p-ISSN 0854-9028 e-ISSN 2549-9343
AGRIC
ejournal.uksw.edu/agric
Vol. 37, No.1, July 2025
Page: 49 - 62

DETERMINANTS OF ARABICA COFFEE PRODUCTION IN MIOMAFFO BARAT DISTRICT, TIMOR TENGAH UTARA REGENCY, INDONESIA

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ARTICLE INFO

Article history:
Received: 22 November 2024
Revised: 8 July 2025
Accepted: 11 July 2025

***Keywords**:*
Arabica coffee, Cobb-Douglas function, Production, organic fertilizer, Timor Tengah Utara Regency

ABSTRACT

Timor Tengah Utara Regency is a region in the eastern part of Indonesia that has the potential for growing coffee plants because the climate conditions are suitable for supporting the growth of coffee plants. In addition to chemical inputs, coffee farmers in the district also use organic fertilizers to cultivate Arabica coffee. This study aims to examine the factors that influence Arabica coffee production in Miomaffo Barat Subdistrict, Timor Tengah Utara Regency. Out of a total population of 127 individuals, 60 Arabica coffee farmers were randomly selected as respondents, accompanied by direct field observations. The Cobb-Douglas production function model was used to analyze the effects of four input variables: land area, organic fertilizer, urea fertilizer, and insecticide. The analysis results showed that organic fertilizer, urea fertilizer, and insecticide significantly affect Arabica coffee yield per hectare. However, only organic fertilizer contributes positively. In contrast, urea fertilizer and insecticide have negative coefficients. Land area does not show a significant effect and even indicates a negative relationship with coffee productivity.

INTRODUCTION

Coffee is an agricultural commodity that is increasingly liked and consumed by people around the world. Indonesian coffee is among the best coffee in the world. The quality of good coffee is determined from the cultivation stage to its processing. Unfortunately, several studies indicate that Indonesian coffee production is not optimal and has a relatively low level of productivity. Tampubolon et al. (2023) concluded that Indonesian coffee production is very low due to various factors, including production techniques that do not apply innovation to increase production.

Timor Tengah Utara (TTU) Regency is one of the regencies in East Nusa Tenggara province which has superior characteristics in the agricultural sector, especially in the wet and dry land agriculture sectors. Timor Tengah Utara Regency is located in the eastern part of Indonesia that has the potential for growing coffee plants because the climate conditions are suitable for supporting the growth of coffee plants. As one of the Arabica coffee production centres on Timor Island, the production distribution in TTU varies by region. To illustrate this dynamic, Table 1 presents a comparison of Arabica coffee planting areas, production volumes, and productivity in several regions of NTT. This information forms the basis for evaluating the potential and challenges of coffee cultivation spatially in the study area.

Although Arabica coffee is an important source of livelihood for the people of Miomaffo Barat, the data indicates that its productivity remains relatively low compared to other regions. With a planted area of 560 hectares, productivity is only 375 kg per hectare still below the averages of Manggarai (516 kg/ha) and Sikka (484 kg/ha). This indicates a need for more effective cultivation practices and better adoption of agricultural technologies. Miomaffo Barat Subdistrict,

This condition reflects that although potential exists, there are still various obstacles in increasing coffee productivity in Miomaffo Barat. With ongoing farmer training, improved cultivation techniques, and better agricultural infrastructure, the region's productivity can still be significantly increased. Most residents depend on the agricultural sector, particularly Arabica coffee, which has become an integral part of household economies. Below is data

Table 1. Comparison of Arabica Coffee Area, Production, and Productivity in 2022

Region	Area (ha)	Production (tons)	Productivity (kg/ha)
Miomaffo Barat (TTU)	560	210	375
Manggarai	15.500	8.000	516
Ngada	10.000	4.500	450
Ende	5.000	2.300	460
Sikka	6.200	3.000	484

Source: BPS NTT Province, 2022

on the development of the planted area and production of Arabica coffee in Miomaffo Barat Subdistrict, presented in Table 2.

