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Cobb Douglas Production Function Analysis with Multiple Linear Regression Method on Rice Farming Business in East Java Province

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Rice production, area of harvest, agricultural labour, rainfall.

Abstract

One of the staple foods of the people of Indonesia besides corn is rice. East Java Province is a potential rice-producing area because most of its territory is an agricultural area. This makes the province continue to increase rice production for the continuity of Indonesia's food self-sufficiency, especially in the East Java region itself. This study aims to determine the effect of harvest area, agricultural labor, and rainfall on rice production in East Java Province during the period 2001-2021. The analysis used is the Cobb-Douglas production function with multiple regression analysis using the Eviews. The results showed that the harvest area and agricultural labor had a positive effect on rice production. Meanwhile, rainfall has no effect on rice paddy production.

1. INTRODUCTION

Indonesia's development and economy depend heavily on the agricultural sector. The majority of Indonesia's population live from farming. Therefore, the agricultural sector plays an important role in providing food, industrial raw materials, business opportunities, and means of earning a living for farmers. Rice is one of the agricultural products that is needed by the community. This is because rice is the main food crop for the Indonesian population. Several reasons why sustainable rice production is important are that rice is the staple food of the Indonesian people, is a valuable commodity for maintaining food security in rice farming, which has become part of the lives of Indonesian farmers, which has opened many jobs and businesses and rice contributes to household income. stairs (Hamdan, 2013) .

Rice plays an important role in meeting Indonesia's staple food needs. According to Kumalasari (2013) , the culture of rice consumption in Indonesian society is still high, even though 95% of countries have access to rice as a staple food and only 5% of countries have various staple foods other than rice. For the people of Indonesia, food (rice) is the most basic need, and must be met first before other needs to sustain life and make a living.

According to Suryana (2012) rice is one of the basic needs for Indonesia's food security because 80 percent of the population gets carbohydrates from rice which is almost evenly distributed throughout the country. In addition, poor households spend more than 30 percent of their income on rice, making it one of the most important sources of carbohydrates. Because most of the East Java region is agricultural, it has the potential to become a rice producing area. Table 1.1 describes the development of rice production.

Table 1.1 Rice Production in East Java Province in 2017-2021

Year	Rice Production (Tons)
2017	12432793
2018	10537922
2019	9580934
2020	9944538
2021	9789588

Source : BPS East Java, processed

Based on Table 1.1, rice production in East Java has decreased from year to year for the last five years. However, despite the declining trend in rice production, East Java is Indonesia's largest rice producer, producing 9.94 million tonnes in 2020 from 1.75 million hectares of cropland. Ngawi produced 818.62 thousand tonnes of rice, followed by Lamongan

804.82 thousand tonnes, Bojonegoro 690.08 thousand tonnes, Jember 620.32 thousand tonnes, and Banyuwangi 521.43 thousand tonnes. These ten regions are the top ten contributors to rice production in East Java. Then Tuban which produced 488.66 million tons, Madiun which produced 464.93 million tons, Nganjuk which produced 437.62 million tons, Ponorogo which produced 416.10. million tons, and Gresik which produced 375.06 million tons.

Meanwhile, rice production in East Java from January to December 2021 was 9.789 million tons, down 1.56 percent from 9.944 million tons in 2020. The highest rice production was in March 2021 with production of 2.19 million tons, seeing the lowest production, namely 0.30 million tons. The potential for rice production in several regions, including Lamongan, Bojonegoro and Ngawi Regencies, has decreased, resulting in a significant decline in rice production in 2021. According to BPS data, rice production fell by 0.40 million tonnes each (10.82 percent) and 0.22 million tonnes (10.44 percent) between the May-August 2021 and September-December 2021 subrounds compared to the same period in 2020.

Based on this background, researchers wanted to find out how much rice production in East Java Province between 2001 and 2021 was influenced by the production factors used in this study: harvested area, agricultural labor and rainfall.

2. LITERATURE REVIEW

2.1 Harvest Area

In terms of production factors, the conversion of agricultural land to the development of other sectors such as housing, offices, roads, hotels and malls has also reduced the availability of land as one of the production inputs. Land scarcity is affected by this condition (Putra & Nasar, 2015) . Planting area and production factors affect rice harvest area. Kalsim (2018) said that the community should understand and participate in efforts to promote a more stable planting area. For lowland rice, extension activities and PTT programs must be intensified and carried out with maximum community participation. Three months after planting, the harvested area has a positive correlation with the planted area. Conversely, the harvested area will also decrease three months after the planting area. Farmers will harvest a larger area in the next three months if their planted area is higher. One of the factors affecting production is land area. The amount of production will increase in proportion to the area of land. On the other hand, production will be lower if the land area is small (Onibala et al., 2017) .

