

Analysis of the Influence of Subsidized Fertilizer Availability, Land Area Per Capita and Agricultural Labor on Rice Productivity in Madiun Regency

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Abstract

This study aims to analyze the effects of subsidized fertilizer availability, land area per capita, and agricultural labor on rice productivity in Madiun Regency during the 2015–2024 period. The study employed a quantitative approach using secondary time-series data obtained from the Central Bureau of Statistics and related institutions. Data analysis was conducted using multiple linear regression with the assistance of EViews 12 software. Before estimating the regression model, classical assumption tests were carried out, including normality, autocorrelation, multicollinearity, and heteroscedasticity tests. The results indicate that partially, subsidized fertilizer and land area per capita do not have a significant effect on rice productivity. Meanwhile, agricultural labor has a significant negative effect on rice productivity. Simultaneously, all independent variables significantly affect rice productivity in Madiun Regency. The coefficient of determination value of 0.728532 indicates that 72.85% of the variation in rice productivity can be explained by subsidized fertilizer, land area per capita, and agricultural labor, while the remaining percentage is influenced by other factors outside the research model. These findings suggest that improving rice productivity cannot rely solely on the availability of production factors, but also requires more effective farm management, improved human resource quality, and the implementation of more efficient and appropriate agricultural technology.

INTRODUCTION

The agricultural sector is one of the strategic sectors in regional economic development, especially in maintaining food security, improving community welfare, and absorbing labor. According to Soekartawi (2003), agricultural activities are a production process that combines various production factors such as land, labor, capital, and technology to produce agricultural output, where the success of the process can be measured through the level of productivity achieved. In Indonesia, the food crop subsector, especially rice, still has a very important role because it is the main source of food for most people. Rice is also a strategic commodity that determines the stability of national food security, so increasing its productivity is a major concern in the development of the agricultural sector (Dini, 2023).

Madiun Regency as one of the agricultural areas in East Java Province has considerable agricultural potential, especially in rice commodities. The availability of large rice fields and the support of a relatively adequate irrigation system make this area have a fairly high rice production capacity. However, rice productivity in Madiun Regency still fluctuates from year to year. Based on data from the Central Statistics Agency (BPS), rice productivity increased in the 2015–2021 period, then decreased in 2022, and increased again in the 2023–2024 period. This condition shows

that the increase in rice productivity has not been stable and is still influenced by various production factors, both technical and non-technical. These productivity fluctuations indicate that there are problems in the management of agricultural production factors that can affect the efficiency and sustainability of rice farming businesses in Madiun Regency.

One of the important factors that is suspected to affect rice productivity is the availability of subsidized fertilizers. Fertilizers have an important role in supporting plant growth because they contain nutrients needed by plants to increase production yields. Therefore, the government provides subsidized fertilizer programs to help farmers obtain fertilizer at a more affordable price while supporting increased agricultural productivity. According to Rigi et al. (2019), subsidized fertilizers are a means of agricultural production whose procurement and distribution receive government subsidy assistance to meet the needs of farmers and farmer groups. However, the implementation of the subsidized fertilizer program in the field still faces various obstacles, such as distribution delays, inaccuracy of recipient targets, and limited amounts of fertilizer available. This condition causes the effectiveness of subsidized fertilizers in increasing rice productivity to not run optimally.

In addition to subsidized fertilizers, per capita land area is also an important factor that affects agricultural productivity. Land area per capita reflects the average ownership of agricultural land by each worker or farmer. The larger the land area managed, the greater the need for production facilities and labor so that it can affect the level of production and income of farmers (Sembiring et al., 2022). However, in recent years, the per capita land area in Madiun Regency tends to decline due to the increase in the population and agricultural workforce which is not balanced by the increase in the area of rice fields. In addition, the conversion of agricultural land into residential, industrial, and infrastructure development has also led to a decrease in agricultural productive land (Ayu, 2022). As a result, the average land tenure by farmers becomes increasingly limited so that it can affect the efficiency and productivity of rice farming businesses.

