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The Effect of Agricultural Infrastructure Policies on Rice Production in Indonesia

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Abstract

The purpose of this study is to analyze how government policies related to agricultural facilities and infrastructure have an impact on rice production in Indonesia. This study uses panel data from 34 provinces in Indonesia observed for 8 years from 2015 to 2022. Maximum Likelihood (M) Robust Least Square Method (RLS) regression method was used in this study. The results showed that all variables studied, namely extension, irrigation development, reservoir development, tractor assistance, and subsidized fertilizer, had a positive impact on rice production in Indonesia. Therefore, to achieve food security and improve the economy of farmers, the government must continue and develop these agricultural policies.

Keywords *policy implementation, agriculture, productivity, infrastructure*

INTRODUCTION

Every country tries to achieve economic growth with equal distribution of welfare. In addition to high growth rates, the people's economy is also expected to increase. Economic growth is inseparable from the increase in output per capita or the production of goods and services in a particular area within a certain period of time. Likewise Indonesia, the government has made various efforts to increase the GDP figure which is one of the instruments of a country's economic growth.

The agricultural sector is one of the main sectors that support the Indonesian economy. (Silvia et al., 2023) stated that Indonesia is an agricultural country with the main source of income from the agricultural sector. According to (Meyer, 2019), the agricultural sector plays a much larger role in economic growth and development in developing countries including Indonesia. In Indonesia, food crops, horticulture, plantations, livestock, hunting and agricultural services, forestry and logging, and fisheries are subsectors of the agricultural sector (Ernawati et al., 2021).

In addition to contributing to GDP, the agricultural sector is important because it absorbs a large number of workers and is the main source of food production. This can support the national food security program and the sustainable development agenda. Therefore, there needs to be support and efforts from various parties to support agriculture, especially from the Government. In an effort to increase agricultural production, the government through the Directorate General of Agricultural Infrastructure and Facilities (Ditjen PSP) of the Ministry of Agriculture continues to develop and strengthen policies that encourage the growth of the agricultural sector. Some of the government's policies to support agriculture include extension, agricultural water supply, agricultural tools and machinery assistance and fertilizer subsidies.

In fact, rice production has shown a decline despite the government's various policies. Indonesia's rice production reached more than 81 million tons in 2017. However, production dropped drastically to 59 million tons in 2018, and since then there has been no significant increase. This inevitably raises questions about why rice production has drastically decreased since 2018 while government policies such as subsidized fertilizer allocations have increased. Therefore, it is very important to conduct research related to government policies in the field of agricultural infrastructure to find out whether these policies are right on target and have an effect on increasing production.

Research on the relationship between government policies and agricultural production has often been conducted, but most of them use the same method, namely using Ordinary Least Square (OLS) regression analysis with primary data, so that the analysis carried out is limited to the number of policy inputs with a smaller area. The renewal in this study is to use more production factor inputs as well as the use of a different regression method, namely Robust Least Square (RLS).

LITERATURE REVIEW

According to (Beattie & Taylor, 1996), production is the process of combining and organizing materials and forces in the form of inputs, factors, resources, or production services to produce goods or services. Producers can convert inputs into outputs by using various kinds of labor, capital, and production equipment (Pide, 2014). According to Nicholson & Snyder (2017), the Cobb-Douglas production function is one of the most commonly used production functions. The mathematical equation is as follows:

$q = f(k,l) = A.\, k^{\alpha}.\, l^{\beta}$ which is linearized into $Ln\ q = Ln\ A + \alpha\ Ln\ k + \beta\ Ln\ l$

Where, q is output (amount of production), k is capital, l is labor, A is the coefficient of production and α, β are elasticity values. This production function can be adjusted to the number of input variables required under different conditions (Debertin, 2012).

