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The Effects of Land Area, Number of Coffee Trees, and Maintenance Costs on Robusta Coffee Production in Duyung Village, Mojokerto Regency

Yose Putra Oentoro*, Joko Priyono

Universitas 17 Agustus 1945 Surabaya

*Correspondence: Yose Putra Oentoro
Email: Oentoro1@gmail.com

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Abstract: This study aims to examine the role of land area, number of coffee trees, and maintenance costs in determining Robusta coffee production among farmers in Duyung Village, Trawas District, Mojokerto Regency. A quantitative approach was employed using primary data collected through questionnaires distributed to 55 coffee farmers, with the sample size determined using the Slovin formula. The variables analyzed include land area, number of coffee trees, maintenance costs, and Robusta coffee production measured in kilograms. Data were analyzed using multiple linear regression with the assistance of EViews 13 software to evaluate the relationship, magnitude of influence, and statistical significance of each independent variable. The results indicate that land area, number of coffee trees, and maintenance costs simultaneously have a significant effect on Robusta coffee production. Partially, land area (X1) has a positive and significant effect on production, the number of coffee trees (X2) does not have a statistically significant effect, and maintenance costs (X3) have a significant negative effect on production. These findings suggest that land area and efficient management of maintenance costs play a more decisive role in increasing coffee yields, while the number of trees alone is not the main determinant of production. Overall, this study provides empirical evidence on key factors influencing the productivity of Robusta coffee farming and may serve as a reference for developing strategies to improve agricultural productivity in Duyung Village.

Keywords: Land Area, Number of Coffee Trees, Maintenance Costs, Robusta Coffee Production

Introduction

Indonesia is one of the world's major coffee-producing countries, where coffee plays a strategic role in economic development, rural livelihoods, and socio-cultural sustainability. In recent years, domestic coffee consumption has increased by approximately 8% annually, while production growth has lagged behind at around 2%, creating a potential risk of Indonesia shifting from a net coffee exporter to an importer (ICO, 2021) (Martauli, 2018). This imbalance is largely attributed to low productivity, as the national average yield of Robusta coffee remains at about 677 kg ha^{-1}, significantly lower than that of leading producers such as Brazil and Vietnam, which exceed 1.5 t ha^{-1} (Agronomy, 2019). These conditions highlight the urgent need to improve productivity through more efficient use of production factors to support sustainable coffee-based agricultural development.

Previous studies have demonstrated that Robusta coffee production is influenced by various production factors, particularly land area, plant population, capital, labor, and maintenance costs (Haryoko et al, 2018) (Isyariansyah et al, 2018) (Firly, 2024). Other research has emphasized the role of agroclimatic conditions and cultivation practices in determining coffee productivity at the farm level (Farkhan et al, 2024) (Leo et al, 2023). Empirical studies conducted in established Robusta coffee production centers in Indonesia—such as Lampung, Banyuwangi, Karawang, and Temanggung—generally indicate that land area and the number of coffee trees are dominant determinants of production, although the magnitude of their effects varies across regions (Darwis et al, 2020) (Nurhayati et al, 2024) (Setiawan et al, 2022). However, most of these studies focus on mature production areas with relatively stable yields and long-established coffee farming systems.

To date, limited research has addressed the determinants of Robusta coffee production in newly developing areas characterized by transitional farmers who have recently shifted from other crops to coffee cultivation. Desa Duyung in Mojokerto Regency represents such an area, possessing considerable potential for Robusta coffee development due to its fertile andosol and mediterranean soils (Rahmawan, 2010), yet lacking official production records and exhibiting substantial yield variation among farmers. These disparities are presumed to be associated with differences in land size, number of coffee trees, and maintenance costs, which have not been empirically examined. Therefore, this study offers novelty by analyzing the effects and efficiency of key production factors in a newly emerging Robusta coffee production area with unstable production conditions.

Based on this background and the identified research gap, the objective of this study is to analyze the effects of land area, number of coffee trees, and maintenance costs on Robusta coffee production in Desa Duyung, Mojokerto Regency, and to provide empirical evidence to support productivity enhancement and regional agribusiness development strategies.