Another factor that also affects rice productivity is agricultural labor. Agricultural labor is human resources who are directly involved in cultivation activities, ranging from land cultivation, plant maintenance, to the harvesting process. The existence of a productive workforce is one of the indicators of the success of agricultural sector development because it is related to the ability to increase production and farming efficiency (Juswandi, 2023). However, the agricultural sector currently faces various challenges, such as low levels of education of the workforce, lack of ability to operate agricultural technology, and reduced interest of the younger generation to work in the agricultural sector. This condition has the potential to reduce the efficiency of farming activities and hinder the increase in rice productivity.

Some previous studies have shown that agricultural production factors have different influences on rice productivity. Research by U Maman (2021) explains that the realization of subsidized fertilizers, especially Urea and NPK fertilizers, is able to increase the productivity of paddy fields through meeting the needs of plant nutrients. Laim's research (2022) shows that the productivity of rice farming is influenced by capital, seeds, land area, labor, fertilizers, and pesticides. Ardhiansyah (2024) found that rice productivity in East Java is influenced by land area and population, while rainfall and fertilizer prices do not have a significant influence. Furthermore, Klau (2025) explained that rice field productivity is influenced by land area, seeds, and fertilizers, while the workforce has not been able to increase production optimally. Olivia Vivilianty Titin Pekawolu's research (2022) also shows that land area and urea fertilizer have an effect on paddy rice production, while labor and several other production inputs have not had an optimal effect.

However, previous research still has some limitations. Most studies only use indicators of crop area or planting area and have not considered much land area per capita as an indicator of structural pressure in the agricultural sector. In addition, previous research was mostly carried out at the national and provincial levels so that it has not been able to describe the specific conditions of certain agrarian areas, including Madiun Regency. Therefore, this study has *novelty* by using the variable land area per capita as a structural indicator of the agricultural sector and using the latest data for the 2015-2024 period within the scope of Madiun Regency.

Based on this description, this study aims to analyze the influence of the availability of subsidized fertilizers, land area per capita, and agricultural labor on rice productivity in Madiun Regency, both partially and simultaneously. This study uses a quantitative approach with secondary data in the form of *a time series* obtained from the Central Statistics Agency and the Agriculture Office. The analysis was carried out using the multiple linear regression method with the help of the EViews 12 software. The results of this study are expected to provide empirical evidence regarding the factors that affect rice productivity as well as be a consideration in the formulation of more effective, targeted, and sustainable agricultural policies in Madiun Regency.

METHODS

This study applies a quantitative approach to determine the relationship between independent variables and bound variables. The data used is in the form of secondary data in the form of a *time series or time series* with an observation period of 2015–2024. The data in this study was obtained from official sources, such as the Central Statistics Agency and other related agencies. Rice productivity is used as a dependent variable. Meanwhile, the independent variables analyzed consisted of the availability of subsidized fertilizers, land area per capita, and agricultural labor. To analyze the relationship between these variables, this study used multiple linear regression method with the help of EViews 12 software. Before the estimation process is carried out, the regression model first passes several classical assumption tests. The tests include normality tests, autocorrelation tests, multicollinearity tests, and heteroscedasticity tests. This stage is important to do so that the model used really meets the basic requirements in regression analysis. Thus, the estimated results obtained can be more accurate, feasible to use, and do not lead to biased conclusions.

The regression model in this study is formulated as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e$$

Description:

Y = Rice Productivity	
X ₁ = Availability of subsidized fertilizer	
X ₂ = Land area per capita	
X ₃ = Agricultural workforce	β_0
= Constant	$\beta_1, \beta_2, \beta_3$
β_2, β_3 = Regression Coefficient	
e = Error term	

Hypothesis testing in this study was carried out using the t-test to analyze the influence of each independent variable individually. Furthermore, the F test is used to assess the influence of the overall independent variable on the dependent variable. The determination coefficient (R^2) is used to determine the extent to which the research model is able to explain changes or variations that occur in rice productivity.