In 2024, the planted area rose again to 171 hectares, but production dropped to 18.55 tons, and productivity decreased to 108.48 kg

Table 2. Arabica Coffee Area and Production in Miomaffo Barat Subdistrict, TTU Regency, 2021–2024

Year	Area (ha)	Production (tons/year)	Productivity (kg/ha)
2021	213	0,02	0,09
2022	560	210	375
2023	10	5,00	500
2024	171	18,55	108,48

Source: BPS TTU Regency, 2025 and Miomaffo Barat Subdistrict in Figures, 2022

per hectare. This variability indicates unstable management and output, likely affected by technical, climatic, socio-economic, and institutional factors. Currently, coffee cultivation is still carried out individually and has not been developed collectively through organized farmer groups for sustainable development. Research by Suryana et al. (2024) emphasized that local innovation adoption by farmers in Garut Regency improved the quality and viability of coffee farming. These innovations include pruning techniques, plant grafting, sun-dome drying, and using coffee waste to create value-added products such as organic fertilizer, ceramics, and coffee-based sweets. This shows that innovative approaches can also be applied in Miomaffo Barat to enhance the economic value and sustainability of coffee production. The interesting thing that the use of organic fertilizers was quite common among farmers

Arabica coffee production in Miomaffo Barat trends over the past four years have shown significant fluctuations, indicating both challenges and untapped development potential.

In 2021, the coffee cultivation area in Miomaffo Barat reached 213 hectares, but production was extremely low only around 20 kilograms, or about 0.09 kg per hectare. This suggests that most plants had not yet reached the productive stage or faced land management and cultivation technique constraints. In 2022, the situation improved significantly, with the planted area increasing to 560 hectares and production soaring to 210 tons. Productivity rose to 375 kg per hectare, reflecting more efficient cultivation practices. However, in the following year (2023), there was a dramatic drop in cultivated area to just 10 hectares. Despite this, productivity peaked at 500 kg per hectare the highest in four years indicating that the remaining land was managed more intensively and efficiently.

According Pradita et al. (2024) Arabica coffee is a leading commodity influenced by environmental, social, cultural, economic, technological, and institutional factors. However, sustainable farming practices still face challenges such as excessive pesticide use and limited technical knowledge. Ambarita & Kartika (2015) found that land area, pesticide use, labor, and fertilizer significantly affect coffee production. Therefore, understanding production dynamics and the use of input factors is crucial to developing strategies for increasing coffee production in Miomaffo Barat. A study by Worku et al. (2022) in Ethiopia also confirmed that the physical quality of coffee beans is significantly affected by growth conditions and post-harvest techniques. Factors such as altitude, cultivation system, shade availability, and post-harvest processing methods interact to determine the quality of the harvest. Based on this background, it becomes essential to identify and understand the key factors influencing Arabica coffee production in Miomaffo Barat Subdistrict. This knowledge will serve as a foundation for formulating policies and strategies aimed at improving productivity and the sustainable welfare of farmers.

METHODS

This research was conducted in Suanae and Fatuneno Villages, located in Miomaffo Barat Subdistrict, Timor Tengah Utara Regency. Miomaffo Barat District with its capital Eban has an altitude of 1,068 m above sea level, which is the highest area in North Central Timor Regency.

Suanae and Fatuneno Village were selected because they are known as seedling centres and the main locations for Arabica coffee cultivation in the area. Data collection was carried out through direct field observations and structured interviews with coffee farmers. The respondents in this study were households engaged in Arabica coffee farming. The sampling technique used was simple random sampling, with a total of 60 farmers selected from a population of 127 Arabica coffee

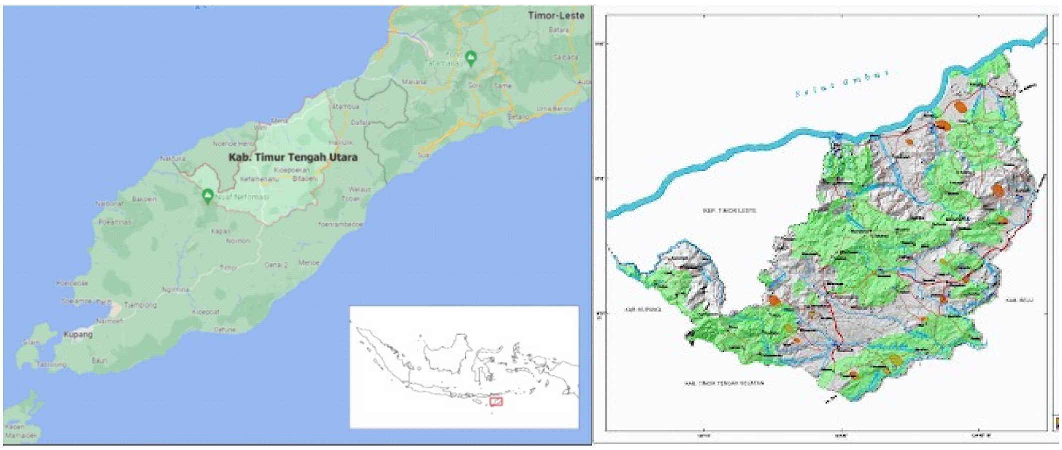

Figure 1. Map of Timor Tengah Utara Regency
(Source: https://perkim.id/profil-pkp/profil-kabupaten-kota/profil-perumahan-dan-kawasan-permukiman-kabupaten-timor-tengah-utara/)

farmers evenly distributed across the two villages. The data used in this study comprised both primary and secondary data. Primary data were obtained directly from farmers through questionnaires and interviews, while secondary data were sourced from relevant institutions such as the Central Bureau of Statistics and the regional Department of Agriculture.

