics Agency (BPS) and the local Department of Agriculture, as well as relevant literature. The primary data collection techniques employed a mixed-method approach for triangulation, ensuring high data credibility. The questionnaire was carefully designed using predominantly ratio scales to capture exact quantitative metrics (e.g., coconut production volume, land area in hectares, the number of workers, and the exact percentage of damaged trees). To mitigate the potential for self-reporting bias, the questionnaire administration was immediately followed by structured interviews. The interview protocol was designed to cross-validate the respondents' written answers, particularly regarding sensitive or complex variables such as actual monthly income and historical price fluctuations at the farm-gate level. Furthermore, the documentation procedure involved extracting verified secondary time-series data and agricultural reports from the Central Statistics Agency (BPS) and the Simeulue Regency Department of Agriculture to contextualize the primary findings.

The definitions used in this study are as follows: farmers' income refers to the net revenue obtained from the sale of coconut products after deducting all production costs within a specified period, and it is measured in Indonesian rupiah (Rp). Land area denotes the total extent of coconut plantations that are actively managed and cultivated by farmers, expressed in hectares (Ha). Selling price refers to the average unit price received by farmers for coconut products at the point of sale, measured in rupiah per kilogram (Rp). Labor represents the total number of workers involved in plantation maintenance, harvesting activities, and coconut

business management, measured in individuals. Trees damaged by pest attacks refer to the level of pest infestation affecting coconut plantations, which impacts both the quality and quantity of production, and is expressed as a percentage (%).

Data Analysis Technique

Prior to the main data analysis, the research instrument (questionnaire) was rigorously tested for validity and reliability to ensure measurement accuracy. A pilot study was conducted on a small subset of the population (e.g., 20 farmers) outside the primary sample. Instrument validity was assessed using the Pearson Product-Moment correlation, ensuring that all items accurately measured the intended constructs ($p < 0.05$). Concurrently, instrument reliability was evaluated using Cronbach's Alpha coefficient. Only items that met the minimum threshold of > 0.60 were retained, confirming that the questionnaire consistently measured the independent and dependent variables.

The data analysis technique employed was multiple linear regression, which was used to assess the impact of independent variables on the dependent variable. The multiple linear regression model that was utilised is expressed as follows:

$$Y= \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \varepsilon\ldots\ldots\ldots (1)$$

Substituting the variables utilised, and transforming the dependent variable income using the natural logarithm to linearise both the dependent and independent variables, the model equation becomes:

$$Ln\_Income= \beta_0 + \beta_1 Land+ \beta_2Price+ \beta_3 Labor + \beta_4Trees + \varepsilon.....(2)$$

Notes:

Ln Income = The monthly income of coconut farmers, measured in rupiah, then transformed into the natural logarithm. Land = The land area used by coconut farmers to produce coconuts, measured in hectares. Price = The selling price per kilogram of coconuts sold by farmers to consumers, measured in rupiah. Labor = Labor used by coconut farmers in managing coconut production, measured in person. Trees = Trees damaged by pests, causing losses to coconut farmers, measured in percent. β_1-β_4 = Regression coefficients for each independent variable. e = Erros term

Prior to conducting the regression analysis, classical assumption tests were performed. These included tests for normality, multicollinearity, heteroscedasticity, and autocorrelation. This ensured that the regression model met the BLUE (Best Linear Unbiased Estimator) criteria. Subsequently, hypothesis testing was conducted using a partial test (t-test) to assess the effect of each independent variable on the dependent variable, and a simultaneous test (F-test) to determine the combined effect of all independent variables. Furthermore, the coefficient of determination (R^2) was used to assess the extent to which the independent variables account for variation in the dependent variable. The collected primary data were tabulated and analyzed utilizing IBM SPSS Statistics software (version 22). The primary data analysis technique employed was multiple linear regression.

