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Economic Efficiency of Rice in South Lampung Regency

Aryan Ari Sepri YH[1,*], Masyhuri[2], Lestari Rahayu Waluyati[2]

[1]*Student of Master Agricultural Economic, Department of Agricultural Socio Economics, Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta, Indonesia*
[2]*Department of Agricultural Socio Economics, Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta, Indonesia*
[*]*Corresponding author. Email: aryanari15@mail.ugm.ac.id*

ABSTRACT
This study aims to determine the factors that affect rice production and determine the level of economic efficiency of rice farming. The research was conducted in Taman Agung Village, Kalianda Sub-District and Sidorejo Village, Sidomulyo Sub-District, South Lampung Regency with 85 farmers as respondents. The data were analysed by using multiple regression analysis of the stochastic frontier production function Maximum Likelihood Estimation (MLE) method with software frontier 4.1. The results showed that the effect on increasing rice production in Lampung Selatan Regency was land area, seed, N fertilizer and liquid pesticides, while those that affected and decreased production were labor. The average levels of technical, economic and allocative efficiency are 0.91; 0.80 and 0.88, respectively. Farmers need to consider the high use of labor so that rice production would increase.

Keywords: *economic efficiency, factors of production, rice farming, stochastic frontier*

1. INTRODUCTION

The agricultural sector contributes a lot to the economy in Indonesia, the contribution is obtained from national development. One of the national development goals is to achieve food self-sufficiency, especially rice through food crops. Food crops are all types of plants that can produce carbohydrates and protein, therefore food crops are the main source of staple food for most of the Indonesian population and most of the world's population. Types of food crops in Indonesia consist of rice, corn, soybeans, potatoes and cassava [1].

One of the most widely cultivated food crops in Indonesia, namely rice plants, rice plants play an important role for the community's economy for basic needs and as a source of farmers' income. Rice plants are included in the grass group and can survive in stagnant water, unlike other food crops, such as corn, potatoes, soybeans and cassava which will die if waterlogged continuously. Rice is able to live in stagnant water due to the presence of tubes in the leaves, stems and roots [2].

Rice plants are widely cultivated in Indonesia, because it has a literal suitability. One of the provinces that cultivates rice plants is Lampung Province. Lampung Province is the sixth contributor to rice production in Indonesia and the second on the island of Sumatra by island in Indonesia after South Sumatra [3]. The contributors was obtained from 15 regency's and cities in Lampung province, one of the regency's that contributed the highest productivity was South Lampung Regency with 6.03 tons/ha in 2019. Rice production and productivity in South Lampung Regency fluctuated in the 2015-2019 period. The highest rice production occurred in 2017 with 638,599 tons and the lowest in 2019 with 265,878 tons. Even though 2019 was the lowest production in the last 5 years, it produced a high productivity of 6.03 tons/ha.

In fact, the main problem that occurs in rice farming in Lampung Province is low productivity, which is thought to be caused by the lack of application of recommended cultivation technologies such as the use of seeds and fertilizers, environmental factors, and socio-economic conditions and farmer institutions [4].

However, these problems can be overcome if the requirements such as the required production factors have been fulfilled. The production factor consists of several elements such as land area, organic fertilizer, chemical fertilizer, powdered pesticide, liquid pesticide, seeds, capital, labor and processing methods. Meanwhile, Soekartawi states that there are three requirements for production factors, like it land area, capital and labor. If one of the factors of production is not available, the production process will not run [5].

The use of production factors will affect the level of technical, allocative and economic efficiency which is indicated by how much maximum production is produced from each available production factor. In addition, Kune revealed that the managerial ability of farmers in cultivation technology and its capability in processing various relevant information will greatly affect the achievement of the level of efficiency so that every decision can be taken properly. Rice farmers must be able to allocate every input used so that their farming can be efficient and obtain sufficient profit to support their families and develop their farming [6].

Based on the description above, the objectives to be obtained from this study are to determine the factors that influence rice production in South Lampung Regency and analyse the level of economic efficiency of rice farming in South Lampung Regency.