Shaikh et al., (2016) found, through the use of *Ordinary Least Squares* (OLS) regression analysis, that rice productivity in Jaffarabad Balochistan District was affected by land area from 2008 to 2012. Harini et al., (2019) found that land area agricultural land area affecting rice production in North Kalimantan between 2011 and 2017 using *Ordinary Least Squares* (OLS) regression analysis.

2.2 Labor

Especially for seasonal farming, labor is one of the determining factors. Planting decreased due to lack of labor, which affected plant growth, productivity, and product quality (Nurmala, 2012) . Many economic and non-economic factors influence the shift of agricultural to non-agricultural labor. The study by the findings of Tocco et al., (2012) shows that (1) individual characteristics (age, education, experience, gender, marital status, and ethnicity) influence the decision to move jobs from the agricultural sector to the non-agricultural sector. (2) family characteristics (number of children, age of children, and family size); (3) characteristics of agricultural businesses (land holding area, farming area, agricultural products, farming systems, and agricultural productivity); (4) financial characteristics (non-work income, agricultural subsidies, social benefits, and irregular income); and (5) characteristics of location and labor market (labor absorption rate, access to

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work, population density, urbanization, and regional location).

Several previous studies, such as Rohman et al., (2022) found that land area, urea, ZA, manure, insecticides, labor, and rice production in Bancelok Village were all influenced by R/C ratio analysis and Cobb Douglas production function analysis. .

Jrengik District, Sampang District In Angkaes, Weliman District, Malacca Regency, land area and labor have had a significant effect on rice production from November 2015 to May 2016, according to Tou (2017) using OLS (*Ordinary Least Square) multiple regression analysis.*

2.3 Rainfall

One factor that greatly influences plant growth and production is water. The quantity of rainfall, the amount of irrigation, and the ability of the soil to hold water all have a significant effect on water availability. Plants can be harmed by too much or too little water. Crops suffer from water-stressed conditions caused by low and uneven rainfall. Increased vegetative damage, including delayed leaf opening, drying of young leaves, damage to green leaves, and damage to the entire crown, even in extreme conditions can be caused by a prolonged lack of water supply (Sinaga et al., 2017). Crop production is heavily affected by rainfall. Yields are strongly influenced by the total amount of rainfall (Anwar et al., 2015) .

3. RESEARCH METHODS

According to Joesron & Ftharrozi (2003) the extreme isoquant form of the Cobb Douglas production function is the form of that function. In their 1928 article entitled " *A Theory of Production* ," Cobb, CW, and Douglas introduced this production function. This equation can be used to represent the Cobb Douglas production function mathematically.

$$Q = AK^{\alpha}L^{\beta}$$

Where:

Q = outputs
K = capital inputs
L = labor input
A= technology efficiency/coefficient parameter
α = elasticity of capital input
β = labor input elasticity

The Cobb Douglas production function can be obtained by linearizing the equation to:

$$LnQ= LnA+\alpha LnK+\beta LnL+\varepsilon$$

Parameters of elasticity and input efficiency (A) can be easily obtained by regressing the equation. Therefore, the ability of the Cobb Douglas function to be easily made linear makes it easier to obtain, which is one of its conveniences (Joesron & Ftharrozi, 2003).

Associative research method used in this study. According to Joesron & Ftharrozi (2003) associative research aims to determine the relationship between two or more variables. Cobb-Douglas Multiple Linear Regression Analysis is the analytical tool used. The Cobb-Douglas function, whose equation is transformed into natural logarithms (Ln) due to differences in units of measurement between the independent variables in the equation, is the method used to determine the factors that affect rice production in East Java Province. from the following equation:

$$LnPP = Ln\beta_0 + \beta_1 LnTKP + \beta_2 LnLP + \beta_3 LnCH + \varepsilon$$

Where:

LnPP : variable natural log of Rice Production (Tons)
LnTKP : natural log of variable Agricultural Labor (Person)
LnLP : natural log variable Harvested Area (Ha)
LnCH : natural log variable natural log variable Rainfall (mm)
ε : Error term (Error Factor)
β_0 : Constant
$\beta_1 \cdots \beta_4$: Regression coefficient of the independent variable

Ordinary Least Square (OLS) is the model used in this study. The following additional tests were carried out to support the OLS results: a) Classical Assumption Testing consists of: Autocorrelation (Breusch Godfrey Test), heteroscedasticity (White Test), multicollinearity (VIF Test), and normality (Jarque-Bera test) b) The following is a test statistics: Coefficient of Determination (R2), Effect Validity Test (t test), and Model Goodness Test.