RESULTS AND DISCUSSION

The Simeulue Regency, with an area of approximately 1,838 square kilometres, has a tropical climate, with relatively high rainfall and temperatures conducive to agricultural activities. According to data from the 2026 population census, the population of Simeulue Regencyw was approximately 158,920. This finding suggests that agricultural land remains adequately available and possesses potential for development, particularly for coconut farming, which serves as the primary source of income for a considerable segment of the population (BPS, 2026).

The administrative boundaries of Simeulue Regency are defined by its direct border with the Indian Ocean on all sides. While this poses challenges for the accessibility, distribution, and marketing of agricultural products, it also supports the growth of tropical plantation commodities like coconuts, which are well-suited to local environmental conditions. The community's reliance on this commodity establishes coconuts as a primary economic driver. Therefore, given the geographical conditions, natural resource potential, and the socio-economic characteristics of its people, Simeulue Regency is deemed an appropriate and relevant location to examine the influence of economic and environmental factors on coconut farmers' income. The dataset, collected from 97 coconut farmers residing in the sub-districts of Teupah Selatan, Salang, and Alafan in Simeulue Regency, was analysed using a questionnaire. The analysis revealed the characteristics of the respondents by gender and education level. The objective of the present study's categorisation of respondents is to provide a clear characterisation of the study population. The following is a table showing the gender of the respondents:

Table 3. Frequency Distribution of Respondents by Gender

No	Gender	Number of Respondents	Percentage (%)
1	Women	11	11,3
2	Male	86	88,7
3	Total	97	100,0

Source: primary data (processed 2026)

As indicated in Table 3, the majority of respondents in this study were male. Among the total sample of 97 respondents, 86 (88.7%) identified as male, while 11 (11.3%) identified as female. This percentage suggests that male participation in coconut farming activities at the study site is predominant. This finding suggests that work in the agricultural sector, particularly in the realm of coconut farming management, is predominantly executed by men. This is attributable to the fact that such work typically demands greater physical strength and direct involvement in the production process. Conversely, the involvement of women is comparatively restricted, and is ordinarily characterized by the performance of supportive activities or tasks that do not necessitate arduous physical exertion.

The demographic profile reveals a pronounced gender imbalance, with male respondents accounting for 88.7% of the sampled coconut farmers. This skewed distribution is deeply intertwined with the socio-cultural fabric and physical operational demands of agriculture in Simeulue Regency. Traditional coconut cultivation in this region involves strenuous physical labor, such as climbing tall trees, harvesting, processing copra, and transporting heavy yields over rough terrain tasks culturally and traditionally designated to men. Moreover, rural communities in this region largely adhere to patriarchal norms, where the male is recognized as the formal head of the household and the primary custodian of land management and financial transactions. While this gender imbalance inherently limits the generalizability of the findings to female agricultural perspectives, it precisely mirrors the actual operational demographic of primary farm managers in Simeulue. Consequently, the insights captured in this study heavily reflect the strategic decisions, risk perceptions, and economic realities of male household heads who bear the direct responsibility of navigating both market price fluctuations and environmental pest hazards.(Rietveld et al., 2023; Kailashkumar et al., 2023; Ndubi et al., 2023).

Furthermore, the respondents' educational level is a salient characteristic that can influence farmers' ability to manage their farms, make decisions, and understand agricultural information and technology. Higher education has been shown to be positively associated with a more open mindset toward innovation, superior managerial skills, and greater ease in accessing information related to the production and marketing of agricultural products. The

following table presents a demographic overview of the respondents in terms of their educational attainment.

Table 4. Distribution of Respondent Frequency by Education Level

No	Education Level	Number of Respondents	Percentage (%)
1	Elementary School	14	14,4
2	Junior High School	42	43,3
3	High School	31	32,0
4	Bachelor	10	10,3
5	Total	97	100,0

Source: primary data (processed 2026)

As illustrated in Table 4, the majority of respondents had a junior high school diploma, comprising 42 individuals (43.3% of the sample). This was followed by those with a senior high school diploma, accounting for 31 respondents (32.0%). The third-largest group was elementary school graduates, with 14 individuals (14.4%), while 10 respondents (10.3%) held a bachelor's degree or other educational qualifications. This distribution suggests that the majority of coconut farmers in the study area have a secondary or primary education level. Consequently, it can be concluded that, in general, the respondents' educational level is moderate, which may affect their ability to access information, adopt technology, and manage their farming operations more optimally (S. Chen et al., 2025; Ding et al., 2025; Indriasari et al., 2024).

