AGRO EKONOMI, Vol 33, Issue.2, December 2022, Page. 60-72
DOI : http://doi.org/10.22146/ae.66704
ISSN 0215-8787 (print), ISSN 2541-1616 (online)
Available at https://jurnal.ugm.ac.id/jae/

The Economic Efficiency of Rice Farming Production Factors in Karawang Region

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Submitted : 17 Juni 2021 ; Revised : 09 November 2021 ; Accepted : 19 September 2022

ABSTRACT
The population's food needs are increasing during the COVID-19 pandemic. If the pandemic lasts longer, it is feared that a food crisis will occur, because residents will scramble to stock up on food. This study aims to analyze the efficiency level of rice productivity and the determinants that affect rice productivity to face the food crisis. This study uses secondary data and primary data, obtained from interviews. The data analysis method used is the Cobb-Douglas Stochastic Frontier Production Function approach with the Maximum Likelihood Estimation (MLE) method and multiple linear regression, which is obtained using Stochastic Frontier Analysis and E-Views 8 analysis tools. Production of land area, seeds, and pesticides have a significant effect on rice production in Karawang Regency. While the use of production factors of urea fertilizer, NPK fertilizer, SP36 fertilizer and labors workdays did not have a significant effect on rice production in Karawang Regency. The level of technical efficiency in rice farming in Karawang Regency reaches 0.9607 which indicates that rice farming is technically close to efficient. The combination of the use of land area production factors, seeds, urea fertilizer, SP36 fertilizer in rice farming in Karawang Regency has not yet reached the optimal point that is economically efficient. The level of elasticity of production in rice farming in Karawang Regency reaches a value of 1.3971 so that rice production has a scale that is increasing return to scale.

Keywords: Efficiency, Return to Scale, SFA

How to cite : Aenunnisa. N., Hasan, Z., and Ayomi, N.M.S. 2022. The Economic Efficiency of Rice Farming Production Factors in Karawang Region . Agro Ekonomi 33(2), 60-72

INTRODUCTION

The increasingly widespread spread of the COVID-19 pandemic has prompted the government to issue regulations regarding work from home, physical distancing, and regional quarantine, which impacts changing conditions in all aspects of life, including changes in systems performance patterns in the food sector. This change has become a concern for the community regarding food security because food is a basic need for everyone (Hirawan & Verselita, 2020). Food availability during the COVID-19 pandemic holds necessary attention because it can affect the food crisis if it is not appropriately managed. The role of farmers as producers in food availability is a dilemma. On the one hand, the pandemic has provided a policy for physical distancing; on the other hand, the pandemic has pushed food needs to remain stable where it is predicted that there will be demand for the same food consumption even though activities in the community are limited. The fundamental problem that has become a concern in policymaking in the agricultural sector, especially the food sub-sector, is the relatively low level of productivity in some areas. The decline in food demand was experienced in several regions (Hartati, 2013). for example, Bangka Belitung Islands, West Kalimantan, Central Kalimantan, and the Riau Islands, especially rice commodities, because these regions, productivity is lower than the average value of national production. Therefore, particular interventions are needed in areas with low productivity, such as the Bangka Belitung Islands, West Kalimantan, Central Kalimantan, and the Riau Islands (Badan Pusat Statistik, 2021). This intervention helps increase rice production to meet the demand of food needs in the regions.

From a production perspective, Farmers have a leading role in producing rice productivity. This role is related to the ability of farmers to allocate various inputs of production factors efficiently, which is expected so that farmers can obtain maximum results in rice farming. In contrast, if farmers are at a low level of efficiency of production factors, farmers still have not maximized production results in their farming (Rivanda et al., 2015a). The level of efficiency that reaches the maximum will impact farmers' income. The less precise combination and several production factors will impact the low output produced or high costs incurred (Miftachuddin, 2014). Many research findings show that the productivity of rice farming in several parts of Indonesia is still not efficient; for example, Semarang Regency (Ayomi et al., 2017), Kudus Regency (Miftachuddin, 2014), Tabanan Regency (Putra et al., 2018) and Karawang Regency (Rivanda et al., 2015). Meanwhile, the research results by Kusnadi et al. (2011) showed that the productivity of rice farming in Java is efficient. The difference in the findings of this study is, obviously, based on various factors of production.

