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Analysis of Allocative Efficiency in Rice (Oryza sativa L.) Farming in the Batu Alam Industrial Area, Cirebon Regency

Ujang Sarifuddin [1], Misy Rosmawati [2], Farida Mardhatilla [3], Siti Wahana [4].
[1] Student at Gunung Jati Swadaya University, Cirebon, West Java, Indonesia
[2] Student at Gunung Jati Swadaya University, Cirebon, West Java, Indonesia
[3] Lecturer at Gunung Jati Swadaya University, Cirebon, West Java, Indonesia
[4] Lecturers at Gunung Jati Swadaya University, Cirebon, West Java, Indonesia
Corresponding Author : fmardhatilla@gmail.com

Abstract. This research analyzes the efficiency of farming costs and the factors influencing rice farming costs. The research method used was descriptive quantitative with data collection techniques through surveys and interviews with 176 rice farmer respondents in the natural stone industrial area of Cirebon district. The analysis used is frontier cost analysis using frontier4.1 software using the Maximum Likelihood Estimation (MLE) approach. This research shows that the average cost efficiency or allocative level in the natural stone industrial area is 0.20. The factor that influences the inefficiency of rice farming in natural stone industrial areas is age. Factors directly influencing farming costs are land area, urea, labor, rice selling price, land rental price, and labor wages.

Keywords: Allocative Efficiency, Rice Farming, Frontier

INTRODUCTION

Rice plants (Oryza sativa) are one of the most important types of food plants in the world. Meeting food needs that continue to increase along with the human population requires increasing the productivity of rice plants. Using the latest agricultural technology has become one of the best ways to increase rice productivity significantly. As a national strategic food commodity, rice is susceptible to politics, economics, and social insecurity. The following factors play an essential role in the national economy: (1) rice is the staple food for 95% of Indonesia's population, with a share of energy consumption of more than 55%, and (2) around 30% of poor households' expenditure is allocated to rice and (3) More than 25.6 million farming households enjoy employment opportunities and sources of income from rice farming (Dzikrillah et al., 2017).

Indonesia's rice production 2023 will reach 53.98 million tons of dry grain, and the rice harvest area will reach 10.21 million ha. This will decrease from 2022, producing 54.75 million tons of dry grain and the rice harvest area reaching 10.45 million ha. Suppose disruptive agricultural food production technology needs to be implemented to solve the problem of increasing national food production, including rice, quickly and massively from upstream to downstream. This condition is predicted to increase in 2045 (Marwanti Marwanti et al., 2023).

According to Afandi (2018), Cirebon Regency is one of the rice producers in West Java. According to BPS 2023 data, the area of rice plantations in Cirebon district reached 92,081 ha. With its rice granary position, Cirebon Regency helps maintain food security throughout the district. In 2019, Cirebon Regency can produce 672,630 Tons/GKP of rice, according to data released by the Cirebon Regency Central Statistics Agency (BPS). Rice production then rose to 709,105 tons/GKP in 2020, fell to 703,044 tons/GKP in 2021, then fell again to 701,059 tons/GKP in 2022, but rose again to 705,316 tons/GKP in 2023. This data shows that rice production has fallen for the last two years.