2. RESEARCH METHODS

Research was conducted in Kalianda Sub-District and Sidomulyo Sub-District, South Lampung Regency. Kalianda Sub-District and Sidomulyo Sub-District were chosen as research locations because they are one of the centers of rice production in South Lampung Regency with productivity of 4.98 tons/ha and 5.24 tons/ha [7]. The data were obtained using proportional random sampling from rice farmers in Taman Agung Village, Kalianda Sub-District and Sidorejo Village, Sidomulyo Sub-District with a total of 85 rice farmer's respondents.

The data were analysed quantitatively using the stochastic frontier production function with the method Maximum Likelihood Estimation (MLE). The mathematical model used in this study, as follows:

$$\ln Y = \alpha_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + (V_i - U_i) \quad (1)$$

Description:

Y = Rice production (Kg)
α_0 = Intercept
β_1- β_8 = Regression coefficient
X_1 = Land area (Ha)
X_2 = Seed (Kg)
X_3 = Fertilizer N (Kg)
X_4 = Fertilizer P (Kg)
X_5 = Fertilizer K (Kg)
X_6 = Liquid pesticide (Liter)
X_7 = Solid pesticide (Kg)
X_8 = Labor (work day)
V_i = Errors made due to random sampling
U_i = Effect of technical inefficiency

To determine the value of the effect of technical inefficiency in this study, the following equation as follows:

$$U_i = \delta_0 + \delta_1 \ln Z_1 + \delta_2 \ln Z_2 + \delta_3 \ln Z_3 + \delta_4 \ln Z_4 + \delta_5 \ln Z_5 + \delta_6 \ln Z_6 \quad (2)$$

Description:

U_i = Effects of technical inefficiency
δ_0 = Intercept
δ_1-δ_6 = Regression coefficient
Z_1 = Age of farmer (Years)
Z_2 = Farming experience (Years)
Z_3 = Education level (Years)
Z_4 = Frequency of attending counselling (Times)
Z_5 = Land ownership Dummy (D = 0 other, D = 1 owned)
Z_6 = Seed Dummy (D = 0 seed derivatives, D = 1 new or purchased seed)

The stochastic frontier production function and inefficiency function are carried out simultaneously with the software Frontier 4.1 using the program with the method Maximum Likelihood Estimation (MLE) [8]. The output of this program will produce the value of the technical efficiency of rice farming, with the formula:

$$TE_i = \frac{Y}{Y^*} = \frac{E\,(Y_i|U_i,X_i)}{E\,(Y_i|U_i=0,X_1)} = E[exp\ exp\ (-U_i)\ /E_i] \quad (3)$$

Description:

TE_i = Technical efficiency of farmer to i
Y = Actual production
Y^* = Potential production (obtained from the stochastic frontier production function)

Where value of TE_i ranges between 0 and 1.

If the value of TE is closer to 1 then rice farming can be said to be more technically efficient and if value of TE is getting closer to 0, then rice farming can be said to be inefficient.

Table 1. Estimation of Production Function Stochastic Frontier of Rice Farming

Variable	Coefficient	Std. Error	t-ratio
Constant	0.805 ^{ns}	0.543	1.482
Land area (X_1)	0.977***	0.117	8.301
Seed (X_2)	0.489***	0.736	6.647
Fertilizer N (X_3)	0.670***	0.818	8.193
Fertilizer P (X_4)	0.594 ^{ns}	0.411	1.446
Fertilizer K (X_5)	0.334 ^{ns}	0.292	1.144
Liquid Pesticides (X_6)	0.366***	0.385	9.510
Solid Pesticides (X_7)	-0.286 ^{ns}	0.220	-1.299
Labor (X_8)	-0.383***	0.753	-5.092
Sigma-squared	0.418***	0.134	3.121
Gamma	0.210***	0.267	7.860
Log like hood function OLS	11.090		
Log like hood function MLE	21.532		

Source: Primary Data Analysis, 2021
Note: ***) = real at the level of α 1% (t-table = 2.6411)
**) = real at the level of α 5% (t-table = 1.9912)
*) = real at the level of α 10% (t-table = 1.6648)

Economic efficiency is achieved if technical efficiency and allocative efficiency are achieved. The difference in the level of efficiency between farmers can be caused by differences in the level of technical efficiency or price by the two. Economic efficiency is the product of all technical efficiency and the price efficiency of all input factors [9].