Many factors affect the efficiency of rice farming productivity. Production input factors in the form of seeds, fertilizers, and labour are factors that can increase agricultural productivity, based on research in Tabanan regency (Putra et al., 2018, Karawang Regency (Rivanda et al., 2015a), Bali Provincy (Suharyanto, 2015). Meanwhile, according to Listiani et al. (2019a) and Marwah (2012), these variables do not significantly affect the productivity of rice farming. The lack of combination and number of production factors will impact the low output produced or the high production costs incurred by farmers (Miftachuddin, 2014).

In terms of production, in 2020 in the West Java Provincy, Karawang Regency ranks second with a total production of 1,087,873 tons under Indramayu Regency of 1,363,311 tons which became the granary in the West Java provincy (Badan Pusat Statistik, 2021). Base on this problem, the big question is whether the rice production system in Karawang Regency has achieved efficiency? How did Karawang Regency become one of the Regencies who production system can be adopted for areas that are still below the national average production?

Meanwhile, in the midst of the Covid-19 pandemic, apart from causing a health crisis and an economic crisis, there is another fundamental problem, namely the food crisis (Clapp & Moseley, 2020). Due to social restrictions and social interaction patterns have changed drastically. As a result, the distribution chain pattern is hampered on all fronts, including food. The findings of Jusriadi et al. (2020) research that Indonesia is threatened with a food crisis due to the stock of rice reserves controlled by the Government through the Logistics Affairs Agency (BULOG) is only available for a few months. Plus, many people then stockpile food just in case when the pandemic continues. In 2018, before the pandemic, The Karawang Regency produced 1,124,447 tons of rice (BPS Karawang, 2019). while in 2020 rice production in the Karawang Regency decreased to 1,087 874 tons of rice (BPS Karawang, 2022).

Based on the above problems, efforts to mitigate the food crisis caused by the Covid-19 pandemic are urgently needed through increased production. The measure that can be done is with production efficiency. Thus, efficiency is the most important thing to analysis. This study tries to break down several variables into more specifics. The description above encourages researchers to analyze production factors including land area, seeds, urea fertilizer, NPK fertilizer, SP36 powder, pesticides and labors workdays on production results and analyze the efficiency level of rice farming production factors in Karawang Regency in mitigating the food crisis.

METHODS

This research was conducted in March 2020 after the Covid-19 pandemic was detected in Indonesia. The research locations were the Laksana Tani farmer group in the Banyusari sub-district, the Rahayu farmer group in the Kotabaru sub-district, and the Lugina farmer group in the Tirtamulya sub-district. The selection of the research location was based on the consideration that the sub-district had the most active Farmer Groups in the agricultural sector, Karawang Regency. Sources of data in this study use primary data and secondary data. Primary data was obtained through a survey method. The survey was conducted using farmer interviews guided by a questionnaire. This research uses a purposive cluster area random sampling method. In sampling, farmers used a sample of 120 farmers from three combined farmer groups consisting of Banyusari District, Kotabaru District, and Tirtamulya District. The sampling technique is based on purposive sampling with the criteria that farmers have a minimum land area of 1 hectare and a minimum rice production of 5 tons/ha because the national average rice production is 5.7 tons/ha. From each sub-district that meets the criteria of 33 farmers in each sub-district so that the number of samples from all sub-districts is 99 farmers. Primary data collected consisted of farmers, land area, input-output structure, and labour. In addition to primary data, this study also uses secondary data collected from agricultural agencies or offices, including the Central Bureau of Statistics.