The variables analyzed in this study included: land area (X_1), quantity of organic fertilizer (X_2), amount of urea fertilizer (X_3), and volume of insecticide (X_4). The Cobb-Douglas production function model was applied to analyze the relationship between input and output in Arabica coffee production. This model is appropriate because it describes the functional relationship between various production input factors and output in agricultural production processes. According to Amalia (2014), this model provides a more structured understanding of the contribution of each input factor to production output. The general form of the Cobb-Douglas production function used in this study is as follows:

$$LnY = ln\beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \epsilon_i$$

Where:

Y : Arabica coffee production per land area (kg/ha)
X_1 : land area (ha)
X_2 : organic fertilizer (kg/ha)
X_3 : urea fertilizer per land area (kg/ha)
X_4 : urea fertilizer per land area (kg/ha)
β_0 : intercept
β_1 - β_4 : elasticity coefficients of each input
ϵ_i : elasticity coefficients of each input
$0 < \beta_i < 1$ (*diminishing return*)

This model was estimated using the Ordinary Least Squares (OLS) approach with statistical software to ensure parameter accuracy and the validity of the model used. The collected data were analyzed using Eviews software.

Table 3. Characteristics of Respondents According to Age, Education Level and Gender

No	Characteristic	Total	%
1.	Age		
	- 35 – 42	12	20.00
	- 43 – 50	15	25.00
	- 51 – 58	11	18.33
	- 59 - 66	16	26.67
	- > 66	6	10.00
2.	Education		
	- Illiterate	0	0.00
	- Primary School	24	40.00
	- Junior High School	20	33.33
	- Senior High School	11	18.33
	- College	5	8.33
3.	Gender		
	- Male	46	76.67
	- Female	14	23.33

Source: Primary data processed, 2024

RESULTS AND DISCUSSIONS

Respondent Profile

The age range of respondents varied from 35 to 72 years, with an average age of 52 years. In terms of education level, the majority (approximately 73.3%) had only completed elementary or junior high school. Around 18.3 percent had completed high school, and only 8.3 percent had received higher education.

Coffee cultivation in Miomaffo Barat Subdistrict is generally carried out individually by farmers, with limited financial resources posing a major obstacle to optimal land management. The limited capacity of local human resources to integrate production input elements also presents a significant challenge to increasing Arabica coffee productivity in the region. In addition, frequent fluctuations in market prices increase uncertainty for farmers in determining production volumes each harvest season. This uncertainty is further exacerbated by climate variability and changing environmental conditions.

Thamrin et al. (2021) argued that low coffee productivity in Indonesia is caused by several factors, including suboptimal agro-climatic conditions, traditional farming practices, and limited access to capital and technology. Land management aspects such as fertilization, pruning, and pest and disease control have not yet been implemented optimally. Tampubolon et al. (2023) also noted that, compared to other major coffee-producing countries, Indonesia's coffee production remains relatively low. One of the main causes is the low adoption of agricultural technology innovations. A study by Putu et al. (2021) showed that the availability of resources such as capital, labour, and access to technological information greatly affects farmers' decisions to adopt production innovations. Furthermore, Cassamo et al. (2023) found that climate change negatively affects land suitability for Arabica coffee production, particularly in open planting systems without shade. They recommend agroforestry systems as a solution to maintain sustainable coffee production. Zignol et al. (2023) emphasized the importance of microclimate management through tree shading in agroforestry systems, as it has been shown to improve Arabica coffee yields

Figure 2. Organic Fertilizer use dan low adoption of agricultural technology in Arabica Coffee Farming in Miomaffo Barat Subdistrict
(Source: Primary data, 2024)

in its native region of Ethiopia. To face future challenges, flexible and adaptive agroforestry systems should be designed based on spatial data and in-depth analysis to ensure the sustainability of coffee farming.

Distribution of Production Inputs and Arabica Coffee Farm Outputs

Nuddin (2019). stated that arabica coffee production is influenced by both internal and external factors. External factors, such as rainfall, are beyond the control of farmers, while internal factors such as land area, number of productive trees, farming costs, and labour can be controlled and managed by the farmers. Based on field data, the land managed by farmers ranged from 25 to 200 hectares. Most respondents (83.33%) had land between 25 and 113 hectares, while the remainder (16.66%) cultivated more than 113 hectares.