The description of variables in this study provides an overview of the data characteristics prior to further analysis. The dependent variable is coconut farmers' income, which serves as an indicator of their economic well-being. The independent variables include land area, which reflects production capacity; selling price, which affects revenue; labour, which represents human resources and experience; and damaged trees, which act as a risk factor for crop yields. The application of descriptive analysis enables the determination of the mean, variation, and distribution of the data. These elements form the foundation for understanding the relationships among the variables in this study. The following table presents a comprehensive list of the variables employed in this study:

Table 5. Descriptive Analysis

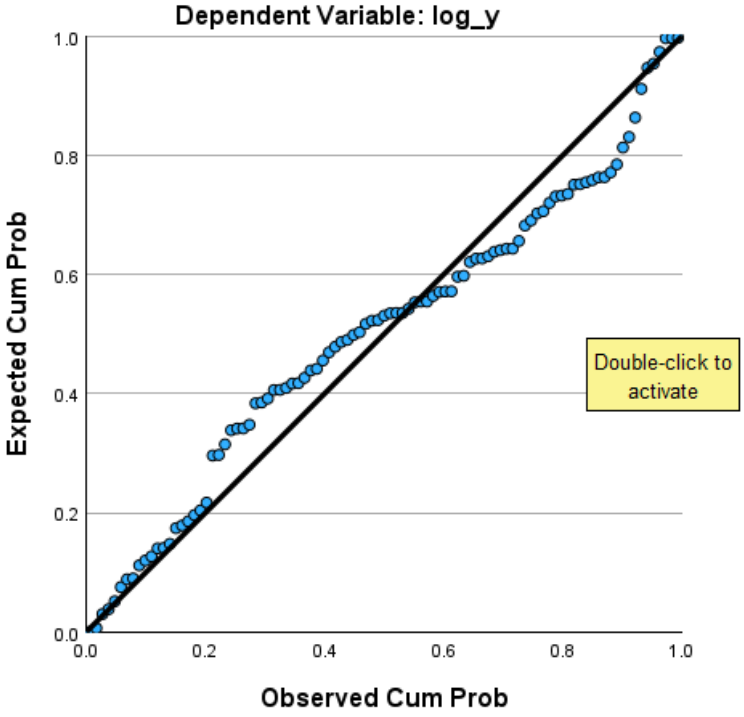
No	Variable	N	Minimal	Maximum	Average	Std. Deviation
1	Income (Rupiah)	97	500.000	30.000.000	2.848.453	4.374.621
2	Land Area (Ha)	97	1	100	4,8	12,4
3	Coconut Price Per Kilo (Rupiah)	97	3.000	6.000	5.108	555
4	Labor (Orang)	97	1	16	2	1
5	Damaged Trees (%)	97	0,00	75,00	23,77	14,1

Source: primary data (processed in 2026)

Table 5 presents descriptive statistics for the research variables, providing an overview of the data used in the analysis. The monthly income variable for coconut farmers ranges from Rp500,000 to Rp30,000,000, with a mean of Rp2,848,453 and a standard deviation of Rp4,374,621. This finding suggests that the majority of farmers in the region are at a middle-income level, although income variation is substantial, as evidenced by the high standard deviation. This finding suggests the presence of economic disparities among farmers, which are likely influenced by varying production factors.

In addition, the mean land area possessed by farmers is 4.8 hectares, with a range of 1.0 to 100.0 hectares, for the variables total and productive land area. The mean value of the coconut price per kilogram is Rp5,108, with a price range of Rp3,000 to Rp6,000. This indicates that prices are relatively stable but still fluctuate. Concurrently, the workforce ranges from 1 to 16 individuals, with an average of 2 workers, suggesting that the majority of coconut farming enterprises continue to operate on a small-to-medium scale. Damaged trees continue to pose a challenge, as evidenced by the percentage of damaged trees, which averages around 23.77% and reaches a maximum of 75%. This condition suggests that pest-damaged trees may have a substantial impact on crop productivity, which could be a pivotal factor influencing coconut farmers' income levels at the study site.

