



Article

Determinants of Coffee Farmers' Income: The Role of Land Area and Production Volume in Pargarutan Jae Village

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ABSTRACT

This study aims to analyze the effect of production land area on the income of coffee farmers in Pargarutan Jae Village, South Tapanuli Selatan. The method used is a quantitative approach involving 109 coffee farmer respondents selected using the accidental sampling method. Data were collected through questionnaires, observations, and documentation, then analyzed using Structural Equation Modeling Partial Least Square (SEM PLS). The results show that the production land area has a significant influence on increasing coffee production, which in turn positively impacts farmers' income. The majority of farmers have a last education level of vocational high school/general senior high school and are in productive age, with most incomes at the lower-middle level. The validity and reliability of the research instruments have been well tested, with loading factor and AVE values meeting the criteria for convergent and discriminant validity. These findings indicate that managing and increasing the production land area is a key factor in improving the welfare of coffee farmers in the area.

INTRODUCTION

The agricultural sector in Indonesia plays a crucial role in supporting various aspects of community life and economic activities. Agriculture has become a focal point in economic development efforts as it constitutes one of the main pillars of the national economy. National development strategies position the agricultural sector as a top priority. The objectives of agricultural development include increasing production to meet domestic food and industrial raw material needs, promoting exports, enhancing farmers' income, expanding employment opportunities, and creating equitable business opportunities within the community [1]. Indonesia is recognized as one of the world's largest coffee producers, playing an important role in building global coffee trade in the agricultural sector [2]. Coffee serves as a leading commodity that becomes one of the important sectors for the national economy and represents a significant source of income for many farmers. The main provinces producing coffee in the last three years according to the Central Statistics Agency (BPS) are South Sumatra, North Sumatra, and Lampung.

Land area and production play important roles in determining coffee farmers' income. Land area serves as a determinant of production factor influence because it is generally concluded that the larger the cultivated land area, the greater the production volume generated by that land [3]. Increased land area directly contributes to enhanced coffee farmers' income because higher production can generate greater income [4].

Land area represents a production factor that plays a more important role compared to other production factors because the return from land area is higher than other factors. The scale of agricultural business is determined by the land area owned by farmers, which ultimately affects the efficiency level of the farming operations conducted. Land area can determine the quantity or yield obtained by farmers. Some farmers engaged in coffee farming do not possess sufficiently large land areas, resulting in suboptimal coffee production that impacts farmers' income [5].

Production fundamentally represents the product of harvested area and productivity per hectare of land, so the production volume of a region depends on the harvested area in the corresponding year or the level of productivity [6]. When production volume increases, the income obtained will rise, and ultimately, the production generated by farmers contributes to improving farmer community welfare [7]. Coffee production has a significant influence on coffee farmers' income. Asmara and Nurholifah [8] in their research stated that production affects farmers' income because higher production leads to greater revenue received by farmers.

Agricultural income is divided into two categories: gross income and net income. Gross income refers to total revenue before deducting production costs, while net income represents income after subtracting production costs [4]. Net farming income measures the returns obtained by farming families from the use of production factors. The success of a farming operation can be assessed from the income amount obtained by farmers in managing their farming business [6]. A farmer's income generated from product sales is influenced by the production level achieved by the farmer.

One of Indonesia's coffee production centers is North Sumatra Province. According to coffee production data from the last three years, North Sumatra ranks as the second-largest coffee producer. North Sumatra Province, consisting of various regencies engaged in smallholder coffee farming, includes South Tapanuli Regency among others, with coffee plantation area in South Tapanuli Regency over the last five years according to BPS data approximately 4,804.00 hectares with production levels reaching 2,514.00 tons. Pargarutan Village is located in South Tapanuli Regency, East Angkola District, where farmers and community members generally depend on their coffee farming operations for livelihood.