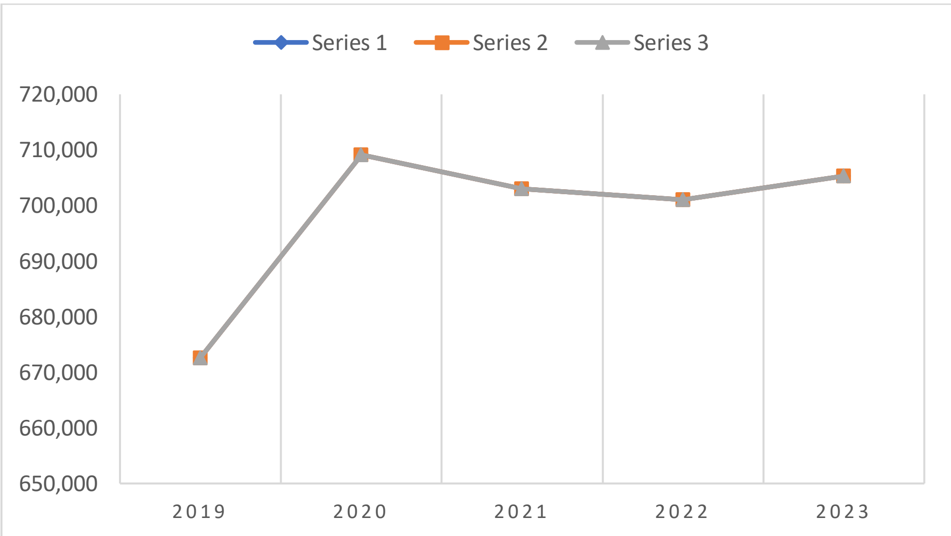

Figure 1. Cirebon Regency Rice Production

Source: BPS Cirebon Regency

The natural stone industry is an industry that operates in the craft sector; this industry is located in 3 sub-districts of Cirebon Regency, namely Dukupuntang sub-district, Palimanan sub-district, and Depok sub-district. Cirebon Regency contributes to rice production in West Java, including the 3 sub-districts contributing to rice in Cirebon

Regency, which is adjacent to the natural stone industry. Of the 3 sub-districts, the planting area, harvest, and production area in 2023 are:

Table 1. Planted area, harvested area, rice production in Cirebon district 2023

No	Subdistrict	Planting Area (ha)	Harvested Area (ha)	Production (GKP)
1	Dukupuntang	3549	3546	2 6137
2	Palimanan	2377	2068	1 6097
3	Depok	1559	1419	1 1146

Source: BPS, 2023

The table above shows that the Dukupuntang sub-district is the sub-district that contributes the most significant rice production in the natural stone industrial area. However, from year to year, rice productivity in these 3 sub-districts has decreased after introducing the natural stone industry. Because the natural stone industrial center is located near productive rice land, the decline in rice productivity means that rice production in the natural stone industrial area still needs to be fully maximized. Farmers generally increase the amount of production inputs such as pesticides, fertilizers, and others to increase production yields; this causes increases in farming production costs. High farming costs and low farmer income will affect the efficiency of existing farming costs. (Sembiring, 2022). Therefore, this research aims to analyze the efficiency level of farming costs and the socio-economic factors of inefficiency, namely age, education, farming experience, and family responsibilities.

LITERATURE

Lowland rice farming as a food crop commodity is an agricultural product that has a vital role in meeting the food needs of the Indonesian people, so attention to this commodity is endless. The need for lowland rice as the primary food ingredient in Indonesia is increasing along with the increasing population. The success of rice farmers will impact food availability for the community. On the other hand, failure to manage farming will have an impact on the availability of rice as a staple food and will affect the level of welfare of farmers. (Astuti, 2017).

The excavation industry is an industry that extracts all types of minerals apart from chemical elements, minerals, and natural deposits such as oil, coal, and natural gas. The natural stone industry in the Cirebon district is one of the mining industries with potential mineral resources (Santika et al., 2021). Apart from having a positive impact, the natural stone industry in Cirebon Regency also causes pollution in irrigation canals due to natural stone waste produced from industrial activities, according to (Santika et al., 2021). Natural stone industry waste is in the form of mud and fine powder mixed with water during processing. It is thrown into river flows and irrigation and carried onto agricultural land, resulting in deposition on agricultural land.

The concept of efficiency in this research refers to the efficiency described by Farell (1957). There are 3 categories of efficiency: technical, allocative, and economic. Technical efficiency is the ability of a farm to use production inputs to obtain maximum results at a certain technological level. Allocative efficiency is the ability of a farm to use inputs that produce output with minimum costs using a specific technology. Economic efficiency is a condition where technical and allocative efficiency are genuinely efficient. (Ivanni *et al* ., 2019).

METHOD

The research method used in this research is descriptive quantitative research. Sugiyono (2020) states that quantitative research aims to test hypotheses by obtaining data by measuring or observing previously determined variables samples from 44 farming groups from 12 villages affected by natural stone waste. Withdrawals are made using the Slovin formula. The following is the Slovin formula for determining the number of samples to be studied in research:

$$n = \frac{N}{1 + N(e)^2}$$

Information:

n = sample size

N = population size

e = critical value (accuracy limit). In this study used 5%

This study's sample size was 176 rice farmers affected by natural stone industry waste.