Research Method

Research Design

This study employed a quantitative explanatory research design with a descriptive–verificative approach to analyze the effects of land area, number of coffee trees, and maintenance costs on Robusta coffee production. The quantitative approach was selected to ensure objective and statistically measurable analysis based on numerical data collected from farmers. The explanatory nature of the study allows not only the description of production conditions but also the examination of causal relationships between independent variables and coffee output. The research was conducted in Desa Duyung, Trawas District, Mojokerto Regency, an emerging Robusta coffee production area with favorable agroclimatic conditions. The research process was carried out over a four-month period, from preliminary field observation to final data analysis.

Population, Sample, Sampling

The population of this study consisted of all Robusta coffee farmers residing in Desa Duyung, totaling 122 farmers, based on village monograph data from 2025. The sample size was determined using the Slovin formula with a margin of error of 10%, resulting in 55 farmers selected as respondents. A simple random sampling technique was applied to ensure that each farmer had an equal probability of being selected. Farmers who were actively cultivating Robusta coffee during the study period were included in the sample, while those who had ceased production or had incomplete farming records were excluded. All selected respondents met the inclusion criteria, and no sampled respondents were removed during the data collection process.

Intervention Procedure

This study utilized both primary and secondary data. Primary data were collected through structured questionnaires and direct interviews with coffee farmers. The questionnaire was designed to capture quantitative information on land area (hectares), number of coffee trees (units), maintenance costs (IDR per production cycle), and Robusta coffee production (kilograms per harvest). The instrument was developed based on indicators commonly used in previous empirical studies on coffee production factors and agricultural production economics. Prior to data collection, the questionnaire was reviewed to ensure content validity, clarity, and consistency with research objectives. Measurement was conducted using ratio-scale data to support regression analysis. Secondary data were obtained from official publications of the Central Bureau of Statistics (BPS), relevant government reports, and scientific literature related to coffee agribusiness and production economics.

Data Analysis

The data were analyzed using multiple linear regression analysis with the assistance of EViews version 13 to assess the influence of land area, number of coffee trees, and maintenance costs on Robusta coffee production. Hypothesis testing was conducted using the F-test to evaluate the simultaneous effect of independent variables and the t-test to examine their partial effects. The coefficient of determination (R^2) was used to determine the proportion of variation in coffee production explained by the independent variables. Prior to regression analysis, classical assumption tests—including normality, multicollinearity, heteroscedasticity, and autocorrelation tests—were performed to ensure the validity and reliability of the regression model. The results of this analysis are expected to provide robust empirical evidence regarding the key factors influencing Robusta coffee productivity in Desa Duyung.

Result and Discussion

Normality Test

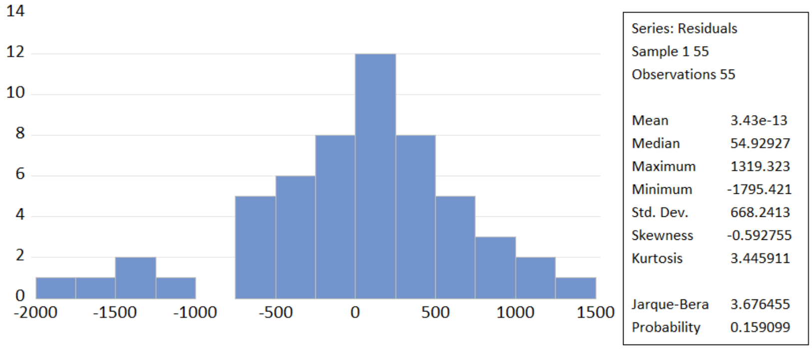

Figure 1. Normality Test

The results show that the Jarque–Bera statistic is **3.676** with a probability value of **0.159**, which is higher than the 0.05 significance level. This indicates that the regression residuals are normally distributed. The histogram shows a relatively symmetric distribution around zero, supported by skewness (–0.592) and kurtosis (3.445) values within the acceptable range. Therefore, the normality assumption is satisfied.