Some studies explored about the effect of land area and production on farmer's income. Land area has a positive and significant effect on the income of rice farmers, where every additional land area that occurs will increase the income of farmers. [9]. Although numerous studies have explored the factors influencing agricultural income, particularly for commercial crops such as coffee, most have focused on macro-level data or employed basic correlation techniques. There remains a lack of empirical evidence on how land size and production volume affect the income of smallholder coffee farmers at the village level using robust models such as SEM-PLS. Moreover, limited attention has been given to rural areas like Pargarutan Jae Village, where coffee serves as the primary livelihood. This study aims to address this gap by providing micro-level model-based insights that can inform local agricultural policies and intervention programs.

METHODS

Sample and Data Collection Method

This study uses a quantitative approach, utilizing statistical data collection to facilitate calculations through the use of statistical data. The population in this study were all coffee farmers in Pargarutan Village who were met accidentally or by chance. Sample selection was carried out using the accidental sampling method with a non-probability sampling technique, involving 109 respondents. According to Sugiyono [10], accidental sampling is a sampling technique based on chance, whereby anyone who happens to meet the researcher can be used as a sample, provided that the person is deemed suitable as a data source. Data were collected through questionnaires, literature reviews, observations, and documentation, then tested

for validity and reliability. Confidential and sensitive information and data obtained from the farmers will be treated as confidential and will not be published or disclosed to the public.

Measurement

The questionnaire administered to coffee farmers in Pargarutan Village utilized a Likert scale containing statements with modified values ranging from 1 to 5 (strongly disagree, disagree, neutral, agree, and strongly agree). This research was conducted in Pargarutan Jae Village, East Angkola District, South Tapanuli Regency, from February to April 2025.

Data Analysis Technique

Data analysis, which constitutes descriptive analysis, comprises respondent profiles including gender, age, educational background, occupation, land area owned, and income generated by coffee farmers. Quantitative analysis employs Structural Equation Modeling-Partial Least Square (SEM-PLS) method, which illustrates relationships among latent variables measured using indicators (measurement model/outer model and structural model/inner model) for hypothesis testing.

RESULTS AND DISCUSSION

Descriptive Analysis

The characteristics of coffee farmer respondents in Pargarutan Jae Village were categorized based on gender, age, education, occupation, and income.

Table 1. Respondent Characteristics by Gender

Gender	Frequency	Percentage
Female	44	40 %
Male	65	60 %
Total	109	100 %

Table 1 demonstrates that the majority of respondents, totaling 65 individuals (60%), are male, while 44 respondents (40%) are female. This distribution is attributed to the fact that work in this sector generally requires significant physical strength, particularly in activities such as land cultivation, planting, pruning, and harvesting in areas located in hilly or mountainous regions.

Table 2. Respondent Characteristics by Age

Age	Frequency	Percentage
20 - 25 years	8	7 %
26 – 35 years	34	32 %
36 – 45 years	36	33 %
46 – 60 years	31	28 %
Total	109	100 %

The data in Table 2 indicates that the majority of respondents are aged 36-45 years with a percentage of 33% or 36 individuals. The second largest group of respondents are aged 26-35 years with a percentage of 32% or 34 individuals. It can be concluded that the average respondents or coffee farmers are productive farmers, meaning that this coffee plantation business is operated optimally using available physical labor. The third largest group of respondents are aged 46-60 years with a percentage of 28% or 31 individuals, while respondents aged 20-25 years represent 7% with a relatively low number of 8 individuals. Age can influence a farmer's performance, particularly in terms of ability to receive and understand new innovations. The older a farmer becomes, the greater the challenges faced in implementing modern agricultural methods. However, age does not diminish their responsibility; indeed, their experience

becomes an advantage. The productive period of farmers significantly influences the speed of adopting new innovations [11].