Previous research found that the production factors of extension, irrigation, embung, tractor and fertilizer can increase production. Effective extension can increase technology adoption and rice yields (Nakano, 2023). Farmers can increase yields through extension due to technology transfer and training (Panupong et al., 2018). The results of research by Sary et al. (2023) concluded that seed quality and increased use of irrigation infrastructure greatly influenced the increase in rice yields. According to Ariska (2022), farms in areas with irrigation generate more income than farms in areas without irrigation. According to Nardi et al. (2021), land, labor, and embung (reservoir) contribute to increasing rice production. According to the research results of Herdiansyah et al. (2023), tractor use has a positive effect on rice production. Magezi et al. (2022) found that tractor use increased planting in rows which resulted in better rice yields than manual labor. According to Jin et al. (2002), balanced fertilization can increase rice production and farmers' income. Through balanced fertilizer use and proper water management can support sustainable agriculture (Lina et al., 2022).

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METHOD

Because it uses numbers and data, this research is a quantitative research with data from 34 provinces in Indonesia from 2015 to 2022. The data used is secondary data obtained from the Directorate General of Agricultural Infrastructure and Facilities (Ditjen PSP), the Agricultural Extension and Human Resource Development Agency (BPPSDMP) and the Central Statistics Agency (BPS). The production function analyzed in this study is:

$$Ln\ RP_{it} = \alpha + \beta_a\ Ln\ EX_{it} + \beta_b\ Ln\ IR_{it} + \beta_c\ Ln\ RS_{it} + \beta_d\ Ln\ TR_{it} + \beta_e\ Ln\ SF_{it} + \varepsilon_{it}$$

Where RP is the amount of rice production (tons), EX is the number of Agricultural Extension Centers (units), IR is the number of tertiary irrigation and pumps (units), RS is the number of reservoirs (units), TR is the amount of tractor assistance, SF is the amount of subsidized fertilizer types Urea, SP36, NPK and ZA (tons).

In the OLS method analysis, model selection is done by Chow, Hausman and Langrange Multiplier tests. In order to be the Best Linear Unbiased Estimator (BLUE), it is necessary to test the classical assumptions on the OLS model. All required classical assumptions must be met for OLS to be the best estimator. If any assumptions are not met, the resulting regression model will be ineffective and inaccurate (Zahriyah et al., 2021). One of the reasons classic assumptions are not met is the presence of outliers in the data. Outliers are values that are very different from other values in the data set that can affect the results of the analysis (Efgivia, 2024). Because outliers often provide information that other observations do not, outliers should not simply be removed (Hasanah, 2012).

For these conditions, a regression method that is robust to the presence of outlier data is required. When the residual distribution is not normal or there are some outliers affecting the model, Robust Least Square (RLS) regression method can be used as an alternative analysis method. Although this regression analysis does not make the residuals normal, the model created by RLS is more accurate than the OLS model (Hidayatulloh et al., 2015). In robust regression, there are five estimator approaches, namely maximum likelihood (M) estimation, least median of square (LMS) estimation, least trimmed square (LTS) estimation, scale (S) estimation, and MM estimation. M estimation is the most commonly used among these approaches because it is more effective in dealing with outliers (Siswanto, 2017). The following is a comparison of the OLS and RLS weighting functions of Huber's M estimation (Pradewi & Sudarno, 2012):

a. OLS, $w(ei)=1$

b. RLS Huber, $w(ei) = \begin{cases} 1, & untuk |ei| \leq 1.345 \\ \frac{1.345}{|ei|}, & untuk |ei| > 1.345 \end{cases}$

where ei is the residual (y_i - $\hat{y}_i$), and the values 1.345 is a tuning constant.

According to Widodo & Dewayanti (2016), the OLS method parameter estimation is better than the M-estimation robust regression method for data without outliers. Conversely, for data with outliers, the parameter estimation of the M-estimation robust regression method is better than the OLS method.

Descriptive Statistics

Descriptive statistics are statistical techniques that summarize data by providing an overview of the characteristics of the data set. All the data collected in this study have a mean value greater than the standard deviation, which means that the deviations are not large and that the distribution of the data is even.

Table 1. Descriptive statistics

	Ln RP	Ln EX	Ln IR	Ln RS	Ln TR	Ln SF
Mean	13.109	4.762	4.436	2.051	5.325	10.902
Median	13.429	4.856	4.585	2.303	5.652	11.136
Maximum	16.428	6.380	8.733	5.591	9.023	14.669
Minimum	6.230	1.946	0.000	0.000	0.000	0.000
Std. Dev.	2.093	0.938	1.762	1.269	1.913	2.280
Observations	272	272	272	272	272	272

Source: Estimated Result (2024)

OLS Model Selection Test

The Chow, Hausman, and Lagrange Multiplier tests are the three stages of testing used to select the best model.