In terms of fertilization, the use of organic fertilizers was quite common among farmers. About 53.33 percent of respondents applied 196–403 kg/are of organic fertilizer, while 46.66 percent applied more than 403 kg/are. Additionally, farmers also used urea fertilizer as a supplementary input. Most of them (75%) used urea in the range of 495–513 kg/are, while 25 percent applied more than 513 kg/are. The use of insecticides also played a key role in cultivation practices. Insecticide application ranged between 400–800 L/are, with 71.66% of farmers using more than 601 liters/are, and the remaining 28.33 percent using 372–601 L/are.

According to Anggraini et al. (2022) production is the process of combining various input factors to produce goods and services. In agriculture, the combination of production factors such as land, fertilizers, and pesticides directly affects output. The annual coffee production among respondents varied, ranging from 382 to 820 tons per year. About 28.33% of farmers produced between 382–601 tons, while the majority (71.66%) achieved production in the range of 602–820 tons.

Data Analysis Result

1. Classical Assumption Tests

Before estimating the regression model, classical assumption tests were performed to ensure the validity of the model. These included tests for normality, multicollinearity, and heteroscedasticity.

a. Normality Test

The normality test aims to ensure that the residuals of the model are normally distributed. In this study, the Jarque-Bera method was used. The test results showed a probability value of 0.408 (> 0.05), indicating that the residuals follow a normal distribution.

b. Multicollinearity Test

Multicollinearity indicates a strong linear relationship among independent variables. The test was performed by checking the Variance Inflation Factor (VIF). The VIF values for all independent variables were below 10: land area (1.038), organic fertilizer (1.095), urea fertilizer (1.175), and insecticide (1.149). Thus, it can be concluded that there is no multicollinearity in the model.

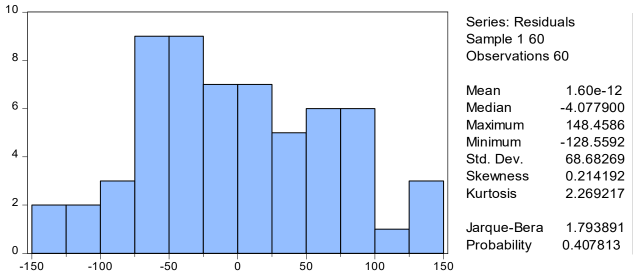

Figure 3. Normality Test

Source: Primary data processed, 2024 (Eview's Output)

Table 4. Multicollinearity Test

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
Contant	443360.5	5256.835	NA
LN_Land Area	0.038550	3.866162	1.037539
LN_Organic Fertilizer	0.014309	25.12272	1.095009
LN_Urea Fertilizer	1.585776	4839.034	1.174904
LN_Insectiside	0.005584	22.72496	1.149307

Source: Primary data processed, 2024 (Eview's Output)

c. Heteroscedasticity Test

To detect whether there is non-constant variance (heteroscedasticity) in the error terms, the Glejser test was used. The observed R-squared probability was 0.3981 (> 0.05), indicating no signs of heteroscedasticity in the regression model.

2. Analysis of Factors Affecting Arabica Coffee Production

In the context of Arabica coffee production, the Cobb-Douglas production function method was used to examine the influence of land area, organic fertilizer, urea fertilizer, and insecticide. The results of the Cobb-Douglas production function analysis are presented in Table 6.

Table 5. Heteroscedasticity Test Glejser

F-statistic	0.997674	Prob. F (4,55)	0.4167
Obs*R-squared	4.058976	Prob. Chi-Square (4)	0.3981
Scaled explained SS	3.065460	Prob. Chi-Square (4)	0.5469

Source: Primary data processed, 2024 (Eview's Output)

Table 6. Determinants of Arabica Coffee Production in Miomaffo Barat Subdistrict, TTU Regency

Variable	Coefficient	Standard Error	t-statistic	Probability
C	5188.810 **	65.8532	7.792723	0.0000
LN_Land Area	-0.065674 ns	0.196342	-0.334486	0.7393
LN_Organic Fertilizer	0.650393**	0.119619	5.437208	0.0000
LN_Urea Fertilizer	-9.202789 **	1.259276	-7.308001	0.0000
LN_Insectiside	-0.187083 **	0.074729	-2.503487	0.0153
R-squared	0.678952			
Adjusted R-squared	0.655603			
F-statistic	29.07847			
Prob(F-statistic)	0.000000			