Economic efficiency describes the ratio of the minimum observed total cost of production (C*) to the total actual total cost of production (C) [10]. In this study, economic efficiency analysis was carried out using the Cobb-Douglas stochastic frontier cost function model as follows:

$$\text{Ln } C = \beta_0 + \beta_1 \text{ In } Y + \beta_2 \text{ InP}_2 + \beta_3 \text{ InP}_3 + \beta_4 \text{ lnP}_4 + \beta_5 \text{ InP}_5 + \beta_6 \text{ InP}_6 + \beta_7 \text{ InP}_7 + \beta_8 \text{ InP}_8 + \beta_9 \text{ InP}_9 + (V_i\text{-}U_i) \quad (4)$$

Description:

Ln C = Total production costs (IDR)
Y = Rice production (Kg)
β_1- β_9 = Regression coefficient
P_2 = Land rental price (IDR)
P_3 = Price of rice seeds (IDR/Kg)
P_4 = Price of fertilizer N (IDR/Kg)
P_5 = Price of fertilizer P (IDR/Kg)
P_6 = Price of fertilizer K (IDR/Kg)
P_7 = Price of liquid pesticide (IDR/Liter)
P_8 = Price of solid pesticide (IDR/Kg)
P_9 = Price of Labor (IDR/Work day)
V_i = Errors made due to random sampling
Ui = Effects of economic inefficiency

However, things to remember in measuring cost efficiency (CE) using computational programs [8]. Therefore, the level of economic efficiency of rice farming is obtained using the formula:

$$\text{EE} = \frac{1}{Cost\ Efficiency\ (CE)} \quad (5)$$

If the value of EE is getting closer to 1, rice farming can be said to be more economically efficient and if value of EE is getting closer to 0 then rice farming can be said to be inefficient.

Economic efficiency (EE) is the product of technical efficiency (ET) and allocative efficiency (AE), therefore the value of allocative efficiency (AE) can be obtained by the equation:

$$\text{AE} = \frac{EE}{ET} \quad (6)$$

Where value of AE ranges between 0 and 1.

3. RESULTS AND DISCUSSION

3.1. Factors Influencing Rice Production

Factors that affect rice farming can be identified by using analysis of production function. The production function used in this study is the stochastic frontier with the estimation method Maximum Likelihood Estimation (MLE). Results of estimation production function of stochastic frontier rice farming can be seen in table 1.

The value of log likelihood function MLE (21.532) is greater than the log likelihood function of OLS (11.090), this shows that the model in the study is quite good to

describe the actual condition of rice farming in South Lampung Regency. Based on the results of analysis, it can be seen that the sigma-squared value is 0.418 and is significant at α 1%, so interpreted that diversity of rice production in South Lampung Regency is contributed by inefficiency effects and external effects have significant variations. Meanwhile, the gamma value is 0.210 and is significant with α 1%. This shows that the inability of farmers to achieve maximum production caused by internal factors of farmers is 21% while factors outside the control of farmers are 69%. These results are in accordance with the research [11] and [12].

The variable of land area affects rice production with a coefficient value is 0.977 and is significant at α 1%. Land area is the most responsive factor to efforts to increase production because it has the largest coefficient. Land is the most important production factor in rice farming. In addition, farmers make use of the land that is used properly so that it can produce the expected production. These results are in accordance with the research [13].

The t-count value of variable seed is 6.647 which is greater than the t-table value of 2.641 at the confidence level 99%, the meaning is seed variable has a significant effect on rice production with a coefficient value of 0.489. The rice varieties used by farmers are superior varieties so that are able to produce high production, although there are farmers who use derivative seeds but are taken from good varieties so that are able to produce good production. The varieties that are widely used by farmers like it IR 64, *Cilamaya Muncul* and *Ciherang*. This situation are in accordance with research [12].

