

DETERMINANTS OF RICE PRODUCTIVITY ON THE ISLAND OF JAVA

Nanda Ayu Permatasari¹, Arif Andri Wibowo^{2*}, Arintoko³, and Uus Kusyati⁴

¹⁻³Economics Development, Jenderal Soedirman University, Indonesia

⁴Regional Office of the Directorate General of Treasury of Central Java, Indonesia

*Email corresponding author: arif.andri.wibowo@unsoed.ac.id

Article Information: Received – June, 25, 2026, Published – August, 10, 2026

Abstract

Rice productivity is a critical indicator in agricultural sector development, as it contributes to food availability and strengthens regional food security. Java Island, as the center of national rice production, exhibits a relatively high level of rice productivity, influenced by economic factors, agroclimatic conditions, and government policies related to the agricultural sector during the 2018–2024 period. This study aims to analyze the effects of agroclimatic factors, agricultural sector Gross Regional Domestic Product (GRDP), pump irrigation development, agricultural microcredit (KUR), and the Price Index Received by Farmers (It) for the rice subsector on rice productivity in Java Island. This study employs panel data regression, with model selection conducted through the Chow Test and Lagrange Multiplier (LM) Test, resulting in the Common Effect Model (CEM) as the best-fitting model. The results indicate that agricultural sector GRDP and rainfall have a positive and significant effect on rice productivity, whereby both variables contribute to increasing rice productivity. Pump irrigation development shows a positive but insignificant effect. Meanwhile, agricultural KUR and the Price Index Received by Farmers (It) for the rice subsector have a negative and significant effect on rice productivity, suggesting that increased financing and prices received by farmers do not necessarily lead to higher productivity, with It identified as the most dominant variable based on its coefficient value. The findings imply that enhancing rice productivity in Java Island requires effective water resource management, improved efficiency in agricultural KUR disbursement, and comprehensive strengthening of the agricultural sector to support sustainable rice productivity growth.

Keywords: Rice Productivity; Agricultural Sector GRDP; Agroclimatic Factors; Pump Irrigation; Agricultural Microcredit (KUR)

INTRODUCTION

The agricultural sector plays a strategic role in supporting Indonesia's economic development and national food security. This commitment is reflected in the Sustainable Development Goals (SDGs), particularly Goal 2 (Zero Hunger), which emphasizes ending hunger, improving nutrition, and promoting sustainable agricultural systems to enhance food production and productivity (Guiné et al., 2021). In Indonesia, food security is also regulated under Law No. 18 of 2012 on Food, which highlights four interconnected dimensions of food security, namely food availability, accessibility, utilization, and stability (Tono et al., 2023). Among various agricultural commodities, rice remains the most strategic staple food commodity, contributing significantly to national food security and socioeconomic stability (Auliya et al., 2024).

Java Island plays a pivotal role in achieving Indonesia's food security objectives. Despite occupying a relatively smaller land area compared to other major islands, Java contributes substantially to national rice production due to its favorable agroecological conditions, relatively developed agricultural infrastructure, and intensive farming practices. Consequently, maintaining and improving rice productivity in Java has become an important policy priority for ensuring sustainable food availability and supporting agricultural development in Indonesia.

Figure 1 presents rice productivity across the five rice-producing provinces in Java Island during the period 2018–2024. The data reveal considerable differences in productivity levels among provinces. East Java consistently recorded the highest rice productivity during the observation period, whereas D.I. Yogyakarta exhibited the lowest productivity level. Moreover, rice productivity across provinces tended to fluctuate over time and showed only modest improvements during the study period.