Table 3. Respondent Characteristics by Education

Educational Background	Frequency	Percentage (%)
Elementary School	4	3%
Junior High School	13	12%
Senior High School/Vocational School	84	77%
Diploma III	5	5%
Bachelor's Degree	2	2%
Master's Degree	1	1%
Doctoral Degree	0	-
Total	109	100%

The data in Table 3 shows that the majority of respondents have completed senior high school/vocational school education with a percentage of 77% comprising 84 respondents. Conversely, the second largest group of respondents completed junior high school education with a percentage of 12% or 13 individuals. The third largest group of respondents completed Diploma III education with a percentage of 5% comprising 5 individuals. The fourth, fifth, and sixth categories include farmers with elementary school, master's degree, and bachelor's degree education with percentages of 3%, 2%, and 1% comprising 4, 2, and 1 individuals respectively, while no respondents have doctoral degree backgrounds engaged in coffee farming business. Education influences farmers' thinking patterns and their ability to make decisions or provide alternative solutions to address problems in their farming operations. Farmers with low educational levels tend to find it difficult to accept new ideas or innovations, while farmers with high formal education levels tend to be more receptive to new ideas or innovations presented [12].

Table 4. Respondent Characteristics by Occupation

Occupation	Frequency	Percentage
Farmer/Plantation Owner	77	71%
Civil Servant	11	10%
Private Employee	21	19%
Student	0	-
University Student	0	-
Total	109	100%

The data results in Table 4 show that respondents engaged in coffee farming business in Pargarutan Jae Village are predominantly farmers or plantation owners, with 77 individuals (71%) having occupational backgrounds as farmers / plantation owners. Eleven individuals (10%) work as civil servants, and 21 individuals (19%) work as private employees. Plantation owners typically make coffee farming their primary livelihood, thus possessing greater time, energy, and commitment to manage coffee plantations intensively. Conversely, civil servants and private employees tend to make coffee farming a side business or long-term investment, relying on other laborers for plantation management. These occupational differences can influence the orientation, management, and sustainability of coffee businesses operated.

Table 5. Respondent Characteristics by Income

Income (IDR)	Frequency	Percentage
2,000,000	12	11%
1,500,000	17	16%
1,000,000	56	51%
500,000	24	22%
Total	109	100%

Table 5 explains that the majority of farmer respondents have an income of IDR 1,000,000 (51%) comprising 56 respondents. This indicates that most coffee farmers in Pargarutan Jae Village are at the lower-middle economic level. Conversely, most other respondents have incomes below IDR 1,000,000, where coffee farmers with incomes of IDR 500,000 number 24 respondents (22%), indicating relatively low generated income. Farmers with incomes of IDR 1,500,000 and IDR 2,000,000 total 29 respondents (27%) who can be considered farmers categorized as having upper-middle income.

Table 6. Characteristics Based on Land Area

Land Area	Frekuensi	Persentase
10 - 50 M ³	-	-
51 – 100 M ³	-	-
101 – 150 M ³	23	20%
151 - 200 M ³	29	26%
201 - 250 M ³	25	21%
251 - 300 M ³	15	10%
301 – 350 M ³	14	10%
351 - 400 M ³	-	-
< 10.000M ³	18	13%
Total	109	100%

Table 6 explains that most respondents in this study have different land areas. Of the 109 respondents, the distribution of land areas is not the same. The results in the table show that the majority of respondents have land areas of 151 - 200 m³, and a small number of coffee farmers in Pargarutan Jae Village have very large land areas > 10,000 m³. This shows that most coffee farmers in Pargarutan Jae Village have small to medium-scale land areas, which can affect the level of production and income of farmers.

Measurement Model Analysis (Outer Model Evaluation)

Convergent Validity

Convergent validity in reflective estimation models is assessed based on correlations between indicator scores or values and construct scores calculated using PLS. The loading factor value of each indicator must meet validation criteria, namely greater than (>0.70). Chin in Ghazali [13] states that loading factor values (correlations between indicators and constructs) above 0.70 are considered high, but for preliminary research, values of 0.50 to 0.60 are also adequate.

Table 7. Outer Loading Values

Variable	Indicator	Loading Factor	Status
Land Area (X1)	X1.1	0.884	Valid
	X1.2	0.829	Valid
	X1.3	0.844	Valid
	X1.4	0.730	Valid
Production (X2)	X2.1	0.803	Valid
	X2.2	0.847	Valid
	X2.3	0.876	Valid
	X2.4	0.837	Valid
Income (Y)	Y1.1	0.765	Valid
	Y1.2	0.828	Valid
	Y1.3	0.821	Valid
	Y1.4	0.802	Valid
	Y1.5	0.854	Valid
	Y1.6	0.791	Valid

The results in Table 7 show that overall loading factor values in the model have met convergence criteria because the generated values are greater than 0.7.