N fertilizer is one of the important macro nutrients for the growth of rice plants. The results of the analysis showed that fertilizer N had a significant effect on rice production at the level of α 1% with a coefficient value is 0.670. N fertilizer has a content that functions to stimulate growth and give green color to the leaves so that the use of N fertilizer will help to produce high production. These results are in accordance with the research [11].

The analysis shows that of liquid pesticides has a significant effect on rice production at 99% confidence level with a coefficient value of 0.366. The use of liquid pesticides is still very dominant by farmers to help reduce pests and diseases and help increase rice production. The type of liquid pesticide used by farmers is insecticide to eradicate snails and leaf insect. This situation are in accordance with the research [11].

The labor variable has a negative coefficient of 0.383 and is significant at the confidence level 99%. The use of labor has a very important role in rice farming to optimize production, because the value of the coefficient labor is negative, the use of labor must be reduced so not to reduce the amount of output/ production. The labor is mostly use at the time of planting and harvesting, not during maintenance. The labor used at harvest time is usually 8-15 people according to the area of land planted so that the planting process can be completed immediately, while during the harvesting process, farmers who have large areas prefer to use a machine combine harvester to replace harvest labor because it is more efficient. Save harvest time while farmers with small land area prefer to use labor for harvesting. This situation are in accordance with the research [14].

3.2. Technical Efficiency, Allocative Efficiency and Economic Efficiency

Technical inefficiency is an internal error component (can be controlled by farmers) related to the managerial ability of farmers to manage their farms. The estimation of the factors that influence technical inefficiency can be seen in table 2.

Table 2. Estimation of Factors Affecting Technical Inefficiency of Rice Farming

Variable	Coefficient	Std. Error	t-ratio
Constant	-0.603***	0.185	-3.259
Farmer Age (Z_1)	0.153***	0.430	3.564
Farming experience (Z_2)	-0.146*	0.739	-1.985
Education Level (Z_3)	0.221 ^{ns}	0.137	1.612
Frequency follows the extension (Z_4)	0.863 ^{ns}	0.631	1.367
Land ownership dummy (Z_5)	-0.254**	0.954	-2.666
Seed dummy (Z_6)	-0.195**	0.784	-2.490

Source: Primary Data Analysis, 2021
Note: ***) = real at the level of α 1% (t-table = 2.6411)
**) = real at the level of α 5% (t-table = 1.9912)
*) = real at the level of α 10% (t-table = 1.6648)
^{ns}) = non-significant

Table 3. Distribution of Value Technical Efficiency of Rice Farming

Value of Technical Efficiency	Number of Farmer	Percentage (%)
0.63-0.69	3	3.53
0.70-0.76	1	1.18
0.77-0.83	10	11.76
0.84-0.91	18	21.18
0.92-0.98	53	62.35
Total	85	100
Minimum	0.63	
Maximum	0.98	
Average	0.91	

The analysis show that the variables of farmer age, farming experience, land ownership dummy and seed dummy affect the technical inefficiency of rice farming. The positive sign on the variable of farmer age shows that older the farmer so the higher level of efficiency, while the variable that has a negative sign indicates that the higher the farming experience, the more farmers cultivate not their own land and use derivative seeds, so the level of efficiency is low. This situation are in accordance with research [15] and [16].

The average value of the level of technical efficiency is 0.91 this shows that farmers are only able to achieve rice production of 91% with the use of sacrificed inputs. However, farmers still have the opportunity to increase their potential production is 8%. The level of technical efficiency achieved by rice farmers in South Lampung Regency varies from the lowest technical efficiency level of 63% to the highest technical efficiency of 98%. The most technical efficiency values are in the range of 0.95-1.00 as many 39 farmers (45.88%). Meanwhile, the lowest efficiency value is between 0.63-0.70 totaling 3 farmers (3.53%) as shown in table 3.

Economic efficiency describes the ratio of the observed minimum total production costs (C*) to the actual total production costs (C). Economic efficiency in this study is obtained through the analysis of the input side of production with the average output price prevailing at the farm level. The estimation of the cost of rice farming in South Lampung Regency can be seen in table 4.