4. RESULTS AND DISCUSSION

4.1 Research result

a. Multicollinearity Test

The multicollinearity test is used to determine whether the independent variables in the regression model have a linear relationship or not. The model experiences multicollinearity if the VIF value is greater than 10. The model does not have a multicollinearity problem if the VIF value is less than 10. Table 1.2 displays the results of the multicollinearity test. When all the variables in the model have a VIF value of less than 10, there is no multicollinearity problem.

b. Heteroskeasticity Test

White's test will be used for the heteroscedasticity test. H_0 White test indicates that the estimated model has no heteroscedasticity problem; In addition, the estimated model presents a heteroscedasticity problem for $_{HA}$. Based on Table 1.2, the p value (p value), probability, or empirical statistical significance of White's test appears to be 0.1964 (> 0.10), so that H0 is $_{accepted}$. However, if the p-value (p-value), probability, or empirical statistical significance of White's test is less than H_0, then H_0 is rejected. The model comes to the conclusion that there is no problem with heteroscedasticity.

c. Autocorrelation Test

The Breusch Godfrey (BG) test will be used to measure autocorrelation. H_0 BG test shows that the estimated model does not have autocorrelation problems; The estimated model includes an autocorrelation for $_{HA}$. If the p-value (p-value), probability, or empirical statistical significance of the BG test is greater than H_0, then H_0 is accepted. Conversely, if the p value (p value), probability, or empirical statistical significance of the BG test appears to be 0.8321 greater than 0.10, then H0 is $_{rejected}$. The estimation model concludes that there is no autocorrelation.

d. Normality test

The Jarque Bera test (JB) will be used to determine the estimated residual normality of the model. The residual distribution of normal estimation of the model is represented by H_0 in the JB test; The distribution of estimated residual models has an abnormally high HA. If the p-value (p-value), probability, or statistical significance of JB is greater than H_0, then H_0 is accepted. Conversely, if the p value (p value), probability, or empirical significance of JB from Table 1.2 appears to be 0.574292 greater than 0.10, then H0 is $_{rejected}$. In conclusion, the residual distribution of the model is normal.

e. Test f

Model Existence Test The estimated model exists if all independent variables affect the dependent variable simultaneously (the estimated model regression coefficient is not simultaneously zero). The F test is used to determine whether there is an estimated model. the hypothesis is formulated as follows: H_0: (both the estimated model does not exist or the simultaneous regression coefficient is zero); HA $_:$ The estimated model or regression coefficient does not coincide with zero. $_{HA}$: The estimated model or regression coefficient does not coincide with zero. If the p-value (p-value), probability, or empirical statistical significance F >, H_0 will be accepted; If a p-value (p-value), probability, or empirical statistical significance of F is found, H_0 will be rejected. The p value (p value), probability, or empirical significance of the F statistic is 0.0000 (0.01), so H0 is rejected, as shown in Table 1.2. In conclusion, there are models.

Table 1.2 Econometric Model Estimation Results

LnPP = -11.50905 + 0.1620472 LnLP + (0.000)* 0.280325 LnTKP – 0.021652 LnCH (0.0289)** (0.6702)
R^2 = 0.929628 ; *DW-stat* = 1.7617195; *F-stats* = 74.85823; *Prob. F-stat* = 0.000000
Diagnostic Test 1. Multicoinearity (VIF) LP = 1.715754; TKP= 1.357193; CH= 1.319151 2. Residual Normality (Jarque-Bera) *JB (2)* = 1.19235; *Prob. JB (2)* = 0.574292 3. Autocorrelation (Breusch-Godfrey) χ^2 *(2)* = 0.367569; Prob. χ^2 *(2)* = 0.8321 4. Heteroscedasticity (White) χ^2 *(7)* = 9.864940; Prob. χ^2 *(7)* = 0.1964

Source: Eviews 9, edited.