The analysis used in this study is to measure production efficiency which consists of technical efficiency, allocative efficiency and economic efficiency. Technical efficiency is done by using the production function Stochastic Frontier Cobb-Douglas. The production function Stochastic Frontier Cobb-Douglas is easier to use by transforming it in the form of a linear regression equation which is converted into a linear double log. If the value of the form of the equation $e^p = 1$ then the production activity is in a condition of Constant Return to Scale, if $e^p > 1$ then production activity is in Increasing Return to Scale condition, if $e^p < 1$ then production activity is in Decreasing Return to Scale condition. In the production function, the factors that are expected to affect production in this study are land area, number of seeds, amount of urea fertilizer, amount of NPK fertilizer, amount of SP36 fertilizer, the amount of pesticides, labors workdays. By including 7 relevant variables into the stochastic frontier equation, the following equation can be written:

$$LnY = Ln\ a+\beta_1\ Ln\ X_1+\beta_2\ Ln\ X_2+\beta_3\ Ln\ X_3+\beta_4\ Ln\ X_4+\beta_5\ Ln\ X_5+b_6\ Ln\ X_6+b_7\ Ln\ X_7+v_iu_i$$

Where: Y = Rice Production (tons/period) X_4 = NPK Fertilizer (Kg/period)

X_1 = Land Area (ha/period)

X_5 = Fertilizer SP36 (Kg/ period)

X_2 = Seed (Kg/period)

X_6 = Pesticide (L/period)

X_3 = Urea Fertilizer (Kg/period)

X_7 = Labors Workdays (Days/period)

v_iu_i = error term.

To answer the value of technical efficiency, it can be done by analysis tool using the Stochastic Frontier Analys software (SFA) version 4.1C. processing results software SFA according to Mukhlis (2020) will give an estimate of a variance from the expected parameter, which is close to 1, which means the error value comes from the inefficiency factor. The results of the software frontier produces an estimate of the value of the MLE and OLS likelihood logs which according to Akkaya (2016) reveals a good value when the MLE probability value is> OLS and it can be interpreted that this value is in accordance with the conditions that occur in the field. And if the error term has a small value, it means that the inefficiency value is normally distributed.

In addition to testing technical efficiency, then allocative efficiency analysis can be used with mathematical calculations in accordance with Soekartawi (2003), namely as follows:

$$\frac{NPMx1}{Px1} = \frac{NPMx2}{Px2} = \frac{NPx3}{Px3} \ldots\ldots \frac{NPMxi}{Pxi} = 1$$

The interpretation of the results of the allocative efficiency analysis can be categorized as follows: NPMxi/Pxi = 1, then the use of production factor x_i has achieved allocative efficiency economically. NPMxi/Pxi > 1, then the use of production factor x_i has not achieved allocative efficiency economically. NPMxi/Pxi<1, The use of the factor of production x_i is not economically allocative efficiency. From the results of technical efficiency and allocative efficiency, it will then produce economic efficiency. (Soekartawi, 2003) revealed that economic efficiency is the result of multiplying all technical efficiency with allocative efficiency of all input factors and economic efficiency will be achieved if both (technical and allocative) efficiency are achieved. Systematically can be expressed as follows:

$$E^e = E^t . E^a$$

Where: E^e = Economic Efficiency

E^t = Technical Efficiency

E^a = Allocative efficiency,

To see the effect and relationship using F test analyzed and test using multiple linear regression analysis tool with software E-Views 8. Where the F test is used to simultaneously determine the effect of production factors (land area, number of seeds, amount of urea fertilizer, amount of NPK fertilizer, amount of SP36 fertilizer, amount of pesticides, Labors Workdays) on rice production. and t-test is used to determine the relationship between each variable.

RESULTS AND DISCUSSION

General Description of Respondents

The results of the study showed that of the 90 farmer respondents, 31.11% were aged between 41-50 years, 28.89% were farmers aged 31-40 years, and 25.56% were farmers aged 51-60 years. And the average farmer respondents in this study were 49 years old. Farmers with 49 years of age are still in productive age so that farmers can still maximize their productivity. Yuliana et al. (2017) revealed that the age of the farmer will affect the physicality of an farmer in carrying out farming activities. Kusnadi et al. (2011) also revealed that farmers who are younger than 60 years will produce more efficient farming and the age of farmers aged ta will reduce efficiency so it is necessary to increase the regeneration of young farmers so that rice farming production will be higher. Farming in Karawang Regency is dominated by farmers aged 41-50 years due to the view of farmers there that they expect their children not to work as farmers.

Karawang Regency is an industrial center area so that young people have a high interest in working in the industrial sector compared to working as farmers.