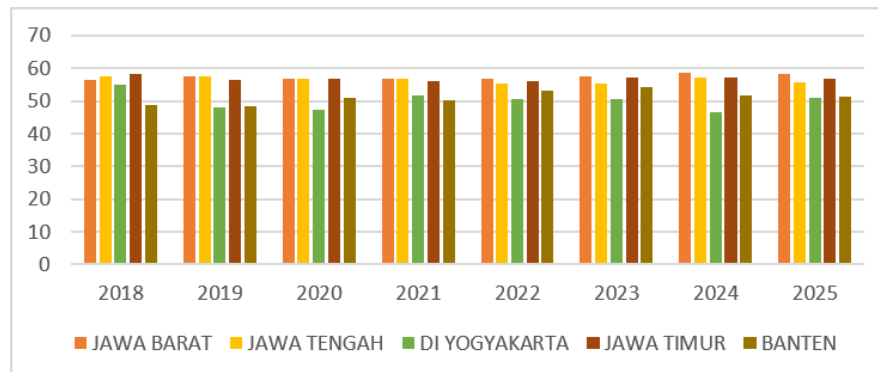


Figure 1. Rice Productivity in Java Provinces, 2018–2024

The fluctuating pattern of rice productivity in Java indicates that productivity improvements remain a significant challenge despite the implementation of various agricultural development programs. The relatively stagnant productivity growth suggests that increasing rice productivity cannot be explained solely by land availability or cultivation intensity. Rather, it is likely influenced by a combination of economic, environmental, and infrastructural factors that shape agricultural production systems. Consequently, understanding the determinants of rice productivity is essential for designing effective and sustainable agricultural policies to strengthen national food security.

The relationship between agricultural production inputs and output can be explained by the Cobb-Douglas production function, which posits that agricultural output is determined by the combination of various production inputs, including capital, infrastructure, technology, and environmental factors. The theory further emphasizes the principle of diminishing returns, whereby additional inputs will eventually generate smaller increases in output when other factors are held constant. In the context of rice farming, productivity is therefore influenced not only by the quantity of production inputs but also by their efficient allocation and utilization.

In addition, Supply Response Theory explains that farmers respond to economic incentives and institutional support when making production decisions. Improvements in output prices, access to agricultural financing, irrigation infrastructure, and government support programs may encourage farmers to adopt better production practices and increase agricultural productivity. Conversely, constraints in accessing productive resources may limit productivity growth. These theoretical perspectives suggest that rice productivity is influenced by both technical and economic determinants operating simultaneously within agricultural production systems (Sulistiyorini & Lasmono Tri Sunaryanto, 2020).

Several factors are considered important determinants of rice productivity. Agroclimatic conditions, particularly rainfall, play a crucial role in determining water availability throughout the crop growth cycle. Appropriate rainfall supports plant physiological processes and contributes positively to agricultural productivity, whereas excessive or insufficient rainfall may adversely affect rice yields. Rainfall variability across regions further highlights the importance of environmental conditions in agricultural production. Access to agricultural financing is another important factor influencing farmers' productivity. People's Business Credit (KUR) has been introduced by the Indonesian government to improve farmers' access to financial resources, enabling them to purchase quality inputs, adopt modern agricultural technologies, and expand production capacity. Adequate financing support is expected to improve farm-level productivity through more efficient input utilization and technology adoption (Karimov et al., 2022).

Irrigation infrastructure also plays an essential role in supporting rice production. Pump Irrigation Development has been implemented to improve water accessibility, particularly in areas that are not adequately served by conventional irrigation systems. The availability of irrigation infrastructure contributes to production stability by reducing farmers' dependence on rainfall and mitigating the adverse effects of climate variability on agricultural output. Economic incentives further influence farmers' production decisions. The Price Index Received by Farmers (It) reflects the prices obtained by farmers for their agricultural products and serves as an indicator of economic incentives within the agricultural sector. Higher farm-gate prices may encourage farmers to intensify production activities and increase productivity. Likewise, the Agricultural Gross Regional Domestic Product (Agricultural GRDP) reflects the economic performance of the agricultural sector and indicates the capacity of regional agricultural development to support productivity improvements (Aditya et al., 2021; Trinugroho et al., 2024).