Description: *Significant at α= 0.01; **Significant at α= 0.05; *** Significant at α= 0.10. The number in brackets is the empirical probability *(p value)* of the t-statistic.

Table 1.3 Influence Validity Test Results

Variable	Sig. t	Criteria	Conclusion
LP	0.0000	< 0.10	Significant
crime scene	0.0289	< 0.10	Significant
CH	0.6702	> 0.10	Not Significant

Source: Eviews 9, edited

f. t test

Test the Significance of the Effect of Independent Variables: Test the Validity of Influence The validity test of the effect tests the significance of the effect of the independent variables, either in whole or in part. Use the t test to determine the validity of the effect. The i-independent variable in the estimated model has no significant effect, according to the t H_0 $_{test}$; HA : The i-independent variable of the estimated model has a significant effect . If the p value, probability, or empirical statistical significance t is greater than; H0 will be accepted. If the value of pp(value), probability, or empirical t is statistically significant, H_0 will be rejected. Table 1.3 displays the findings of the effect validity test.

g. Interpretation of the Coefficient of Determination

The predictability of the estimated model is shown by the coefficient of determination (R^2). The estimated model has an R2 value of 0.929628, as shown in Table 1.2. This shows that the variables harvested area, agricultural labor, and rainfall contributed 92.96 percent of the variation in rice production variables. The remaining 7.04 percent is influenced by non-mode specific variables or factors.

4.2 Research Discussion

Discussion of the initial hypothesis which states that farmers will harvest from a wider area in the next three months, is supported by the finding that harvested area has a positive effect on rice production. One of the factors that influence production is land area. Production yields will increase in proportion to the area of land. Conversely, if the area of land is getting smaller, the production will decrease. This study supports the findings of Nizar & Ariyanto (2016) who found that rice production in Riau Province was affected by harvested area from 2005 to 2013. Fitri et al., (2021) found the same research that increases rice production in Aceh Province between 2021 and 2025 from harvested area.

This study found that agricultural labor had a positive and significant impact on rice production in East Java Province from 2001 to 2021. This is because adding labor will increase rice production.Because each step in the rice crop production process starts from processing land to caring for plants to harvesting the harvest requires more energy, an increase in the number of workers can increase the yield of rice produced in East Java Province. The rice production process also requires an increase in the number of workers at certain times, such as when removing old plants because if they are moved, their growth will be poor. In addition, there is an increase in labor required at harvest due to the possibility of grain germination if the rice plants are not harvested immediately. This is consistent with the findings of research conducted by Onibala et al., (2017) , who found various factors influencing rice production in Koya Selatan Village, Tondano Regency, 2017.

Regression analysis shows that rainfall has no statistically significant effect on rice production. This is because rice plants still need too much water to grow and develop. The quantity of rainfall, the amount of irrigation, and the capacity of the soil to retain water all have a significant impact on water availability. Plants can be harmed by too much or too little water. One of the things that affects plant growth and production is water. Since plants don't get enough water, lack of rainfall is limiting. Even if extreme conditions can result in death, insufficient water supply can increase vegetative damage to plants, including inhibition of leaf opening, drying of young leaves, damage to green leaves, and damage to the entire crown. Aditya et al., (2021) also found that rice production in West Kalimantan was not affected by rainfall from 2000 to 2019.

5. CLOSING

Based on the research results, rainfall did not affect rice production in East Java Province between 2001 and 2021. On the other hand, harvested area and agricultural labor had an effect on rice production. The empirical statistical significance level F is 0.0000 (0.01) indicating that the model used exists. With a coefficient of determination (R2) of 0.929628, the variables harvested area, agricultural labor, and rainfall accounted for 92.96 percent of the variation in rice production variables. The remaining 7.04 percent is influenced by additional non-model variables or factors. According to Nizar & Ariyanto (2016) , the best way to ensure results that are also proportional to the level of production is to use agricultural production inputs in a balanced manner.

Considering that the independent variables used in this study cannot fully explain the factors that cause income inequality in Indonesia, it is hoped that other variables that are more complex and measurable can be used to explain the factors affecting rice production in the future. wider field. In addition, it is hoped that additional researchers will be able to explain the long-term and long-term factors that influence rice production in a region using sophisticated and methodical analytical tools.

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