The education level of 53.33% of respondents is at the level of final primary school education (SD). This proved that farmers' education is dominated by low education so that it becomes a problem in increasing production. Conditions in the field of farmers with low education generally find it difficult to adapt to new technologies. Yuliana et al. (2017) revealed that the level of education of farmers greatly influences the behavior patterns of farmers and the application of more modern agricultural technology. Kusnadi et al. (2011) argue that there is a need for the government's role in handling farmers' education and knowledge where higher education will affect the mindset, which will be more open in receiving all information, easier to adapt and increase technology adoption. Thereforeopit can increase the value of efficiency in agriculture in Karawang regency, people think that working as a farmer does not require a high level of education. Education is not a qualification to become a farmer, but in fact education is a factor that affects the increase in farmer productivity.

The duration of farmer from the research respondents showed that the length of the rice farmer business was 32.22%, dominated by farmers who had been farmer for 31-40 years. This shows that the dominance of rice farmer in Karawang Regency has had a lot of experience and become an expert in the field of farmer because it has exceeded the age of 10 years. Yuliana et al. (2017) revealed that farmers who have been farmer for more than 10 years have good experience and knowledge in running their farmer Suharyanto (2015) also revealed that the business experience possessed by farmers can be an opportunity for farmers to use production inputs in an efficient manner.

The Relationship of Production Factors to Rice Farming Production Results in Karawang Regency

The results of the analysis to determine the relationship between production factors (Xi) and production yields (Y) where carried out using the efficiency production function Cobb-Douglas. Where estimate the regression model as follow:

$$Ln(Y) = 1.0095 + 0.7071*Ln(X_1) + 0.1835*Ln(X_2) - 0.0813*Ln(X_3) - 0.0039*Ln(X_4) - 0.0830*Ln(X_5) - 0.0258*Ln(X_6) + 0.3146*Ln(X_7)$$

Results of regression processing with software E-Views 8 shows that the adjusted R value of^2 0.9732 or a percentage of 97.32%. The interpretation of this value is that the seven independent variables included in the regression model can explain the diversity of production with a value of 97.32%, the remaining 2.68% is the value of other independent variables that are not examined or are outside of the seven established models. Simultaneously the production factors (land area, number of seeds, amount of urea fertilizer, amount of NPK fertilizer, amount of SP36 fertilizer, amount of pesticide, and labors workdays) on rice production in Karawang Regency were

Table 1. F Test Result

	Value
F-Statistic	426.09
Prob (F-Statistic)	0.000000

Source: Primary Data, 2020.

carried out by testing the F test with a 95% confidence level.

The results of the F analysis test showed that the significance value of Prob (F-Statistic) was 0.000000. Prob value (F-Statistic) < 426,09 Results it can be concluded that simultaneously the production factors affect rice productivity in Karawang Regency with a confidence level of 95%. Research by Ellyta et al. (2016) shows that the use of production factors of the same area of land, seeds, fertilizer of urea, NPK, sp36, pesticides and labor workdays produce count the F > F value table and value of lacking significance of 0,05 that it can be in the interpretation that simultaneously had have real impact on the volume of production . Rustam (2013) also said the simultaneously land, seeds, fertilizer urea, fertilizer NPK, fertilizer sp36, The number of pesticides and labor workdays influences rice productivity in Karawang with confidence of 95 %

The results of the partial correlation analysis based on table 2 can be seen that the significance of the production factor of land area has a value of 0.0028, this value shows the value of sig. Land area <0.05 (α=5%) means that the production factor of land area has an influence on rice production. Land for farmers in Karawang Regency is generally leased land that is cultivated by farmers, but there are still many farmers who own private land. Based on data from the 2010 National Farmers Panel or PATANAS, the ownership of rice fields in Indonesia is 28.28% and family-owned land is 0.85% (Winarso, 2012). The average land area of farmers in Karawang Regency in this study is 5.022 Ha. Juliyanti & Usman (2018) said that farmers who use larger farming land will produce higher production and thus the income and welfare of farmers will increase. Ayomi et al. (2017) Said that land area is the main capital in rice farming, because land area is a determinant of the total productivity of rice farming. Land area is also a determining factor and greatly determines the production yield in rice farming.