Subsequently, a normality test was conducted to determine whether the regression model, the independent variable, and the dependent variable follow a normal distribution. The validity of a regression equation depends on the data's normality. The presence of scattered data points along the diagonal line or in the histogram indicates a normal distribution. This, in turn, signifies that the regression model fulfils the normality assumption, a prerequisite for many statistical analyses. The following figure illustrates the normality test:



Source: primary data (processed, 2026)

Figure 1. Normality Test (Normal P-P Plot of Regression)

The normality test graph indicates that the data are scattered around and follow the diagonal line. Therefore, the regression model is normally distributed and satisfies the normality assumption. Subsequently, a multicollinearity test is conducted to ascertain whether the regression model signifies any correlation among the independent variables. A regression model that is fit for purpose should not demonstrate a correlation between independent factors. Tolerance is defined as the extent to which other independent variables do not explain a specific independent variable. If the tolerance value exceeds 0.10 and the VIF is less than 10.00, it can be inferred that multicollinearity is absent. The subsequent table illustrates the outcomes of the multicollinearity assessment.

Table 6. Multicollinearity Test Results

No	Variable	Collinearity Statistics	
		Tolerance	VIF
1	Land Area	0,301	3,323
2	Price	0,979	1,022
3	Labor	0,298	3,360
4	Damaged Trees	0,928	1,077

Source: primary data (processed 2026)

Pursuant to the results of the tolerance calculations, it can be concluded that all variables have values greater than 0.10 and VIF (variance inflation factor) values less than 10.00. This finding indicates that there is no correlation between the independent variables. Consequently, the variables used in this study are independent, and multicollinearity is not a concern. A heteroscedasticity test was subsequently performed to determine whether a robust regression model exhibits uniform residual variability across disparate observations. The regression model is a statistical tool for predicting the dependent variable from the independent variables. However, the validity of the regression model depends on the homogeneity of residual variation across observations. In this test, the criterion is that if the p-value is greater than 0.05, the data are not considered to exhibit heteroscedasticity. The ensuing results of the aforementioned tests are hereby presented:

Table 7. Heteroskedaticity Test Results

No	Model	*Unstandardized* Coefficients		Standardized Coefficients	t	Sig
		B	Std Error	Beta		
1	Contant	0,170	0,822		0,207	0,836
2	Land Area	0,003	0,002	0,294	1,911	0.060
3	Price	-0,038	0,223	0,015	-0,170	0,865
4	Labor	0,022	0,011	0,306	1,978	0,051
5	Damaged Trees	0,001	0,001	0,095	1,088	0,279

Source: Primary data (processed 2026)

The results of the heteroscedasticity test indicate that the Park test showed that land area, coconut price per kilogram, labour, and damaged trees were significant at the 0.005 level. Consequently, the absence of evidence supporting heteroscedasticity can be deduced. Harahap et al., (2025) posits that the objective of the autocorrelation test is to ascertain whether there is a potential correlation between the error term in period t and the error term in period t-1 (i.e., the previous period) within the context of a linear regression model. The Durbin-Watson statistic is a measure of autocorrelation used to assess the reliability of the data. The ensuing discourse will elucidate the outcomes of the aforementioned autocorrelation test.