Previous studies have demonstrated that agroclimatic factors, agricultural financing, irrigation infrastructure, and economic incentives are important determinants of agricultural productivity. However, most existing studies have examined these factors separately and predominantly employed time-series or simple regression approaches within specific regional contexts. Consequently, there remains limited empirical evidence that simultaneously integrates environmental, economic, financing, and infrastructural dimensions using panel data analysis to explain rice productivity across provinces. Given the considerable heterogeneity in agroecological conditions, agricultural infrastructure, and economic characteristics among provinces in Java Island, panel data regression provides a more appropriate analytical framework for capturing both cross-sectional and temporal variations in rice productivity. Integrating multiple determinants within a single model enables a more comprehensive understanding of the factors influencing rice productivity and facilitates more accurate policy recommendations (Azizah et al., 2021; Gollin, 2023; Salviana et al., 2023).

Therefore, this study aims to analyze the effects of agroclimatic factors (rainfall), Agricultural Gross Regional Domestic Product (Agricultural GRDP), People's Business Credit (KUR), Pump Irrigation Development, and the Price Index Received by Farmers (It) on rice productivity across five provinces in Java Island during the period 2018–2024 using panel data regression analysis. The findings are expected to contribute both theoretically and practically by providing empirical evidence for formulating more effective agricultural policies to support sustainable rice productivity and strengthen national food security in Indonesia.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

The relationship between production inputs and agricultural output is explained through the Cobb-Douglas production function (Cobb & Douglas, 1928), expressed as $Q = A L^{\alpha} K^{\beta}$, where Q denotes output, A represents Total Factor Productivity (TFP), L and K denote labor and capital respectively, and α and β represent the output elasticities of these inputs (Gautam, 2024). An inherent principle of this function is the law of diminishing returns, which posits that continuous addition of a single input while holding others constant yields progressively smaller increments in output. Auliya et al. (2024), confirmed that rice production is strongly influenced by the interaction between climatic conditions and production factors, whereby input use beyond the optimal threshold, such as excessive fertilization, reduces nutrient absorption efficiency and productivity. Kryszak et al. (2020), explained that the ratio of marginal product (MP) to average product (AP) serves as a key indicator of each input's marginal productivity contribution, as reflected in the total product (TP) curve: during the increasing-returns stage, additional inputs such as microcredit, rainfall, or pump irrigation still yield substantial production responses, whereas at the optimum stage, additional output declines until MP equals AP (Luttaryana & Hariyati, 2019).

Rice productivity is further explained through Supply Response Theory, which posits that farmers, as price-taking agents, adjust production decisions based on price incentives and other economic

factors (Magrini et al., 2017). A key indicator of price incentives is the Price Index Received by Farmers (It), which measures farm-gate grain price movements using the Modified Laspeyres Index approach (BPS, 2025). Nevertheless, Sulistyorini & Lasmono Tri Sunaryanto (2020), found that the price elasticity of production response is relatively low, as a 1% increase in grain price raises output by only approximately 0.088%, indicating that rice productivity is not determined solely by price, but also by structural factors such as irrigation, technology, and agroclimatic (Firdausi et al., 2025)

Productivity is generally defined as the ratio of output to input employed. BPS (2025), defines rice productivity specifically as the volume of milled dry grain (GKG) produced per unit of harvested area (quintal/hectare) (Bello et al., 2021). Agroclimatic conditions, encompassing rainfall, temperature, humidity, and solar radiation, constitute a critical determinant, with rainfall identified as the most critical variable due to its direct link to water availability throughout the crop growth cycle (Ansari et al., 2023; Sishodia & Ray, 2020). Climago & Nazarudin (2024), found that a 1% decline in rainfall beyond the turning point reduces rice productivity by 0.00796%, while Aditya et al. (2021b) demonstrated a non-linear relationship in which excessive rainfall reduces yield through flooding and disease risk, consistent with the diminishing-returns principle that every production factor, including water, has an optimal threshold. Prior studies have reinforced the linkages among agroclimatic factors, financing, irrigation infrastructure, price incentives, and agricultural economic conditions in relation to rice productivity (Ansari et al., 2023; Guzman-Lopez et al., 2024; Niang et al., 2017). However, most of these studies examine such factors in isolation, employing simple regression or time-series approaches within a single region. This study integrates rainfall, the price index received by farmers, agricultural sector GRDP, pump irrigation, and People's Business Credit (KUR) within a single panel regression model to provide a more comprehensive understanding of the determinants of rice productivity across Java Island.