The number of seeds used by farmers in Karawang Regency is approximately 15,333 kg/ha on average. The result of the significance of the partial correlation of seed production factors on rice production has a value of 0.0215. This value indicates that the value of seed sig. <0.05 (α=5%) which means that seed production factors have an influence on rice production. Mita et al. (2018) said the factor of the number of rice seeds has a significant contribution to the success of rice production. Listiani et al. (2019) stated that high use of rice seeds will increase rice production so that farmers' income will increase..

Fertilizer is one of the determining factors in rice production. The fertilizers used in rice farming in Karawang Regency on average use chemical fertilizers including urea, NPK fertilizer and SP36 fertilizer. The average urea fertilizer used in rice farming in Karawang Regency is 123.6842 Kg/Ha. Farmers are tend to used fertilizer doses that are not evenly distributed and do not comply with government recommendations. The fertilizer recommended by the government is 250 kg/ha (Siallagan et al., 2014). Excessive doses will have a negative effect on rice farming production.

The result of the urea fertilizer production factor on the rice production yield has a partial correlation significance of 0.1590. Its means that the urea fertilizer production factor has no effect on rice production. The significance of the partial correlation of NPK fertilizer has a value of 0.9495 and SP36 Fertilizer has a value of 0,2041. This value indicates that the value of sig. NPK and SP36 fertilizer > 0.05 (α=5%) which means that the production factor of NPK and SP36 fertilizer has no effect on rice production. The use of urea, NPK and SP36 fertilizers if used excessively will reduce the level of production this is due to the inappropriate use of which is not adapted to the conditions of plant needs. This is in accordance with the Results of Listiani et al. (2019) said that fertilizers are useful for increasing rice production but fertilizers that are not as recommended will affect the results of rice farming. Lingga & Marsono (2013) said that the good of fit and appropriate fertilizers must consider the dose, method of use, and efficacy for plants. Handling of fertilizers must be adjusted to the needs of the plant.

Pesticide in rice farming production in Karawang Regency generally use liquid and solid chemical pesticides. The type of pesticide used by each farmer is different of brand and type. Farmers use pesticides according to the needs of the condition of the fields being cultivated. Pesticides are used when rice is attacked by nuisance organisms such as pests and weeds. The the partial correlation of pesticide production factors has a value of 0.0352. Its means that pesticide production factors have an influence on rice production. Khansa Agatha & Wulandari (2018) said that pesticides have an effect on productivity. Pesticides have the power to help increase production by reducing pests by preventing and attacking pests so that production losses can be minimized. In contrast to the results of this study, an important research note by Praditya & Syafrial (2017) said that long-term use of pesticides can reduce farm productivity.

Labor is the most important production factorsoke in rice farming (Setianingsih & Padang, 2018) . In Karawang Region, workers generally do not have special qualifications. The partial correlation of labors workdays has a value of 0.532. It is means the labors wordays production factor is not significant but has an effect on rice production. Silviana & Weriantoni, (2019) said that the labor factor in his research had insignificant results on rice production. In the production of rice farming, the labor factor does not have the same value from each production (Marwah, 2012). The labor factor itself is an important factor in the production of rice farming (Suratiyah, 2015).

Table 2. Output Efficiency Stochastic Frontier Analysis

	Coeffisient	Standard Error	t-Ratio
Beta 0	1.0095	0.0191	1.1083
Beta 1	0.7071	0.0028	0.9745
Beta 2	0.1835	0.0215	0.8494
Beta 3	-0.0813	0.1590	-0.8094
Beta 4	-0.0039	0.9495	-1.1559
Beta 5	-0.0830	0.2041	-0.6041
Beta 6	-0.0258	0.0352	-0.4678
Beta 7	0.3146	0.0532	0.5678
Likehood MLE		0.7853	
Likehood OLS		0.6180	
Mean Efficiency		0.9607	

Source: Primary Data, 2020.

Technical Efficiency

Results of analysis processing software frontier4.1 is shown in Table 2. Based on table 2, the likelihood value of MLE > OLS with a value of 0.7853 > 0.6180, and the standard error value is dominated by small values. Its means that the value is in accordance with the proper conditions in the field and the inefficiency value is normally distributed. This is in accordance with the opinion of (Akkaya, 2016) said that a good value is when the likelihood value is MLE>OLS and it can be interpreted that this value is in accordance with the conditions that occur in the fields. If the value of the error term has a small value, it means that the inefficiency value is normally distributed.