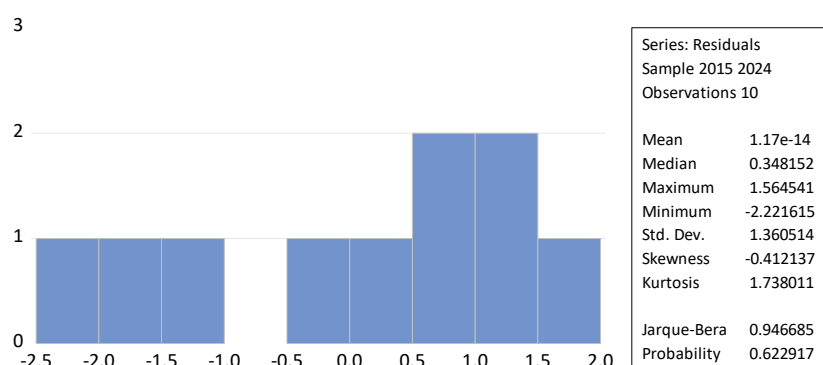
RESULTS AND DISCUSSION

1. Results

Normality Test

Testing of the residual distribution is carried out to ensure that the regression model does not deviate from the basic assumptions. In this study, the test was carried out using the Jarque-Bera (JB) approach through EViews software. The criteria used in this test are based on probability values, where the residual is declared to be normally distributed when the probability value exceeds the significance level of 0.05.

Table 1. Normality Test Results



Source: Eviews 12 data processing

Based on the results of data processing in Table 1, a probability value of 0.622917 was obtained. The value is above the pre-established significance limit from which the conclusion can be drawn that the residual in the model does not indicate a distribution deviation. The regression modeling used in uni has met the assumption of normality.

Autocorrelation Test

Autocorrelation testing aims to identify the presence of relationships between residuals at different periods in regression models. The interpretation of the test results is based on the Chi-Square probability value. If the probability value is less than 0.05, then the model is considered to have

autocorrelation. On the contrary, a value greater than the limit indicates the absence of autocorrelation issues.

Table 2. Autocorrelation Test Results

Breusch-Godfrey Serial Correlation LM Test:

Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.475582 Prob. F(2,3)	0.6616
Obs*R-squared	2.166572 Prob. Chi-Square(2)	0.3385

Source: Eviews 12 data processing

Based on the test results, the probability value was obtained at 0.3385. This value is above the significance level of 0.05, so it can be stated that the regression model does not show any symptoms of autocorrelation. Thus, the model used has fulfilled those assumptions and can be continued for the next stage of analysis. *Obs R – squared*

Multicollinearity Test

The analysis also takes into account the possibility of excessive relationships between independent variables that can affect the stability of the model. These indications are evaluated using the Variance Inflation Factor (VIF) value as the main measure. In general, a model is said to experience multicollinearity when the VIF value exceeds a certain threshold, which is 10. Conversely, if the VIF value is below this limit, then the relationship between the independent variables is still in the normal category and does not interfere with the model.

Table 3. Multicollinearity Test Results

Variance Inflation Factors Date: 04/16/26 Time:

23:07 Sample: 2015 2024

Included observations: 10

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	458.4994	1651.359	OR
X1	0.001145	23.19535	1.118289
X2	2890.825	714.6377	1.568116
X3	0.004794	375.5473	1.540537

Source: Eviews 12 data processing

All independent variables showed a relatively low centered value of VIF and did not exceed the critical limit. This indicates that there is no strong correlation between the free variables in the model. Thus, each independent variable can explain the dependent variable without the excessive influence of the other variables. This condition shows that the regression model is free from the problem of multicollinearity and is suitable for use in the next stage of analysis.