Based on the theoretical and conceptual framework presented above, the research hypotheses are formulated as follows :

1. Rainfall (Agroclimatic Factor)

Rainfall supplies the water required for physiological processes such as photosynthesis and yield formation; both water deficit and excess can impede production. Rainfall has been shown to affect rice productivity in studies by Santoso et al. (2022), who found that the effect of rainfall on upland rice differs across climate types, and Qin et al. (2026), who demonstrated that drought stress significantly reduces rice yield.

H1: Agroclimatic factors (rainfall) have a positive effect on rice productivity.

2. People's Business Credit (KUR) in the Agricultural Sector

KUR addresses capital constraints faced by smallholder farmers in accessing quality inputs and modern technology; within the production theory framework, capital is a critical determinant of output level (Syafani et al., 2025). KUR has been shown to positively affect rice productivity in studies by Malaizarasan et al. (2025), who found that credit-recipient farmers achieved higher productivity (4,399 kg/ha) than non-recipients (3,802 kg/ha); Girma (2022), who demonstrated that credit access facilitates the adoption of modern agricultural technology and Saqib et al. (2018), who noted that agricultural credit ensures the timely availability of production inputs.

H2: KUR in the agricultural sector has a positive effect on rice productivity in Java Island.

3. Pump Irrigation

Water availability is an essential input that cannot be fully substituted by other production factors. Pump irrigation has been shown to positively affect rice productivity in studies by Trinugroho et al. (2024), who found it to be an effective solution for mitigating rainfall variability on rainfed land; Negera et al. (2025), who demonstrated that solar-powered pump irrigation enhances land productivity through more stable water provision; and Hanafi et al. (2025), who found that pump irrigation programs increased cropping frequency and expanded cultivable land.

H3: Pump irrigation has a positive effect on rice productivity.

4. Price Index Received by Farmers (It)

An increase in It reflects higher farm-gate grain prices, which raises farmers' incomes and, consistent with supply response theory, incentivizes optimal input use. It has been shown to positively affect rice productivity in studies by Bashir and Yuliana (2019), who found that rice prices significantly influence production decisions in Indonesia, consistent with FAO (2014) findings in Tanzania and MAPSA (2022) findings in Myanmar, both indicating that stronger price incentives encourage producers to sustain productive input use.

H4: The Price Index Received by Farmers (It) for the food-crop rice subsector has a positive effect on rice productivity.

5. Agricultural Sector GRDP

Agricultural GRDP reflects a region's economic capacity to provide infrastructure, institutions, and investment supporting agricultural production (Chen et al., 2022). Agricultural GRDP has been shown to positively affect rice productivity in studies by Thong et al. (2025), who emphasized the significant role of government intervention through credit access, training, and infrastructure, and Sulaiman et al. (2025), who found that regions with a stronger agricultural economic base are more prepared to adopt cultivation innovations and policies.

H5: Agricultural GRDP has a positive effect on rice productivity in Java Island.

RESEARCH METHODS

The research method used in this study aims to analyze the influence of agroclimatic factors, the price index received by farmers, agricultural sector GRDP, pump irrigation, and People's Business Credit (KUR) on rice productivity in Java Island. This section is divided into four parts.

1. Research Design

The type of research used is quantitative research. A quantitative approach is a research method that emphasizes the objective analysis of relationships between variables through numerical data and statistical testing. This approach was used to analyze the influence of the independent variables on the dependent variable.