Multicollinearity Test

Table 1. Multicollinearity Test

Variance Inflation Factors
Date: 12/15/25 Time: 17:23
Sample: 1 55
Included observations: 55

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	78292.56	9.107370	NA
X1	60254.54	4.958619	1.120436
X2	0.195659	6.046780	1.102691
X3	0.061900	2.752424	1.033856

Based on the Variance Inflation Factor (VIF) values, all independent variables have VIF values below 10.00. This indicates that there is no strong correlation among the independent variables. Thus, the regression model is free from multicollinearity, and each variable independently contributes to Robusta coffee production.

Heteroskedasticity Test

Table 2. Heteroskedasticity Test

Heteroskedasticity Test: Glejser
Null hypothesis: Homoskedasticity

F-statistic	2.293988	Prob. F(3,51)	0.0890
Obs*R-squared	6.539309	Prob. Chi-Square(3)	0.0881
Scaled explained SS	7.338948	Prob. Chi-Square(3)	0.0618

Test Equation:
Dependent Variable: ARESID
Method: Least Squares
Date: 12/15/25 Time: 17:24
Sample: 1 55
Included observations: 55

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	507.0328	174.1813	2.910948	0.0053
X1	242.3902	152.8045	1.586277	0.1189
X2	-0.118824	0.275354	-0.431533	0.6679
X3	-0.277219	0.154877	-1.789930	0.0794

The Glejser test results show that the probability value of Obs*R-squared is **0.0881**, which exceeds the 0.05 significance level. This indicates that the independent variables do not significantly affect the absolute residuals. Therefore, the regression model does not exhibit heteroskedasticity, and the error variance is constant.

Autocorrelation Test

Table 3. Autocorrelation Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	1.773803	Prob. F(2,49)	0.1804
Obs*R-squared	3.713172	Prob. Chi-Square(2)	0.1562

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 12/15/25 Time: 17:25
Sample: 1 55
Included observations: 55
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-48.28501	280.3388	-0.172238	0.8640
X1	47.20683	243.1220	0.194169	0.8468
X2	0.006002	0.444935	0.013490	0.9893

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X3	0.013189	0.245224	0.053783	0.9573
RESID(-1)	-0.080709	0.140959	-0.572572	0.5696
RESID(-2)	-0.261056	0.143681	-1.816906	0.0754

R-squared	0.067512	Mean dependent var	3.43E-13
Adjusted R-squared	-0.027640	S.D. dependent var	668.2413
S.E. of regression	677.4133	Akaike info criterion	15.97711
Sum squared resid	22485550	Schwarz criterion	16.19609
Log likelihood	-433.3705	Hannan-Quinn criter.	16.06179
F-statistic	0.709521	Durbin-Watson stat	1.955645
Prob(F-statistic)	0.619142		

The Breusch–Godfrey LM test shows an Obs*R-squared probability value of 0.1562, which is greater than 0.05. This result indicates that there is no serial correlation among the residuals. Hence, the regression model satisfies the assumption of no autocorrelation.

Multiple Linear Regression Analysis

Table 4. Statistical Test Results

Dependent Variable: Y
Method: Least Squares
Date: 12/15/25 Time: 17:20
Sample: 1 55
Included observations: 55

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	468.2728	279.8081	1.673550	0.1003
X1	3234.916	245.4680	13.17856	0.0000
X2	-0.074810	0.442333	-0.169125	0.8664
X3	-0.670619	0.248797	-2.695443	0.0095

R-squared	0.805831	Mean dependent var	2499.618
Adjusted R-squared	0.794410	S.D. dependent var	1516.504
S.E. of regression	687.6146	Akaike info criterion	15.97428
Sum squared resid	24113506	Schwarz criterion	16.12027
Log likelihood	-435.2927	Hannan-Quinn criter.	16.03074
F-statistic	70.55272	Durbin-Watson stat	2.110207
Prob(F-statistic)	0.000000		

The multiple linear regression analysis produces the following equation:

$$Y = 468.27 + 3234.92X_1 - 0.07X_2 - 0.67X_3 + e$$

Land area (X_1) has a positive and significant effect on Robusta coffee production ($p < 0.001$), indicating that an increase in land size substantially increases output. The number of coffee trees (X_2) shows a negative but insignificant effect ($p = 0.866$), suggesting that tree quantity alone does not significantly affect production. Maintenance costs (X_3) have a negative and significant effect ($p = 0.009$), indicating inefficiencies in maintenance practices.