Heteroskedasticity Test

The heteroscedasticity test was performed to confirm whether the residual values in the regression model had the same variance or not. In this study, heteroscedasticity testing used the Glejser test. The basis for decision-making is seen from the value of probability. If the probability value obtained is greater than 0.05, then the regression model can be said to be free of heteroscedasticity symptoms because the residual variance is stable. On the other hand, if the probability value is below 0.05, then there is an indication that the model has a heteroscedasticity problem. *Obs R – squared*

Table 4. Heteroscedasticity Test Results

Heteroskedasticity Test: Glejser			
Null hypothesis: Homoskedasticity			
	F-statistic	0.737759 Prob. F(3,6)	0.5669
	Obs*R-squared	2.694756 Prob. Chi-Square(3)	0.4411
Source: Eviews 12	Scaled explained SS	0.988169 Prob. Chi-Square(3)	0.8041

data

processing

The test results resulted in a probability value of 0.4411 which was above the threshold of 0.05, so the residual variation could be considered stable. This condition indicates that there is no heteroscedasticity disturbance in the model, so the estimation results are still suitable as a basis for further analysis.

Multiple Linear Regression Analysis

The multiple linear regression approach was used in this study to evaluate the relationship between independent variables and rice productivity as dependent variables. In addition to measuring the

degree of influence of each variable, this model also provides an overview of the direction of the relationships formed in the analyzed system.

Table 5. Multiple Linear Regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	92.21201	21.41260	4.306437	0.0051
X1	0.017458	0.033837	0.515929	0.6244
X2	-4.264831	53.76639	-0.079322	0.9394
X3	-0.216883	0.069238	-3.132405	0.0203
R-squared	0.728532	Mean dependent var		60.45300
Adjusted R-squared	0.592799	S.D. dependent var		2.611224
S.E. of regression	1.666283	Akaike info criterion		4.148242
Sum squared resid	16.65899	Schwarz criterion		4.269276
Log likelihood	-16.74121	Hannan-Quinn crister.		4.015468
F-statistic	5.367364	Durbin-Watson stat		2.023056
Prob(F-statistic)	0.039033			

Source: Eviews 12 data processing

Based on these results, the regression model can be formulated as follows:

$$PP(Y) = 92.21201 + 0.017458X1 + -4.264831X2 + -0.216883X3 + e$$

Coefficient of Determination Test (R²)

The model's ability to explain changes in rice productivity can be known from the value of the determination coefficient or R². This value shows how much the independent variable in the study is able to explain the variation that occurs in the bound variable. Based on the estimated results, the R² value obtained is 0.728532. This means that the variables of subsidized fertilizers, land area per capita, and agricultural labor were able to explain the change in rice productivity by 72.85%. Meanwhile, the rest were influenced by other factors beyond the variables used in this research model.

Table 6. Determination Coefficient Test Results (R²)

R-squared	0.728532
Adjusted R-squared	0.592799

Source: Eviews 12 data processing

There are still around 27.15% of changes in productivity that are influenced by other variables outside the model used. On the other hand, the Adjusted R^2 of 0.592799 reflects the capabilities of the model that have been adjusted for the complexity of the variables and the number of observations.

T test

The evaluation of the influence of each independent variable on rice productivity was carried out through a partial test. This approach allows the identification of the contribution of each variable separately in the regression model. Based on the estimated results in Table 7, it can be seen that the variables of subsidized fertilizer (X1) and land area per capita (X2) have probability values of 0.6244 and 0.9394, respectively. Both values were above the significance level of 0.05, thus showing that statistically they did not have a significant influence on rice productivity.

Table 7. Test Results t

Variable	t-Statistic	Prob.
C	4.306437	0.0051
X1	0.515929	0.6244
X2	-0.079322	0.9394
X3	-3.132405	0.0203

Source: Eviews 12 data processing

In contrast, the variable of agricultural labor (X3) shows a probability value of 0.0203 which is below the significance limit. Negative values carry an indication that the relationship is in the opposite direction. Thus, agricultural labor has been proven to have a significant influence with a negative direction on rice productivity *t – statistik*.