2. Population and Sample

The object of this study is rice productivity in Java Island. This study examines the influence of variables namely rainfall (agroclimatic factor), the price index received by farmers for the rice group, agricultural sector GRDP, pump irrigation, and KUR in the agricultural sector on rice productivity. These variables were selected because they represent the key production, financing, infrastructure, and price-incentive dimensions relevant to rice productivity. The data analyzed cover five provinces in Java Island, namely West Java, Central Java, the Special Region of Yogyakarta, East Java, and Banten, over the period 2018-2024. DKI Jakarta was excluded due to its minimal agricultural sector.

3. Data Collection Methods and Instrument Development

In this study, data were obtained from the official publications of Statistics Indonesia (BPS) and the Ministry of Agriculture, in the form of secondary panel data combining time-series and cross-sectional dimensions.

Tabel 1. Data Sources

Variable	Source
Rice Productivity	BPS-Statistics Indonesia
Agroclimate (Rainfall)	BPS-Statistics Indonesia
KUR in the Agricultural Sector	Ministry of Agriculture
Pump Irrigation Development	Ministry of Agriculture
Price Index Received by Farmers (Rice Group)	BPS-Statistics Indonesia
Agricultural Sector GRDP	BPS-Statistics Indonesia

Rice productivity refers to rice production in the form of Milled Dry Grain (GKG) per unit of harvested area, expressed in quintals per hectare (ku/ha). Agroclimate is proxied by annual rainfall, expressed in millimeters (mm). KUR in the agricultural sector refers to the value of working capital and/or investment credit disbursed to agricultural business actors, expressed in million rupiah. Pump irrigation development is measured by the area of agricultural land served by pump-based irrigation systems, expressed in units. The price index received by farmers for the rice group reflects the development of rice commodity prices received by farmers relative to the base year 2018=100. Agricultural sector GRDP refers to the gross value added generated by agricultural economic activities in a region, measured at constant prices and expressed in billion rupiah. This study used Stata 17 software as the statistical analysis tool. The software was used to process panel data, conduct model selection and classical assumption tests, and estimate the most appropriate regression model.

4. Data Analysis Techniques

This study employs panel data analysis, which combines time-series data with cross-sectional data over a seven-year observation period, from 2018 to 2024. The cross-sectional data cover five provinces in Java Island. The following is the formulation of the panel data regression equation used in this study:

$$PP_{it} = \beta_0 + \beta_1 FA_{it} + \beta_2 KUR_{it} + \beta_3 PIP_{it} + \beta_4 ITP_{it} + \beta_5 AGRDP + \varepsilon_{it}$$

Keterangan :

PP	=	Rice Productivity
PDRB Per.	=	Agricultural Gross Regional Domestic Product (Agricultural GRDP)
ITP	=	Farmers' Terms of Trade Price Index for the Rice Group
FA	=	Agroclimatic Factors
KUR	=	People's Business Credit (KUR)
PIP	=	Pump Irrigation Development
<i>i</i>	=	Province
<i>t</i>	=	Time
β_0	=	Constant
$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$	=	Regression Coefficients
ε_{it}	=	Error Term

RESULTS AND DISCUSSION

1. Result Panel Data Regression Model Selection

The Chow test result of 0.4271 (> 0.05) indicates that the Common Effects Model (CEM) is more appropriate than the Fixed Effects Model (FEM). Therefore, the Fixed Effects Model (FEM) was not selected, and the Hausman test was not required because it is only conducted when FEM is considered a candidate model. Furthermore, the Lagrange Multiplier (LM) test result of 1.0000 (> 0.05) indicates that the Common Effects Model (CEM) is more appropriate than the Random Effects Model (REM). Thus, the Common Effects Model (CEM) was selected as the most suitable model for the panel data regression analysis.