The average value of technical efficiency from the analysis results is 0.9607. This value indicates that the average technical efficiency of rice farming is 96%. It can be concluded that farming has indicated that it is technically close to efficient. Factors of production can be said to be efficient in technical efficiency when the production factors used have produced maximum production output.

Economic Efficiency

The results of mathematical calculations obtained results of economic efficiency which can be seen in table 3. Based on the results of the economic efficiency analysis, it can be seen that the comparison value of the marginal product of production factors (NPMXi) with the price of production factors (PXi) of land area, seeds, urea fertilizer, SP36 fertilizer has a value of PNMXi/Pxi > 1. Land, seeds, urea fertilizer, SP36

Table 3. Results Analysis of Economic Efficiency

Variable	Xi	βi	Pxi	NPMXi	NPMXi/PXi
Land Area	5.02	0.70	3,000,000.00	3,855,268.26	1.28
Seeds	15.33	0.18	10,964.28	32,666.09	29.88
Urea Fertilizer	123.68	0.08	1,878.95	17,999.13	9.58
NPK Fertilizer	150.55	0.01	2,447.44	706.44	0.29
SP36 Fertilizer	117.44	0.08	2,350.00	19,353.44	8.23
Pesticides	4.16	0.03	867,222.22	169,742.04	0.19
Labor	28.00	0.31	2,800,000.00	305,687.49	0.11

Sources: Primary data, 2020

fertilizer in rice farming have not yet reached the optimal point that is economically efficient, so these factors must be added. And the comparison value of the marginal product of production factors (NPMXi) with the price of production factors (PXi) of NPK fertilizers, pesticides and labor has a value of PNMXi/Pxi < 1. Its means that the combination of the use of production factors of NPK fertilizers, pesticides and farm labor is said to be economically inefficient or the production factor has exceeded the optimal so that it must be reduced in its use. In order to reach an allocative efficient point in rice farming, it is necessary to add the production factor of land area, seeds, urea fertilizer, SP36 fertilizer and it is necessary to reduce the production factor of NPK fertilizer, pesticides and labor.

Return to Scale

Based on the results of the previous analysis, it can be seen that the Cobb-Dauglas function states that each independent variable coefficient is the elasticity value of the dependent variable. Based on tables 2 and 3, it is known that the sum of the coefficient values produces a number of 1.3971 in rice farming in Karawang Regency. This production scale is as increasing return to scale. Its means that each addition of a factor input will produce an item in a higher proportion. In this interpretation that each additional factor input by one percent, it will increase an output by 1.3971%.

CONCLUSION AND SUGGESTIONS

The level of rice production in Karawang Regency is technical efficiency level reaching 0.9607. However, in terms of economic efficiency, there are land area, seeds, urea fertilizer, SP36 fertilizer and it is necessary to reduce the production factor of NPK fertilizer, pesticides and labor that need to be considered for reducing production factors, namely NPK fertilizers, pesticides and labor factors. The use of land area production, seeds, and pesticides have a significant effect on rice production. While the use of production factors of urea fertilizer, NPK fertilizer, SP36 fertilizer and labor did not have a significant effect on rice production. The combination of the use of land area production factors, seeds, urea fertilizer, SP36 fertilizer in rice farming in Karawang Regency has not yet reached the optimal point that is economically efficient, so these factors should be added. And the combination of the use of NPK fertilizer production factors, pesticides and farm labor in Karawang Regency said to be economically inefficient or the production factors have exceeded optimal so that their use must be reduced.

Simultaneously the use of production factors of land area, number of seeds, amount of urea fertilizer, amount of NPK fertilizer, amount of SP36 fertilizer, amount of pesticide and labors workdays affect rice production in Karawang Regency with a confidence level of 95%. The level of elasticity of production in rice farming in Karawang

Regency has been increasing returns to scale with a value of 1.397, which means that each addition of a factor input will produce an item in a higher proportion.

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