Table 2. OLS Model Selection Test Results

Test	Effect Test	Statistic	d.f.	Prob.
Chow Test	Cross-section Chi-square	602.6970	33	0.0000
Hausman Test	Cross-section random	62.6663	5	0.0000
LM Test	-			

Source: Estimated Result (2024)

Based on Table 2, the Prob. Cross-section Chi-square is smaller than alpha α (0.0000 <0.05) meaning that the Fixed Effect Model model is better. The next test is the Hausman Test which also shows the prob value on the Cross-section random is smaller than alpha α (0.0000 <0.05), meaning that the Fixed Effect Model model is better. The Langrange Multiplier (LM) test is no longer performed because the results of the Chow Test and Hausman Test have confirmed that the Fixed Effect Model (FEM) model is the best model.

OLS Classical Assumption Test

The Normality Test results indicate that the residual value of the regression model has a normal distribution. This is evident from the Probability Jarque-Bera value of 0.287 which is greater than the alpha significance level α (prob> 0.05). The results of the normality test can be seen in Figure 1.

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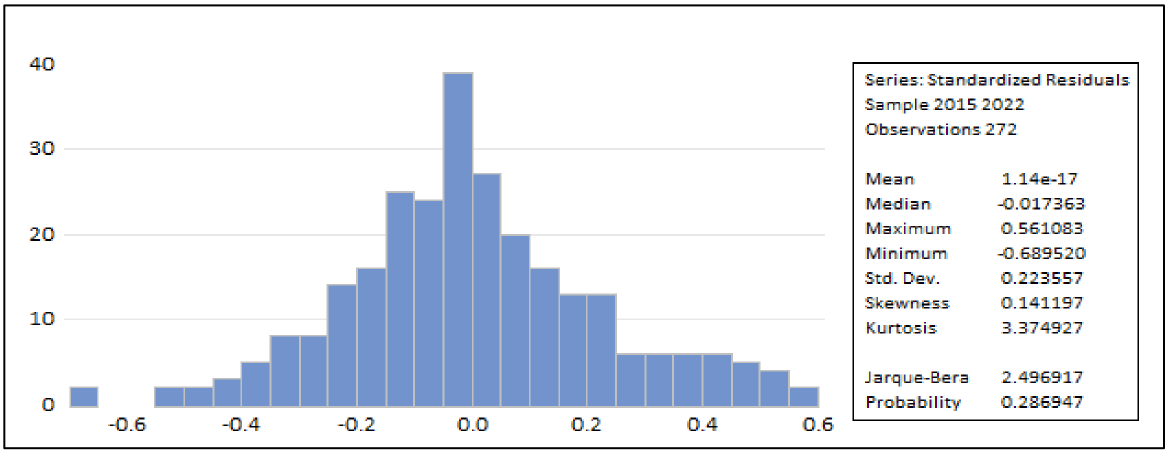


Source: Estimated Result (2024)

Figure 1. Normality Test Results

The correlation test results in Table 3 show that the correlation value between independent variables is smaller than 0.85 so it can be concluded that there are no symptoms of multicollinearity.

Table 3. Multicollinearity Test Results

	Ln EX	Ln IR	Ln RS	Ln TR	Ln SF
Ln EX	1.0000				
Ln IR	0.7513	1.0000			
Ln RS	0.5414	0.2931	1.0000		
Ln TR	0.7029	0.6388	0.4199	1.0000	
Ln SF	0.8453	0.7665	0.5084	0.6885	1.0000

Source: Estimated Result (2024)

The heteroscedasticity test results shown in Table 4 explain that there are still variables that are statistically significant to the absolute residuals as indicated by the probability value that is smaller than alpha α (Prob. <0.05). It can be concluded that there are symptoms of heteroscedasticity in the model.