Table 8. Autocorrelation Test Results

No	Model Summary[b]					
1	Model	R	R Square	Adjusted R Square	Std. Error of The Estimasi	Durbin-Watson
2	1	0,783[a]	0,613	0,597	0,186	2,301

Source: primary data (processed 2026)

As indicated by the findings in Table 8, the autocorrelation test, conducted using the Durbin-Watson method, yielded a value of 2.301. Given that this value is less than 2, it can be concluded that there is no evidence of autocorrelation in the regression model of this study. Consequently, the model fulfils the classical assumption of no autocorrelation. Multiple linear regression is a statistical method employed in studies that investigate the impact of multiple independent variables on a dependent variable. The objective of this analysis is to elucidate the impact of independent variables on the dependent variable. The objective of this study is to examine the influence of land area (Land), selling price (Price), labour (Labour), and pest damage (Damaged Trees) on income (Ln_income) in Simeulue Regency. The following are the results of the multiple linear regression in this study:

Table 9. Research Regression Results

No	Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Std Error	Beta		
1	Contant	5,783	1,429		4,046	0,000***
2	Land	0,012	0,003	0,522	4,419	0,000***
3	Price	0,093	0,387	0,016	0,240	0,811
4	Labor	0,049	0,020	0,294	2,478	0,015**
5	Damaged Trees	-0,001	0,001	-0,053	-0,795	0,429

Source: primary data (processed 2026)
****: 99% confidence level and **: 95% confidence level*

Based on the regression results available in Table 9, the following research equations are arranged:

Ln_Income = 5,783 + 0,012 Land + 0,093 Price + 0,049 Labor - 0,001 Damaged Trees + ε

The results of the regression analysis show that the constant term of 5.783 indicates that when all independent variables are held constant, coconut farmers' income remains at 5.783. This suggests that other factors outside the model also influence income. Additionally, the land area variable has a positive regression coefficient of 0.012, indicating that an increase in land area will be associated with higher farmers' income, assuming all other variables remain constant. Similarly, the selling price variable has a positive coefficient of 0.093, indicating that higher coconut prices will directly boost farmers' income. Furthermore, the labor variable shows a positive regression coefficient of 0.049, indicating that an increase in the number of workers will boost farmers' income by intensifying farming management. Conversely, the damaged trees variable has a negative regression coefficient of -0.001, indicating that an increase in the number of damaged trees will reduce coconut farmers' income. This confirms that environmental factors, particularly crop damage, are one of the constraints on increasing farmers' productivity and income. A partial test (t-test) was conducted to determine whether each variable land area, selling price, labor, and damaged trees has a significant effect on coconut farmers' income in Simeulue Regency. If the significance level (P-value) is less than the error term value of 0.05 (5%), it can be concluded that there is a significant effect. Based on the partial analysis (t-test) of the land area variable, a t-value of 4.419 was obtained, with a significance level of 0.000. This significance value is less than 0.05, indicating that the land area variable has a significant effect on coconut farmers' income in Simeulue Regency. Thus, it can be concluded that the larger the land area owned by coconut farmers, the higher their income tends to be.

Based on the results of the partial test (t-test), the selling price variable did not reach statistical significance (P Value > 0.05), indicating that it does not have a statistically significant effect on the income of coconut farmers in Simeulue Regency. Thus, H0 is accepted, and H1 is rejected. However, this does not necessarily mean that price has no effect; rather, in this study, the effect is not statistically significant due to relatively small and uniform price variations among farmers. The findings indicate that coconut prices are a critical factor influencing farmers' income as they are directly linked to revenue from sales. This aligns with the research by Demisse et al., (2024), which found that higher coconut prices lead to higher farmer income. Therefore, the coconut price variable remains relevant and should be retained in the research model, supported by a strong theoretical foundation and empirical evidence. Based on the partial test results, the labor variable has a t-value of 2.478 and a significance level of 0.015. This significance level is less than 0.05, indicating that the labor variable has a significant effect on the income of coconut farmers in Simeulue Regency. This indicates that labor plays a crucial role in increasing farmers' income. The more labor is used—or the more optimally it is utilized—the more effectively production activities such as maintenance, harvesting, and coconut processing can be carried out, thereby increasing production output and ultimately boosting farmers' income.