The data analysis technique used is cost frontier analysis (CFA). This method is used to analyze the cost efficiency of rice farming. The frontier cost function model has a $U_{\text{I value}}$, which shows the effect of frontier cost inefficiencies caused by production running below the frontier line. Inefficiency factors such as age, education, experience, and family responsibilities are production and cost limits measures. A value of 1 for frontier cost efficiency indicates that the farm is frontier cost efficient (Sembiring, 2022). Maximum Likelihood Estimator (MLE) is used as a parameter in the cost frontier function model where the coefficient value of each independent variable (X) is tested for significant value by comparing the t-ratio value and the t-table value, the independent variable which has a t-ratio value greater than t -table is said to have a significant effect (Wijaya *et al* ., 2023). The model used in this research is as follows:

$$\ln C = \beta 0 + \beta 1 \ln X1 + \beta 2 \ln X2 + \beta 3 \ln X3 + \beta 4 \ln X4 + \beta 5 \ln Y + \beta 6 \ln X6 + \beta 7 \ln X7 + \beta 8 \ln X8 + \beta 9 \ln X9 + \beta 10 \ln X10 + \beta 11 \ln X11 + \beta 12 \ln X12 + \beta 13 \ln X13 + \beta 14 \ln X14 + \beta 15 \ln X15 + \beta 16 \ln X16\ (i + Ui)$$

With :

C : Total Cost Amount

$\beta 0$: Intercept Constant

βi : I-th Rice Production Elasticity (i= 1,2,3,4,…n)

X1 : Production (Kg)

X2 : Land area used (Ha)

X3 : Amount of Seed Used (Kg)

X4 : Amount of Urea Fertilizer Used (Kg)

X5 : Amount of SP36 Fertilizer Used (Kg)

X6 : Amount of NPK Fertilizer Used (Kg)

X7 : Amount of Pesticide Use (Liters)

X8 : Total Labor Use (HOK)

X9 : Rice Selling Price (Rp)

X10: Land rental price (Rp)

X11: Price of Seed (Rp)

X12: Price of Urea Fertilizer (Rp)

X13: Price of SP36 Fertilizer (Rp)

X14: Price of NPK Fertilizer (Rp)

X15: Price of Pesticide (Rp)

X16: Labor Wages (Rp)

Vi : Random error of the model

Ui : Random variable or one-side error term

Determining the value of the inefficiency effect is determined through the equation:

$Ui = \delta 0 + \delta 1 \ln Z1 + \delta 2 \ln Z2 + \delta 3 \ln Z3 + \delta 4 \ln Z4$

Where the factors that influence this allocative/cost efficiency include:

Z1 = age (years)

Z2 = Length of Formal Education (years)

Z3 = Length of Farming (years)

Z4 = Number of Family Members (people)

DISCUSSION

Based on Table 2, 6 variables significantly affect the total production costs of farming, including land area, urea fertilizer, labor, rice selling price, land rental price, and labor wages. The variables land area, urea fertilizer, labor, rice selling price, and labor wages have a significant positive effect; every 1% increase in these variables can increase total production costs by the coefficient of these variables.

The land area variable can increase total costs because the more significant the land area owned by farmers, the higher the total costs used. The variable urea fertilizer can increase total costs due to farmers using excess urea fertilizer because it has become a habit for farmers to use their patterns without considering conditions in the field. Labor variables and labor wages can increase the total costs of rice farming because farming activities are carried out by other people or use labor outside the family, so this causes additional costs in their farming business. (Sembiring, 2022). The selling price variable for rice has a positive value because the selling price of rice will affect income; the smaller the selling price determined, the greater the costs incurred because this is not proportional to the income and production produced.

Meanwhile, the land rental price variable has a significant effect and a negative sign, which means that every 1 increase in the land rental price variable can reduce total production costs by the coefficient of that variable. Just like the land area variable, land rent also has a significant effect on the total cost of rice farming, but this is inversely proportional to the statement that land area has a positive sign while land rent has a negative sign; this is because the smaller the land area, the smaller the land rent used.