Table 4. Heteroscedasticity Test Results

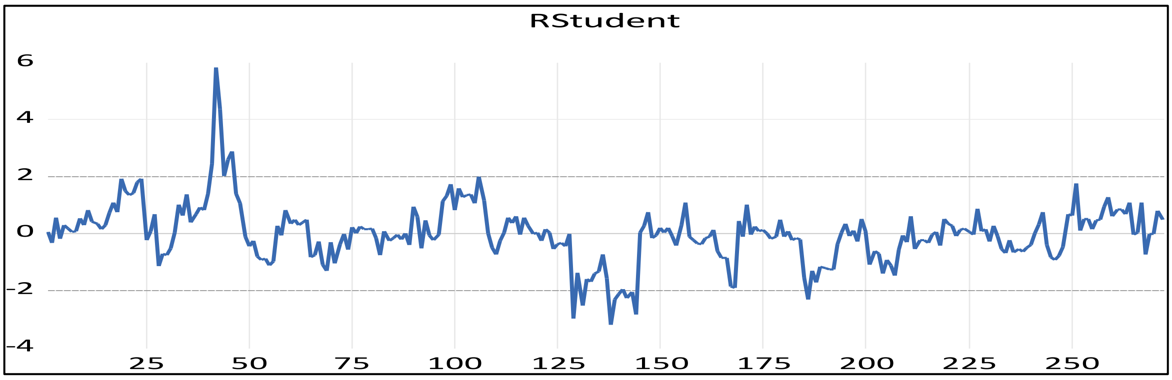
Variable	Coeffisient	Prob.
C	-0.2452	0.7130
Ln EX	-0.0452	0.7165
Ln IR	-0.0061	0.4954
Ln RS	0.0106	0.2108
Ln TR	0.0204	0.0009
Ln SF	0.0482	0.0479

Source: Estimated Result (2024)

The results of the classical assumption test show that there are still criteria that have not been met, namely the heteroscedasticity test, so it can be concluded that the Ordinary Least Squares (OLS) regression results are not the best estimation model.

Outlier Data Test

From Figure 2, it is known that there are still observations that are outliers characterized by R-student values greater than 2 or smaller than -2.



Source: Estimated Result (2024)

Figure 2. Outlier Data Test Results

From the tests conducted previously, it is concluded that the Robust Least Square (RLS) regression analysis method is better to use because the classical assumptions of the OLS model are not met and the model contains outliers. The results of the Huber weighted RLS regression are shown in Table 5.

Table 5. RLS Regression Results

Variable	Coeffisient	Prob.	
C	3.4351	0.0000	***
Ln EX	0.3315	0.0000	***
Ln IR	0.1631	0.0000	***
Ln RS	0.0645	0.0389	**
Ln TR	0.1440	0.0000	***
Ln SF	0.5928	0.0000	***
Rw-squared/Adjusted Rw-squared		0.9256	

Based on the parameter significance test shown in Table 5, it is known that Extension (Ln EX) has a coefficient of 0.3315 with Prob. α of 0.0000 <0.05; Irrigation Development (Ln IR) has a coefficient of 0.1631 and Prob. α of 0.0000 < 0.05; Embung Development (Ln RS) has a coefficient of 0.0645 with Prob. α of 0.0389 < 0.05; Tractor Assistance (Ln TR) has a coefficient of 0.1440 and Prob. α of 0.0000 < 0.01; and Fertilizer subsidy (Ln SF) has a coefficient of 0.5928 and Prob. α of 0.0000 < 0.01. So it can be concluded that all input variables studied, namely extension, irrigation development, reservoir development, tractor

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assistance and subsidized fertilizer, have a positive effect on Rice Production at the 95% significance level.

CONCLUSION

Based on the research results conclusions were obtained are all independent variables namely extension, irrigation development, embung development, tractor assistance and subsidized fertilizer have a significant positive effect on rice production in Indonesia. In addition to the variables studied, there are many other factors that affect rice production characterized by a significant positive coefficient (C).

For policies on extension, irrigation development, embung development, tractor assistance and subsidized fertilizers need to be continued and improved because they have a positive effect on rice production. In addition, because this research is still very limited both from the scope and methods used, it is therefore recommended to future researchers to conduct similar research using different analytical methods or the use of other production factor variables.

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