Average Variance Extracted (AVE) Assessment

The validity criteria of a construct or variable can be assessed through the Average Variance Extracted (AVE) value of each construct or variable.

Table 8. Average Variance Extracted (AVE) Values

Variable	AVE
Land Area	0.679
Production	0.708
Coffee Farmer Income	0.657

The results in Table 8 show that all AVE values are greater than 0.5. This can be interpreted that all latent variables in the eliminated model have met good validity criteria. AVE values are recommended to be greater than 0.5, meaning 50% or more variance of latent variables can be explained. All three latent variables have AVE values > 0.5 , thus it can be stated that each latent variable can be adequately explained by its indicators. The AVE value for land size is 0.679, which means that 67.9% of the variance in the land size construct can be explained by its indicators. The AVE value for production is 0.708, which means that 70.8% of the variance in the production construct can be explained by its indicators. The AVE value for farmers' income is 0.657, which means that 65.7% of the variance in the income construct can be explained by its indicators.

Discriminant Validity

Discriminant validity is an analysis used to determine latent constructs or variables in relation to other constructs within a single model.

Table 9. Cross Loading Values

	Land Area	Production	Income
X1.1	0.884	0.639	0.498
X1.2	0.829	0.537	0.405
X1.3	0.844	0.538	0.457
X1.4	0.730	0.437	0.332
X2.1	0.672	0.803	0.374
X2.2	0.519	0.847	0.504
X2.3	0.539	0.876	0.513
X2.4	0.523	0.837	0.435
Y1.1	0.476	0.490	0.765
Y1.2	0.477	0.447	0.828
Y1.3	0.352	0.390	0.821
Y1.4	0.385	0.430	0.802
Y1.5	0.408	0.469	0.854
Y1.6	0.407	0.424	0.791

The Cross Loading values show good discriminant validity, where indicator correlation values with constructs are higher compared to correlation values with other indicators or constructs. The loading factor value for LL (land area statements) has a value of 0.885, higher than other loading factors, namely production (0.641) and coffee farmer income (0.495).

If the square root of the Average Variance Extracted (AVE) for each construct exceeds the correlation coefficients between that construct and any other constructs in the model, then the model is considered to have satisfactory discriminant validity [14].

Table 10. Fornell-Larcker for Discriminant Validity

	Land Area	Production	Income
Land Area	0.824		
Production	0.660	0.841	
Income	0.520	0.549	0.811

The results in Table 10 show that the calculated square root values of Average Variance Extracted (AVE) for each latent construct are greater than the correlation values between constructs or variables with other latent variables. The Fornell-Larcker discriminant validity criteria in this research are fulfilled, thus it can be stated that all assessment results of the above criteria prove that the outer reflective model in this research is valid.