Based on the results of the partial test (t-test), the damaged trees variable has a calculated t-value of -0.795 with a significance level of 0.429, which is greater than 0.05. This indicates that, statistically, the damaged trees variable does not have a significant effect on coconut farmers' income in Simeulue Regency. Nevertheless, the negative sign of the coefficient suggests that, theoretically, an increase in the number of damaged trees could reduce farmers' income. However, this effect is not strong enough to be considered statistically significant in this study's model. This aligns with research by Hammond et al., (2023), which shows that plant disturbances or damage can affect production yields, ultimately impacting farmers' income, even though this effect is not always directly visible in statistical analysis. Thus, the insignificance of this variable does not necessarily negate its role in farming activities. A simultaneous test (F-test) was conducted to determine whether the variables land, price, labor, and dead trees have a combined effect on the dependent variable. The following is the F-table equation:

Table 10. Simultaneous Test (F-Test)

No.	Model	Sum of Squares	Df	Mean Square	F	Sig
1	Regression	5,052	4	1,263	36,501	0,001
2	Residual	3,183	92	0,035		
3	Total	8,235	96			

Source: primary data (2026)

The results of the F-test indicated that the calculated F-value was 36.501 with a significance level of 0.001. This p-value is less than 0.05, which indicates that the independent variables have a significant effect on the dependent variable. The coefficient of determination (R^2) was calculated to assess the extent to which the independent variables (land area, selling price, labor, and damaged trees) explain the dependent variable (coconut farmers' income). The results of the coefficient of determination can be seen in the adjusted R^2 values, as follows:

Table 11. Coefficient of Determination (R^2) Results

Model	R	R Square	Adjusted R Square
1	0,783[a]	0,613	0,597

a. Predictors: (Constant), X_1, X_2, X_3, dan X_4

Source: primary data (2026)

The Table 11. displays an adjusted R-Square (R^2) value of 0.613. This indicates that 61.3% (0.613 × 100%) of the observed variation in coconut farmers' income can be attributed to the independent variables of land area (X1), selling price (X2), labor (X3), and damaged trees (X4). Conversely, the residual 38.7% (100% – 61.3%) is attributable to other variables not incorporated in the present study. The findings of the multiple linear regression analysis suggest a correlation between land area, selling price, labor, and damaged trees and coconut farmers' income. The objective of this discussion is to interpret the findings by relating them to extant theory and previous research, thereby providing a more profound understanding of the factors influencing changes in coconut farmers' income in Simeulue Regency.

The findings of the multiple linear regression analysis indicate a positive, significant relationship between land area and coconut farmers' income in Simeulue Regency. This indicates that an increase in land area is associated with greater potential for production and income. This finding aligns with the prevailing theory that land area is a primary determinant of farming capacity. Given the log-linear nature of the model, the coefficient of 0.012 for land area represents a semi-elasticity. This indicates that for every 1 hectare increase in land area, the coconut farmers' income increases by approximately 1.2%, ceteris paribus. This specific magnitude highlights the inelastic but positive nature of land expansion on island-based agricultural revenue. This finding is consistent with the research by Alemayehu et al.,(2024) which indicates that land area exerts a substantial influence on coconut farmers' income. Specifically, the study posits that an increase in land area corresponds to higher, managed plant productivity. Additionally, research conducted by Mgalamadzi et al., (2024) suggests a close correlation between land area and farmers' income levels. The correlation between land area and agricultural productivity is well documented: an increase in land area corresponds to greater production and, consequently, increased income for farmers. The findings of this study are consistent with extant theory and should be retained in the research model.

Pursuant to the findings of the multiple linear regression analysis, the coconut price variable has a negligible influence on the revenue of coconut farmers in Simeulue Regency, as evidenced by a p-value exceeding 0.05. Nevertheless, in theory, price is one of the key factors in determining farmers' income levels, as it is directly linked to revenue from the sale of their produce. The insignificance of the price variable in this study can be attributed to the uniformity of coconut prices in the study area, which adheres to market mechanisms, thereby resulting in minimal income variations among farmers. The insignificance of the price variable can be attributed to the monopsonistic market structure prevalent in Simeulue Regency, an isolated island region. Local collectors heavily standardize farm-gate prices, leaving farmers as price-takers with weak bargaining power. Furthermore, seasonal variability in coconut yields across the island often forces farmers to sell at predetermined rates to avoid spoilage, neutralizing the potential income variance typically driven by price fluctuations