Test F

In addition to conducting partial testing, this study also analyzes the influence of independent variables together on dependent variables. This test aims to find out whether the regression model used can explain the relationship between variables simultaneously. Based on the test results shown in Table 8, an F-statistic value of 5.367364 with a probability value of 0.039033 was obtained. Because the probability value is smaller than the significance level of 0.05, it can be concluded that

the variables of subsidized fertilizers, land area per capita, and agricultural labor simultaneously affect rice productivity.

Table 8. F Test Results

F-statistic	5.367364
Prob(F-statistic)	0.039033

Source: Eviews 12 data processing

Although not all variables are significant individually, the combination of variables in the model remains able to explain the change in productivity. Therefore, the regression model used is considered relevant and can be used as a basis for further analysis.

DISCUSSION

The Effect of Subsidized Fertilizer Availability on Rice Productivity

The results of the study showed that the variable availability of subsidized fertilizer (X1) had a probability value of $0.6244 > 0.05$ so that it did not have a significant effect on rice productivity in Madiun Regency. These results show that the increase in the number of subsidized fertilizers has not been able to increase rice productivity optimally. This condition indicates that the success of increasing productivity is not only determined by the availability of fertilizers, but also influenced by the effectiveness of distribution and the accuracy of its use in farming activities.

Empirically, there are still various obstacles in the distribution of subsidized fertilizers at the farmer level, such as delays in distribution, mismatches in the allocation of needs, and limitations in the amount of fertilizer received by farmers. In addition, the use of fertilizers that are not in accordance with the dosage, soil conditions, and plant needs cause the nutrients provided to not be able to increase production to the maximum. This condition causes the effectiveness of subsidized fertilizers in increasing rice productivity to be less optimal.

The findings of this study are in line with the research of Ardhiansyah (2024) which states that the price and availability of fertilizers do not always have a significant influence on rice productivity because production results are more influenced by the effectiveness of managing other production factors. The research of Klau et al. (2025) also explains that the use of fertilizers is not necessarily able to increase productivity if it is not supported by agricultural management and the application of adequate cultivation technology.

Based on these results, increasing rice productivity in Madiun Regency is not enough only through the addition of subsidized fertilizers, but also requires improving the distribution system, increasing supervision of fertilizer distribution, education on the use of balanced fertilizers, and the application of more efficient agricultural technology so that the use of fertilizers can provide more optimal results.

The Effect of Per Capita Land Area on Rice Productivity

The results of the study showed that the variable land area per capita (X2) had a probability value of $0.9394 > 0.05$ so that it did not have a significant effect on rice productivity in Madiun Regency. These results show that the average amount of land tenure by agricultural workers has not been able to directly increase rice productivity.

Theoretically, a larger area of land should be able to increase agricultural production. However, in practice, productivity is not only determined by land area, but also influenced by the quality of land management, the use of technology, and the efficiency of using other production factors. A large land area does not necessarily produce high productivity if land management has not been carried out intensively and efficiently.

In addition, the condition of the conversion of agricultural land into residential, industrial, and infrastructure development has caused productive agricultural land to decrease. Land fragmentation due to the increase in population also causes the average agricultural land ownership to become narrower. This condition has the potential to reduce production efficiency and hinder the increase in rice productivity in Madiun Regency.

The results of this study are in line with the research of Olivia Vivilianty Titin Pekawolu (2022) which shows that the land area has not been able to increase production output optimally without the support of the use of appropriate production inputs. Research by Sembiring et al. (2022) also explains that land area is related to the need for labor and production facilities, but the effectiveness of land use remains the main factor in determining agricultural productivity.

Thus, increasing rice productivity not only requires expanding agricultural land, but also requires more effective land management through agricultural intensification, the application of modern cultivation technology, and the protection of sustainable agricultural land to reduce the impact of land conversion.