**) Significant at the error level 5%
ns) insignificant

Based on the regression results in Table 6, the coefficient of determination (R^2) is 0.6790, indicating that approximately 67.90 percent of the variation in Arabica coffee production per hectare can be explained by the four independent variables in the model: land area, organic fertilizer, urea fertilizer, and insecticide. The remaining 32.10 percent is influenced by other factors not included in the model. In addition, the F-statistic value of 29.08 indicates that the model is jointly significant at the 95 percent confidence level ($\alpha = 0.05$), meaning all independent variables collectively have a significant effect on the dependent variable. As found in previous research, oleh Izzuddin & Rochdiani (2024), arabica coffee farming contributes significantly to farmers' household income in Margamulya Village. Further study by Putri et al. (2018) The results show that the variables of productivity, farming experience, capital, labor, plant age and urea fertilizer simultaneously or jointly affect coffee production.

Partial test results (t-test) show that organic fertilizer is the only variable that has a positive and significant effect on coffee production. The regression coefficient of 0.650 indicates that a 1 percent increase in organic fertilizer use will increase coffee production by 0.65 percent, assuming other variables remain constant. This effectiveness is likely due to organic fertilizer's ability to improve soil structure, water retention, and nutrient availability for plants. This view is supported by Cardona et al. (2025), who stated that organic matter applications like compost enhance soil microbial activity and overall soil quality. Furthermore, research by Sunanto (2019) that farmers are familiar with organic fertilizer is good and efforts to increase Arabica coffee productivity farmers agree through: intensive counseling/training and dissemination of information on Arabica coffee production technology. In addition, studies from Mohammed Kedir & Meseret Nugusie (2021) It was found that integrated use of organic and inorganic fertilizers is recommended for coffee production in Jimma, southwest Ethiopia and other similar agroecologies.

Conversely, urea fertilizer has a significantly negative coefficient of -9.203. This means that a 1% increase in urea use may reduce coffee yield by up to 9.2%, assuming other variables remain constant. This finding suggests that excessive chemical fertilizer application can be detrimental to both soil fertility and plant health. Research by Sittadewi et al. (2024) also noted that the dominance of inorganic fertilizers without biological inputs reduces mycorrhiza populations, which are essential for nutrient absorption in plants. This result is in line with research Indarwati & Tridakusumah (2022) that the use of urea fertilizer input in coffee plants shows a significant effect on production yields.

Insecticide, with a regression coefficient of -0.187 and significant at the 5 percent level, also shows a negative relationship with coffee productivity. This implies that a 1 percent increase in insecticide use tends to decrease yield by approximately 0.19 percent, assuming other inputs remain constant. This aligns with the findings of Indarwati & Tridakusumah (2022b), who stressed the importance of balanced input use to avoid damaging the agricultural ecosystem. Meanwhile, the land area variable has a regression coefficient of -0.066 and is statistically insignificant. This indicates that expanding land area without accompanying intensification efforts does not guarantee increased production. This may reflect management limitations or the dilution of input resources across larger plots. Research by Mairura et al. (2022) in Kenya similarly found that farmers with larger landholdings tended to be less focused on crop intensification, which negatively impacted specific crop productivity.

Overall, the model suggests that the success of Arabica coffee production in Miomaffo Barat depends more on input quality (such as organic fertilizer) rather than merely increasing land size or chemical inputs. Adjusting cultivation techniques and utilizing local innovations are crucial for improving yields sustainably, as supported by studies by Do et al. (2023); and Zignol et al. (2023) which recommend agroforestry systems as a sustainable solution for coffee farm management. The same thing was also conveyed by Pradita et al. (2024) that arabica coffee is recognized as a high-quality commodity that is important to farmers' local economies and is determined by a variety of factors, including environmental, economic, social, cultural, institutional, and technological.

CONCLUSIONS

Based on the data analysis results presented previously, it can be concluded that the independent variables collectively have a significant effect on Arabica coffee production. Organic fertilizer, urea fertilizer, and insecticide are input parameters that influence production per unit area of Arabica coffee land. Among these, organic fertilizer shows a positive and significant impact on productivity, indicating its effectiveness in supporting sustainable coffee cultivation. In contrast, both urea fertilizer and insecticide exhibit negative impacts, suggesting the need to control their usage to avoid damaging soil health and crop yields. Meanwhile, land area does not have a significant influence, implying that expanding cultivation without improving cultivation practices will not necessarily lead to increased productivity.

Village governments need to encourage and stimulate communities to optimize Arabica coffee cultivation. This can be achieved by providing technical guidance, promoting the use of organic inputs, and strengthening institutional support. Addressing the problems faced by farmers is essential to enhance economic welfare independently and sustainably.

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