Consistent with the conclusions of Kondo et al., (2025), this finding further substantiates the positive and significant impact of price on farmers' income. Consequently, fluctuations in commodity prices directly affect farmers' income, as prices are a pivotal determinant of the selling value of their output. An interview with Mr. M. Amin, a coconut farmer residing in Padang Unoi Village, Salang Subdistrict, Simeulue Regency, revealed that the current selling price of coconuts, around Rp4,800 per kilogram, is still relatively low and does not yet yield optimal profits for farmers. According to the aforementioned source, the stipulated price fails to cover the production costs incurred, including, but not limited to, plant maintenance, labor, and distribution of the harvest. This phenomenon has led to a contraction in farmers' income, with a notable decline in comparison to periods characterized by higher selling prices. Consequently, the low selling price of coconuts for farmers is a primary factor contributing to the decline in coconut farmers' income in Simeulue Regency. Consequently, while the selling price variable did not demonstrate a statistically significant effect in this study, theoretical frameworks and extant research findings indicate that price continues to exert a substantial

influence on the income of coconut farmers (Sondak et al., 2025; Nguyen et al., 2023; Singhal & Tarp, 2025; Tang et al., 2024).

The findings of the multiple linear regression analysis indicate that labor has a positive and significant effect on the income of coconut farmers. This indicates that when labor is used optimally, farm productivity increases, thereby leading to higher income. Labor plays a pivotal role in all phases of production, from maintenance to harvest. Consequently, its availability and efficiency are indispensable for the success of agricultural operations. When effective labor management is in place, production processes operate more efficiently, leading to optimized outcomes. The aforementioned findings are consistent with the research conducted by Marwanti et al., (2024, which states that labor has a positive and significant effect on farmers' income. The findings of this study demonstrate a positive correlation between labor input and farmers' income. The results indicate that as farmers' labor input increases, output also increases. Additionally, research conducted by Muda et al. (2022) further corroborates the notion that labor is a pivotal factor in augmenting farmers' income. In the context of agricultural research, studies have demonstrated a substantial impact of labor on farmers' income. This relationship is directly associated with the intensity of land management and the efficiency of production. Consequently, the labor variable plays a pivotal role, exerting a substantial influence on income growth for coconut farmers in Simeulue Regency.

The findings of multiple linear regressions indicate that the variable for damaged trees does not exert a significant effect on the income of coconut farmers in Simeulue Regency, as evidenced by a p-value greater than 0.05. However, theoretically, coconut tree damage remains associated with production levels and farmers' income. Damaged or unproductive coconut trees can reduce the harvest, thereby lowering farmers' income. Damage to crops, including unproductive or damaged coconut trees, can lead to a decline in farmers' income. This phenomenon can be attributed to crop damage, which reduces produce yield and consequently decreases farmers' revenue from coconut sales. Research on the impact of plant pest infestations indicates that crop damage reduces production levels and ultimately reduces farmers' income (Khonje et al., 2026; Tambo et al., 2023; Adams et al., 2024; Sekabira et al., 2023.

An interview with Mr. Suhan Sahrian, a resident of Padang Unoi Village in Salang Subdistrict, revealed that he possesses 1.5 hectares of land, of which approximately 0.5 hectares remain arable. This phenomenon can be attributed to substantial damage to coconut trees, which has led to a significant decline in their productivity. It is estimated that damage to coconut trees reaches approximately 68%, resulting in a substantial portion of the land becoming unproductive. The condition of damaged coconut trees directly affects production, which, in turn, reduces farmers' income. This indicates that this issue is not merely technical but also has tangible economic consequences. It has been demonstrated that an increase in the level of tree damage corresponds to a decrease in the potential harvest yield. Consequently, while the statistical analysis suggests that the variable for damaged trees does not exert a significant effect, field findings indicate that this factor remains important and warrants consideration, as it has the potential to reduce coconut farmers' income in Simeulue Regency. This finding aligns with the conclusions of Albore et al. (2025) who assert that the presence of productive land capable of adapting to environmental changes will enhance the resilience experienced by households, particularly with regard to income and well-being (Ahmed et al., 2025; Sawadogo et al., 2025; He et al., 2024).