2. Result Classical Assumptions

a. Normality Test

Tabel 2. Model Normality Test result

Statistik Uji	Nilai
Jarque-Bera (JB)	1.1740
Chi-Square (df = 2)	1.1740
Probabilitas (p-value)	0.5559

Source: Stata data analysis results (2026)

The normality test was conducted using the Jarque-Bera test to determine whether the residuals of the regression model are normally distributed. The test results show a Jarque-Bera value of 1.1740 with a probability value (p-value) of 0.5559. Since the probability value is greater than the 5% significance level (0.05), the residuals are normally distributed. Therefore, the normality assumption of the regression model is satisfied.

b. Heteroscedasticity Test

Tabel 3. Model Heteroscedasticity Test result

Statistik Uji	Nilai
Chi-Square (χ^2)	13.85
df	20
Prob > χ^2	0.8383

Source: Stata data analysis results (2026)

The heteroscedasticity test was performed using White's test. The results indicate a Chi-Square value of 13.85 and a probability value of 0.8383. Since the probability value exceeds the 5% significance level (0.05), the regression model does not exhibit heteroscedasticity. This finding indicates that the variance of the error terms is constant (homoscedastic), and the model satisfies the homoscedasticity assumption.

c. Multicollinearity Test

Tabel 4. Model Multicollinearity Test result

Variabel	VIF	Tolerance (1/VIF)
PDRB Pertanian	3,25	0,3075
KUR	3,22	0,3106
Pengirpom	1,43	0,7012
ITP	1,38	0,7241
Curah Hujan	1,10	0,9099
Mean VIF	2,08	-

Source: Stata data analysis results (2026)

The multicollinearity test results show that all independent variables have Variance Inflation Factor (VIF) values below the critical threshold of 10 and tolerance values greater than 0.10. Specifically, the VIF values range from 1.10 to 3.25, with a mean VIF of 2.08. These results indicate that there is no multicollinearity problem among the independent variables included in the regression model.

3. Panel Data Regression Model Estimation

The best panel data regression model used in this study is the Cammon Effects Model (CEM). The following is a summary of the estimation results from this model.

Tabel 5. Model Result Model

Variable	Coefficient	Standard Error	t-Statistic	p-value
C	51.85338	2.504278	20.71	0.000
FA (Rainfall)	0.0009654	0.0003117	3.10	0.004
KUR	-0.000000153	0.0000000746	-2.06	0.049
PIP	0.0010266	0.0006121	1.68	0.104
ITP	-0.0382874	0.0188571	-2.03	0.052
AGRDP	0.0000587	0.00000750	7.83	0.000
R-squared	0.8461			
Adjusted R-squared	0.8196			
F-statistic	24.07			0.000

Source: Stata data analysis results (2026)

Based on the statistical output in Table 4, the estimated regression equations are as follows:

$$PP_{it} = 51.85338 + 0.0009654 FA_{it} - 0.000000153 KUR_{it} + 0.0010266 PIP_{it} - 0.0382874 ITP_{it} + 0.0000587 DRB Per._{it}$$

Based on the regression equation model, the analysis results can be interpreted as follows:

a. Konstanta

The constant value of 51.85338 indicates the estimated value of rice productivity when all independent variables, namely agroclimatic factors (rainfall), People's Business Credit (KUR), pump irrigation development, the Price Index Received by Farmers (IT), and Agricultural Gross Regional Domestic Product (AGRDP), are assumed to be zero. This value represents the baseline level of rice productivity before considering the effects of the explanatory variables.

b. Agroclimatic Factor (Rainfall)

The regression coefficient for rainfall is 0.0009654. This implies that a one-unit increase in rainfall (millimeters) increases rice productivity by 0.0009654 units, *ceteris paribus*. The positive coefficient indicates that adequate rainfall contributes positively to rice productivity.

c. People's Business Credit (KUR)

The regression coefficient for agricultural KUR is -0.000000153. This indicates that a one-unit increase in agricultural KUR disbursement decreases rice productivity by 0.000000153 units, holding other variables constant. The negative coefficient suggests that additional agricultural credit does not necessarily translate into higher rice productivity.