Simultaneous Test (F-test)

Table 5. F-Test (Simultaneous Test)

Dependent Variable: Y
Method: Least Squares
Date: 12/15/25 Time: 17:20
Sample: 1 55
Included observations: 55

F-statistic	70.55272
Prob(F-statistic)	0.000000

The F-test results show a probability value of 0.000, which is lower than 0.05. This indicates that land area, number of coffee trees, and maintenance costs simultaneously have a significant effect on Robusta coffee production.

Partial Test (t-test)

Table 6. t-Test (Partial Test)

Dependent Variable: Y
Method: Least Squares
Date: 12/15/25 Time: 17:20
Sample: 1 55
Included observations: 55

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	468.2728	279.8081	1.673550	0.1003
X1	3234.916	245.4680	13.17856	0.0000
X2	-0.074810	0.442333	-0.169125	0.8664
X3	-0.670619	0.248797	-2.695443	0.0095

The partial t-test results indicate that land area significantly affects Robusta coffee production, while maintenance costs have a significant negative effect. In contrast, the number of coffee trees does not have a significant effect on production.

Coefficient of Determination (R^2)

Table 7. Coefficient of Determination (R^2)

Dependent Variable: Y
Method: Least Squares
Date: 12/15/25 Time: 17:20
Sample: 1 55
Included observations: 55

R-squared	0.805831
Adjusted R-squared	0.794410

The R^2 value of 0.8058 indicates that 80.58% of the variation in Robusta coffee production can be explained by land area, number of coffee trees, and maintenance costs. The remaining 19.42% is influenced by other factors not included in the model.

Discussion

This study shows that land area is the most significant determinant of Robusta coffee production in Desa Duyung. The positive effect of land size is consistent with previous studies in Indonesia, which identified land area as a key factor in increasing coffee output (Haryoko et al, 2018) (Isyariansyah et al, 2018) (Setiawan et al, 2022) (Firly, 2024). Conversely, the number of coffee trees has a negative and insignificant effect, indicating that increasing plant population alone does not guarantee higher production, particularly in areas where many trees are still unproductive or poorly managed (Darwis et al, 2020) (Martauli, 2018).

Maintenance costs show a significant negative effect on production, suggesting inefficiencies in input use. This finding supports agricultural production theory, which emphasizes the importance of optimal input allocation rather than higher expenditure (Karmini, 2018) (Imran & Indriani, 2022), and aligns with previous coffee studies reporting similar inefficiencies (Widiastuti, 2025). Overall, the results highlight that improving Robusta coffee productivity in developing areas should focus on efficient land use and better farm management rather than increasing input intensity.

Conclusion

Robusta coffee production in Desa Duyung is significantly impacted by land area, the number of coffee trees, and maintenance costs, all of which together account for about 80.58% of the variation in farmers' yields, according to the results of the hypothesis testing and the discussion provided in this study. This result suggests that a variety of production parameters rather than a single variable govern coffee output, which makes a thorough analytical approach more useful in comprehending production dynamics. Partially, land area has a significant positive impact on production due to relatively optimized land use by farmers, while the number of coffee trees does not significantly contribute to output, likely due to the dominance of young plants and limited replanting activities. On the other hand, maintenance expenses have a big impact on output, which emphasizes how crucial cultivation intensity and management quality are to harvest results. The two factors that have the most effects on Robusta coffee output are land area and maintenance expenses. This is because land size affects the number of producing plants, and maintenance costs are a reflection of farmers' efforts to maintain plant health through insect control and fertilizer. These findings suggest that productivity improvements should concentrate on effective land management and optimal resource usage since growing the number of coffee plants without effective maintenance techniques does not increase yields. From a practical standpoint, focused technical support and farm management training are crucial to improving the sustainability and productivity of Robusta coffee farming in developing production areas like Desa Duyung. Future research is advised to include additional variables like plant age, labor intensity, fertilizer application, and agroclimatic factors, as well as to apply efficiency-based analytical approaches and multi-season data.

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