The Influence of Agricultural Labor on Rice Productivity

The results showed that the variable of agricultural labor (X3) had a regression coefficient of -0.216883 with a probability value of $0.0203 < 0.05$. These results show that agricultural labor has a negative and significant effect on rice productivity in Madiun Regency. Negative coefficient values indicate that an increase in the number of agricultural workers tends to be followed by a decrease in rice productivity.

This condition indicates that an increase in the number of workers is not automatically able to increase agricultural production. The low level of education, limited technical skills, and low ability of the workforce to operate modern agricultural technology can cause the efficiency of cultivation activities to decrease. In addition, the dominance of the elderly workforce and the low interest of the younger generation to work in the agricultural sector also affect the productivity of the agricultural workforce.

Under certain conditions, the increase in the number of workers that is not accompanied by an improvement in the quality of human resources can cause the production process to be less effective. This phenomenon shows a tendency *to diminish return to labor*, which is a condition when additional labor no longer provides a comparable increase in output, and can even reduce production efficiency. The accumulation of labor without a proportional division of labor causes the contribution of additional labor to the output to be smaller.

The results of this study are in line with the opinion of Juswandi (2023) who states that agricultural productivity is influenced by the quality of human resources, education level, age of the workforce, and the ability to use technology in farming activities. Therefore, increasing rice productivity in Madiun Regency not only requires a large number of workers, but also requires improving the quality of the workforce through training, skill development, regeneration of young farmers, as well as the implementation of agricultural mechanization and digitalization so that the efficiency and productivity of farming can increase.

CONCLUSION

Conclusion

Based on the results of the research that has been carried out, it can be concluded that rice productivity in Madiun Regency is influenced by various interrelated agricultural production factors. The results of the analysis showed that the variables of the availability of subsidized fertilizers and the land area per capita did not have a significant effect on rice productivity. This condition shows that the increase in rice productivity is not only determined by the availability of production facilities and the extent of land tenure, but also influenced by the effectiveness of farming management, the accuracy of the distribution of agricultural inputs, and the efficiency of the utilization of production factors at the farmer level.

Meanwhile, the variable of agricultural labor has a negative and significant influence on rice productivity in Madiun Regency. These results indicate that an increase in the number of workers will not necessarily be able to increase production output if it is not balanced with the quality of human resources, the ability to use agricultural technology, and the efficiency of cultivation activities. Therefore, the quality of agricultural labor is an important factor in supporting the increase in rice productivity.

Simultaneously, the variables of the availability of subsidized fertilizers, land area per capita, and agricultural labor have a significant effect on rice productivity in Madiun Regency. The determination coefficient value of 72.85% showed that the variation in rice productivity could be largely explained by these three variables, while the rest was influenced by other factors outside the research model.

This study emphasizes that increasing rice productivity does not only depend on the availability of production factors, but also requires more effective agricultural management, improving the quality of human resources, and applying more modern and efficient agricultural technology. In addition, this research also makes an empirical contribution to the development of agricultural economics studies, especially through the use of per capita land area indicators in analyzing rice productivity in agricultural areas.

ADVICE

Based on the results of the research, local governments are expected to increase the effectiveness of agricultural policies through improving the subsidized fertilizer distribution system so that it is more targeted and according to the needs of farmers. In addition, the protection of productive agricultural land needs to be strengthened to reduce the impact of land conversion that can reduce agricultural production capacity in Madiun Regency.

Improving the quality of agricultural human resources also needs to be a major concern through training, counseling, and mentoring programs related to the use of modern agricultural technology. The development of agricultural mechanization and digitalization is expected to be

able to increase the efficiency of farming while supporting the sustainable increase in rice productivity.

For further research, it is recommended to add other variables related to agricultural productivity, such as agricultural technology, irrigation quality, climatic conditions, and other environmental factors so that the results of the study can provide a more comprehensive picture of the factors that affect rice productivity.

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