Table 2. Results of Rice Farming Cost Function Analysis Using the MLE Method

Variable	**Parameter**	**Coefficient**	**Standard Error**	**t-ratio**
Constant	α	8831.1129	0.9993	8836.5642 ***
Production	β1	-0.0205	0.5994	-0.0342 ns
Land area	β2	1032.5740	0.5394	1914.1015 ***
Seed	β3	0.0678	0.6185	0.1097 ns
Urea	β4	0.1240	0.0750	1.6527 *
SP36	β5	0.0226	0.7228	0.0313 ns
NPK	β6	0.0099	0.7210	0.0138 ns
Pesticide	β7	0.0551	0.2717	0.2030 ns
Labor	β8	0.8070	0.1804	4.4721 ***
Rice Selling Price	β9	322.6661	0.8405	383.8722 ***
Land Rental Prices	β10	-1032.8066	0.3105	-3325.2661 ***
Seed Prices	β11	-0.1462	0.9438	-0.1549 ns
Urea Price	β12	0.0460	0.9654	0.0476 ns
Price SP36	β13	-0.0074	0.3288	-0.0227 ns
NPK price	β14	0.0079	0.3423	0.0231 ns
Pesticide Prices	β15	0.0011	1.0329	0.0011 ns
Labor Wages	β16	166.1832	0.9154	181.5404 ***
Sigma-Square		16.2566	0.7188	22.6159 ***
Gamma		0.9999	0.0000	12027.3290 ***
LR test	**323.54**			
log-likelihood	**-251.73**			

Note: *** : Significant at α = 1%, ** : Significant at α = 5%, * : Significant At α = 10%

Based on Table 2, the gamma value of 0.999 is significant at an alpha level of 1%, meaning that the random error variation is 99.9% influenced by inefficiency factors. These statistical results show that differences in cost efficiency cause the difference between actual costs and the minimum stochastic cost limit. (Sadiq *et* al., 2022). It is also known that the LR test value is greater than the critical value $\chi_1{}^2(2\alpha)$, which means it is not 100% efficient in the research area. (Rizkiyah *et* al., 2014).

Table 3 Variables that influence rice farming inefficiency

Variable	Parameter	Coefficient	Standard error	t-ratio
Age	δ1	-0.2088	1.4589	-14.3151
Education	δ2	-0.0951	0.4324	-0.2199
Farming Experience	δ3	-0.1375	0.9900	-0.1389
Family Dependents	δ4	-0.0371	0.9407	-0.0395

Table 3 shows the variables that cause cost/allocative inefficiencies in rice farming. The farmer age variable has a negative and significant effect at the alpha level of 1%; this means that the older the farmer, the less inefficient the farmer will be in running his farming business. This is also reflected in Idiong's (2005) statement on research. (C.K.Biam *et al* ., 2016). The older a farmer is, the less likely he is to use resources optimally given the available technology. Meanwhile, other variables, namely education, experience, and family support, are insignificant to total costs; these variables do not appear to impact allocative efficiency.

Table 4 Distribution of Allocative Efficiency

Efficiency level	Amount	%
0.10 - 0.20	112	63.64%
0.21 - 0.30	52	29.55%
0.31 - 0.40	6	3.41%
0.41 - 0.50	4	2.27%
0.51 - 0.60	0	0.00%
0.61 - 0.70	2	1.14%
Total	176	100.00%
Mean	0.20	
Max	0.65	
Min	0.10	

Based on Table 4, the average value of farmers' allocative efficiency in the natural stone industrial area of Cirebon district is 0.20, with the lowest value being 0.10 and the highest being 0.65. If farmers want to achieve the highest level of efficiency, they can save costs of 69.23% (1-0.20/0.65)x100). This shows that rice farming in the natural stone industrial area of the Cirebon district still needs to be allocatively efficient. Of the 176 farmers, the overall efficient value was below the average of 0.70. This is similar to the research (Handayani., 2023) It shows that the allocative efficient value of organic rice farming in Lampung province is 0.47.

CONCLUSION

Based on the research results above, it can be concluded that:

1. The 16 variables significantly influencing total production costs are land area, urea fertilizer, labor, rice selling price, land rental price, and labor wages. In contrast, the rest do not significantly influence total production costs, namely the amount of production, seeds, fertilizer SP36, NPK fertilizer, pesticides, land rent, seed prices, urea fertilizer prices, SP36 fertilizer prices, NPK fertilizer prices, and pesticide prices.
2. The results of the allocative efficiency analysis show an average value of 0.20, the lowest value of 0.10, and the highest value of 0.65. All farmers in the natural stone industrial area have not achieved allocative efficiency, so they have been unable to use optimum inputs to produce the optimal output.

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