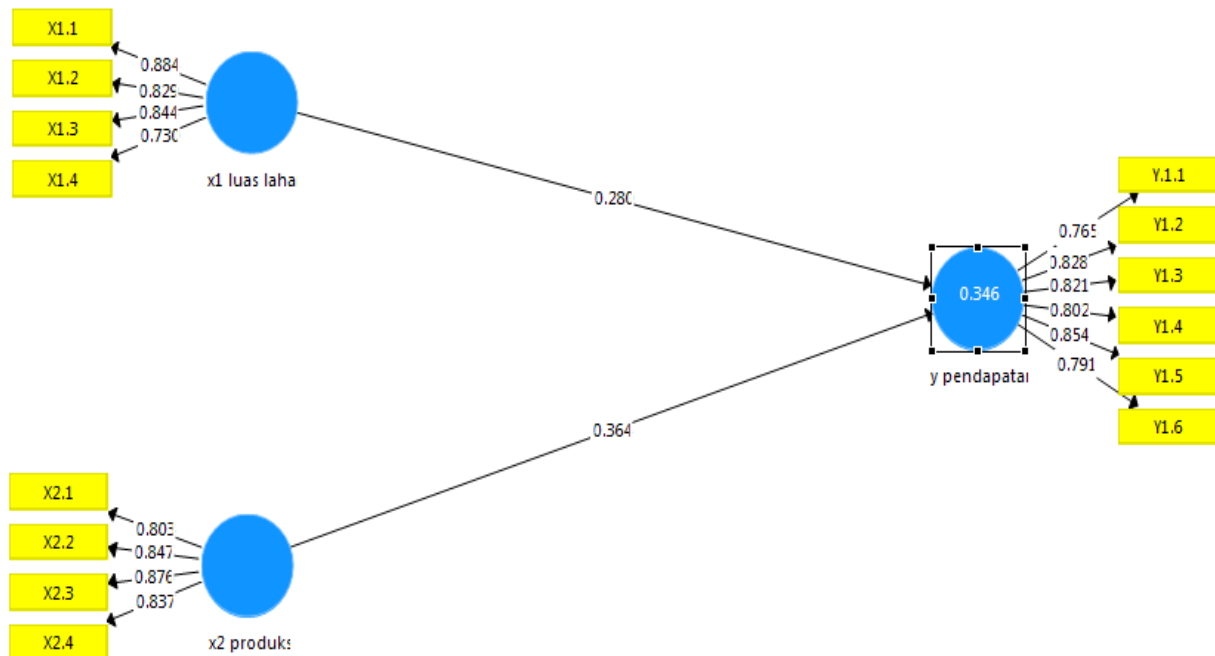
Composite Reliability (Reliability Test) and Cronbach's Alpha

Reliability testing is used to measure internal consistency. PLS-SEM analysis uses recommended values to achieve reliable or valid internal consistency levels, with composite reliability >0.7 and Cronbach's alpha > 0.7 .

Table 11. Composite Reliability and Cronbach's Alpha

Variable	Cronbach's Alpha	Composite Reliability	Status
Land Area	0.841	0.894	Reliable
Production	0.863	0.906	Reliable
Farmer Income	0.896	0.920	Reliable

The reliability test results in Table 11 prove that composite reliability and Cronbach's Alpha values for all latent variables > 0.70 . The obtained values represent manifest variables (indicators) used to measure latent variables in the evaluated model and are considered "Reliable."

**Figure 1. Measurement Model Results (Factor Loading Values)**

Measurement Model Analysis (Inner Model)

Endogenous Construct Variance in R-Square Values

R-Square is a calculation to assess how much endogenous constructs can be explained by exogenous constructs. The coefficient of determination (R-Square) values are expected to be between 0 and 1, where

R-Square values are categorized into 3 categories: 0.67 high, 0.33 moderate, and 0.19 low.

Table 12. R-Square and Adjusted R-Square Analysis

Endogenous Variable (Construct)	Adjusted R Square	R Square	Status
Farmer Income (Y)	0.346	0.333	Moderate

The analysis results presented in Table 12 show that the R-Square value has a simultaneous or combined influence of X1 and X2 on Y of 0.333 with an adjusted R-square value of 0.346. All exogenous constructs (X1 and X2) simultaneously affect Y by 0.346, meaning that farmer income variables can be explained by land area and production variables with a diversity of 34.6%. The remaining 66.7% of the variation is not explained by the model, which may be attributed to other variables not included in the model, measurement errors, or random factors.. This R² value is categorized by Chin 1998 in Ghazali and Latan [15] as between moderate and substantial.