d. Pump Irrigation Development (PIP)

The regression coefficient for pump irrigation development is 0.0010266. This means that a one-unit increase in pump irrigation development increases rice productivity by 0.0010266 units, *ceteris paribus*. The positive coefficient indicates that improvements in irrigation infrastructure tend to support rice productivity.

e. Price Index Received by Farmers (IT)

The regression coefficient for the Price Index Received by Farmers is -0.0382874. This implies that a one-unit increase in the farmer price index decreases rice productivity by 0.0382874 units, assuming other variables remain constant. The negative coefficient indicates an inverse relationship between the farmer price index and rice productivity.

f. Agricultural Gross Regional Domestic Product (AGRDP)

The regression coefficient for Agricultural GRDP is 0.0000587. This means that a one-unit increase in Agricultural GRDP increases rice productivity by 0.0000587 units, *ceteris paribus*. The positive relationship suggests that stronger agricultural economic performance contributes to higher rice productivity.

4. Coefficient of Determination

Based on the estimation results, the R-squared value is 0.8461, indicating that approximately 84.61 percent of the variation in rice productivity can be explained by rainfall, agricultural KUR, pump irrigation development, the Price Index Received by Farmers, and Agricultural GRDP. The remaining 15.39 percent is explained by other variables outside the scope of this study. The Adjusted R-squared value is 0.8196. This result indicates that, after adjusting for the number of explanatory variables included in the model, approximately 81.96 percent of the variation in rice productivity is explained by the independent variables, while the remaining 18.04 percent is attributable to factors not included in the model.

5. Hypothesis Test

a. F-Test

The F-test produced an F-statistic value of 32.11 with a probability value of 0.0000. Since the probability value is lower than the 5 percent significance level ($0.0000 < 0.05$), the null

hypothesis is rejected. This finding indicates that rainfall, agricultural KUR, pump irrigation development, the Price Index Received by Farmers, and Agricultural GRDP jointly have a significant effect on rice productivity in Java Island.

b. t-Test

The t-test is employed to examine the partial effect of each independent variable on rice productivity. The interpretation of each variable is presented as follows :

a. FA (Rainfall)

The rainfall variable has a coefficient value of 0.0009654 with a probability value of 0.004. Since the probability value is less than 0.05, rainfall has a positive and significant effect on rice productivity. Therefore, the hypothesis stating that rainfall affects rice productivity is accepted.

b. Agricultural KUR

The agricultural KUR variable has a coefficient value of -0.000000153 with a probability value of 0.049. Since the probability value is less than 0.05, agricultural KUR has a negative and significant effect on rice productivity. Therefore, the hypothesis stating that agricultural KUR affects rice productivity is accepted.

c. Pump Irrigation Development

The pump irrigation development variable has a coefficient value of 0.0010266 with a probability value of 0.104. Since the probability value is greater than 0.05, pump irrigation development has a positive but statistically insignificant effect on rice productivity. Therefore, the hypothesis stating that pump irrigation development affects rice productivity is rejected.

d. Price Index Received by Farmers (IT)

The Price Index Received by Farmers variable has a coefficient value of -0.0382874 with a probability value of 0.052. Since the probability value is less than the 10 percent significance level, this variable has a negative and significant effect on rice productivity at the 10 percent significance level. Therefore, the hypothesis stating that the farmer price index affects rice productivity is accepted at the 10 percent level of significance.

e. Agricultural Gross Regional Domestic Product (AGRDP)

The Agricultural GRDP variable has a coefficient value of 0.0000587 with a probability value of 0.000. Since the probability value is less than 0.05, Agricultural GRDP has a positive and significant effect on rice productivity. Therefore, the hypothesis stating that Agricultural GRDP affects rice productivity is accepted.