The findings suggest a complex interaction between economic inputs and environmental threats. The lack of price competitiveness forces farmers to rely heavily on expanding land area and maximizing labor input to sustain their income. Furthermore, optimal labor utilization is not only directed at harvesting but also at mitigating environmental risks, such as managing the 23.77% average rate of pest-damaged trees. Thus, human capital (labor) acts as a buffer against both market rigidity (price) and environmental degradation (Oryctes rhinoceros infestations). It

is important to acknowledge the presence of potential confounding variables that could influence farmers' income. Factors such as the age of the coconut trees, the intensity of fertilizer application, and farmers' specific managerial experience were not controlled for in this model. For instance, older trees naturally have declining yields regardless of labor input, which could interact with the severity of pest damage. Future studies should incorporate these variables to isolate the effects of land and labor more precisely.

CONCLUSION

A comprehensive analysis and discussion of available data reveals that a multitude of interrelated economic and environmental factors influence coconut farmers' incomes in Simeulue Regency. These factors contribute to farmers' income levels in distinct ways; therefore, it is essential to fully understand them to identify appropriate measures to enhance farmers' well-being. The economic factors that significantly impact the income of coconut farmers in Simeulue Regency include land area, selling price, and labor. Land area is the primary factor to consider, as the larger the managed land area, the greater the production potential. This, in turn, directly impacts farmers' income. Furthermore, selling prices are pivotal, as they determine the revenue farmers receive. Market price fluctuations directly affect farmers' income: price increases boost income, while price decreases reduce it. Conversely, labor constitutes a pivotal element in the success of agricultural operations. Optimal labor utilization has been shown to facilitate streamlining the entire production process, from maintenance to harvest. This, in turn, has been shown to increase productivity and maximize yields. Consequently, enhancing labor management efficiency emerges as a pivotal strategy to increase coconut farmers' income.

The yield of coconut production among coconut farmers in Simeulue Regency is influenced by a multitude of factors, including land area, selling price, labor, and the presence of damaged trees. In addition to economic factors, environmental factors such as damaged trees also affect farmers' income. Damage to coconut plants can reduce productivity and the quality of the harvest, leading to a decline in income. Consequently, the financial well-being of coconut farmers is influenced by a confluence of economic and environmental factors. To enhance farmers' well-being in Simeulue Regency, a multifaceted approach emphasizing effective, sustainable management is imperative. In light of the research findings, it is recommended that coconut farmers optimize land use and improve routine plant care, particularly pest control, to maintain productivity and harvest quality. This approach is expected to lead to higher income. Conversely, the local government is expected to provide support through extension services, training, and technical assistance related to coconut plantation management. This includes efforts in pest control and improving production quality, as well as playing a role in maintaining price stability to ensure farmers' income is more secure.

Furthermore, given the pronounced male dominance in primary farming activities (88.7%), local government interventions must adopt a gender-inclusive approach. While extension services for pest control and land optimization should target the predominantly male workforce, policy initiatives should also aim to empower women in the agricultural sector. Providing training and capital for women to engage in downstream processing—such as producing high-value derivatives like virgin coconut oil (VCO) or coconut shell charcoal—can effectively diversify income sources, mitigate the impact of fluctuating farm-gate prices, and ultimately enhance overall household economic resilience. In addition, future researchers are encouraged to expand their studies by incorporating additional variables that have not yet been examined in this research. This would allow for a more comprehensive analysis of the factors influencing coconut farmers' income.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work the authors used DeepL and Grammarly in order to translating and checking grammar. After using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

Author 4: Formal analysis; Methodology; Writing - original draft.

Author 5: Supervision; Validation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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