Hypothesis Testing

Hypothesis testing was conducted by examining t-statistics and p-value. Hypotheses in this research can be declared significant if results comply with the Rule of Thumb, where p-value is below 0.05, and t-statistics 1.96 (significance level=5%) can be used (one-tailed) t-value 1.96 (significance level=5%). Based on structural model results in the figure, the summary of these results is compiled in tabular form presented in the following table:

Table 13. Direct Effect Hypothesis Testing

Variable	Original Sample	T Statistics	P Values
Land Area → Income	0.280	2.392	0.017
Production → Income	0.364	3.139	0.002

The hypothesis test results shown in the table indicate hypothesis test values from which conclusions can be drawn:

- Land area has a positive and significant effect on income. This is because the T-statistic value (2.392) > T-statistic value (1.96) with P-value 0.017 < 0.05. Therefore, Ha1 is accepted and H01 is rejected.
- Production has a positive and significant effect on income. This is because the T-statistic value (3.139) > T-statistic value (1.96) with P-value 0.002 < 0.05. Therefore, Ha2 is accepted and H02 is rejected.

DISCUSSION

The relationship between X1 (Land Area) to Y (Income) and X2 (Production) to Y (Income) shows that the results of the test conducted by researchers through hypothesis testing (Indirect Effect) show that both variables have a positive and significant effect on coffee farmers' income. Land area and production simultaneously provide a greater contribution to increasing farmers' income. This means that when farmers are able to expand their land while increasing production volume, the final result in the form of income received will be even higher. This shows that both in terms of business scale and production efficiency, both have an important role in supporting the welfare of coffee farmers.

Specifically, the relationship between variables X1 (Land Area) to Y (Income) shows the results of the hypothesis test with a significance level of 0.017 < 0.05. This value shows that land area has a direct effect on coffee farmers' income. These results are in line with research conducted by Daini, Iskandar, Mastura [16]. The extent or not of the land owned by the feed that the area of land directly has a significant influence on the income of coffee farmers, where the research conducted proved that the extent or not of

land owned by coffee farmers to plant coffee has a positive influence on the high or low income of coffee farmers in Pargarutan Jae Village, East Angkola District, South Tapanuli Regency.

However, when compared to variable X2 (Production), the results of the hypothesis test show that production has a greater influence on farmers' income with a significance value of $0.002 < 0.05$. This finding is consistent with previous research by Pradnyawati and Wayan [6] which stated that production has a positive effect on coffee farmers' income. Production, as the total amount of harvest produced by farmers, directly reflects the final output of the entire cultivation process, so it is logical that an increase in production volume is directly proportional to the increase in income received by farmers.

Furthermore, when viewed through an economic approach, these results can be explained through the theory of marginal productivity and input efficiency, where increasing output from one factor (for example, production intensification on the same land) will provide greater additional income than simply adding other input factors (such as land area) without efficiency. A study by Akinpelu et al. [17] conducted on coffee farmers in Nigeria showed that increasing productivity per hectare contributed 40% to the increase in income, compared to only 15% from land expansion. This shows that increasing production efficiency (through the use of technology, superior seeds, and modern agricultural management) is much more effective in increasing income.

In line with this, Hung Anh et al. [18] in their research in Vietnam emphasized that the sustainable intensification approach, namely increasing production through efficient and environmentally friendly input management on limited land, can increase coffee farmers' income by 30%–35%. In fact, Fernando [19] in their study in Colombia concluded that investment in productivity inputs such as fertilizers, cultivation techniques, and post-harvest had a greater impact on increasing income (25%) than adding land (10%).

CONCLUSION

These findings provide important policy implications. Local governments and agricultural institutions are advised not only to encourage land expansion, but to focus more on increasing production capacity and land efficiency through coffee cultivation technique training programs, subsidies for superior seeds and organic fertilizers, and increasing access to production technology. In addition, the formation of farmer groups or cooperatives is also important to facilitate collective input purchases, strengthen market access, and improve farmers' bargaining position against middlemen.

However, this study also has limitations. Several important variables have not been included in the model, such as labor, production input costs, variations in selling prices, market access, and climate and infrastructure conditions. The absence of these variables can affect the results, because limiting prices or increasing production costs can cause income to remain low even though production increases. Therefore, it is recommended that further research include total factor productivity (TFP) analysis, and use a more comprehensive structural approach to capture the dynamics of coffee farmers' income as a whole.

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