The following is a discussion of the research results:

1. The Effect of Rainfall on Rice Productivity

Rainfall contributes to rice productivity by ensuring adequate water availability throughout the crop growth cycle. Sufficient rainfall supports physiological processes such as nutrient absorption, tillering, and grain filling, thereby improving productivity. This finding is consistent with the Cobb-Douglas production theory, which emphasizes the role of natural resources as important production inputs in agricultural output. Previous studies by Aditya et al. (2021) and Azizah et al. (2021) similarly found that rainfall positively influences rice productivity in Indonesia.

4. The Effect of Agricultural KUR on Rice Productivity

Agricultural People's Business Credit (KUR) does not necessarily improve rice productivity unless the financing is effectively allocated for productive farming activities. Access to credit alone is

insufficient if farmers do not utilize the funds for purchasing quality inputs or adopting agricultural technologies. This finding supports the Cobb-Douglas production framework, which highlights that capital contributes to output only when efficiently combined with other production factors. Similar results were reported by Ayal et al. (2024), who found that agricultural credit may have limited or even adverse effects on farm productivity when misallocated.

3. The Effect of Pump Irrigation Development on Rice Productivity

Pump irrigation development plays an important role in maintaining water availability, particularly during dry seasons and climate-related shocks. However, its contribution to rice productivity depends on consistent implementation and effective utilization. Fluctuations in irrigation development programs across provinces may limit their productivity-enhancing effects. Studies by Cui et al. (2022) and Trinugroho et al. (2024) suggest that irrigation infrastructure alone is insufficient to improve agricultural productivity without complementary investments in technology adoption, institutional support, and farmer capacity building.

4. The Effect of the Farmers' Terms of Trade Price Index (IT) on Rice Productivity

Changes in the Farmers' Terms of Trade Price Index do not always translate into higher rice productivity. Higher prices received by farmers may reflect supply shortages caused by declining production rather than improvements in agricultural performance. According to Nerlove's Supply Response Theory, farmers' production decisions are influenced by price incentives but are constrained by factors such as land availability, capital, technology, and climatic conditions. Therefore, price incentives alone may not immediately increase productivity. This finding is consistent with Triwidia et al. (2024), who emphasize that agricultural productivity is also determined by the availability and efficiency of production inputs.

5. The Effect of Agricultural GRDP on Rice Productivity

Agricultural Gross Regional Domestic Product (GRDP) reflects the economic capacity of the agricultural sector to support production activities through investment, infrastructure, and technological development. Higher agricultural GRDP enhances farmers' access to productive resources and strengthens agricultural performance, ultimately contributing to increased rice productivity. This finding aligns with the Cobb-Douglas production theory, which posits that improvements in production inputs and economic capacity positively affect agricultural output. Previous studies by Musyarrofah et al. (2025) found that agricultural economic growth contributes positively to improvements in agricultural productivity through increased investment and technological development. Similarly, Susanti et al. (2021) reported that regions with stronger agricultural sector performance tend to achieve higher productivity levels due to better resource allocation and production efficiency. These findings indicate that strengthening the agricultural sector's economic performance plays an important role in enhancing rice productivity.

CONCLUSION

Based on the panel data analysis, rice productivity in Java Island during 2018–2024 is influenced by both agroclimatic and economic factors. Rainfall and agricultural GRDP positively contribute to increasing rice productivity, indicating the importance of water availability and agricultural sector performance in supporting rice production. In contrast, agricultural KUR and the Farmers' Terms of Trade Index (It) exhibit a negative relationship with rice productivity, suggesting that financing schemes and price incentives do not necessarily translate into productivity gains when they are not effectively utilized or are influenced by market dynamics. Meanwhile, pump irrigation development has not yet demonstrated a significant contribution to rice productivity during the study period. The findings imply that efforts to improve rice productivity in Java Island should focus on strengthening water resource management, enhancing the effectiveness of agricultural financing programs, and improving agricultural infrastructure utilization. In addition, policies that support

investment, technology adoption, and the overall performance of the agricultural sector are necessary to achieve sustainable increases in rice productivity.

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