The sigma-squared value is 0.833 and is significant at α 5%, the meaning is cost inefficiency in rice production. Meanwhile, value of gamma is 0.954 and significant with α 1%. This explains that there is a difference between the actual cost and the minimum cost caused by inefficiency of 95%. These results are in accordance with research [12] and [13]. The value of log likelihood function MLE (29.430) is greater than log likelihood function of OLS (27.268), this shows that model in this study is quite good

Table 4. Estimation of the Stochastic Frontier Cost Function of Rice Farming

Variable	Coefficient	Std. Error	t-ratio
Constant	-0.188***	0.538	-3.494
Land rental price (X_2)	0.110***	0.267	4.105
Price of Seed (X_3)	0.180 ^{ns}	0.155	1.162
Price of N fertilizer (X_4)	0.674 ^{ns}	0.449	1.500
Price of P fertilizer (X_5)	-0.137**	0.536	-2.564
Price of K fertilizer (X_6)	-0.380 ^{ns}	0.281	-1.350
Price of pesticides liquid (X_7)	0.355***	0.506	7.021
Price of pesticides solid (X_8)	0.198***	0.225	8.779
Price of labor (X_9)	0.470***	0.118	3.955
Sigma-squared	0.833**	0.332	2.503
Gamma	0.954***	0.250	3.812
Log-like hood function OLS	27.268		
Log-like hood function MLE	29.430		

Source: Primary Data Analysis, 2021

Note: ***) = real at the level of α 1% (t-table = 2.6411)
**) = real at the level of α 5% (t-table = 1.9912)
*) = real at the level of α 10% (t-table = 1.6648)
^{ns}) = non-significant

Table 5. Distribution of Value Economic Efficiency of Rice Farming

Value of Economic Efficiency	Number of Farmer	Percentage (%)
0.48-0.57	5	5.88
0.58-0.66	8	9.41
0.67-0.76	16	18.82
0.77-0.86	28	32.94
0.87-0.96	28	32.94
Total	85	100
Minimum	0.48	
Maximum	0.96	
Average	0.80	

Table 6. Distribution of Value Allocative Efficiency of Rice Farming

Value of Allocative Efficiency	Number of Farmers	Percentage (%)
0.50-0.66	8	9.41
0.67-0.85	25	29.41
0.86-1.05	44	51.76
1.06-1.24	7	8.24
1.25-1.44	1	1.18
Total	85	100
Minimum	0.50	
Maximum	1.44	
Average	0.88	

to describe the actual condition of the total cost of rice farming in South Lampung Regency.

The estimation results of the cost function show that the variables of land rent, liquid pesticide prices, solid pesticide prices and labor prices have a significant effect on the cost function with a significance of α 1% and the price of fertilizer P has a significant effect on the cost function with a significance of α 5%. Meanwhile, price of seed, price of fertilizer N and price of fertilizer K do not affect the cost function.

The average value of economic efficiency is 0.80 with an efficiency distribution of 0.48 to 0.96. Farmers to able achieve the level of economic efficiency are 56% or a total of 48 people while those not reached the level of economic efficiency are 37 people (44%) as shown in table 5. The results show that if rice farmers in South Lampung Regency to achieve the highest economic efficiency, farmers have the opportunity to save costs by (1-[0.80/0.96]) or 16% and farmers not efficient can save costs by (1-[0.48/0.96]) or 50%.

The average value of allocative efficiency of rice farming in South Lampung Regency is 0.88 with a distribution of 0.50 to 1.44 can be seen in table 6. The meaning is the majority of farmers are already efficient in allocating production factors. Allocatively efficient conditions reflect the ability of farmers to use production factors in optimal proportions according to their respective price levels. Even though already quite high, there is still room for farmers to increase it again. Another thing explains that if farmers want to achieve the highest allocative efficiency, farmers can save costs by 1-(0.88/1.44) or 38%. Meanwhile, farmers with the lowest allocative efficiency can save costs by 1-(0.50/1.44) or 65%.

4. CONCLUSION

Factors that influence the increase in rice production in South Lampung Regency are land area, N fertilizer seeds and liquid pesticides, while those that affect and reduce production are labor. The average value of technical, allocative and economic efficiency is 0.91; 0.88 and 0.80.

SUGGESTIONS

Reduce the production factor of labor so rice production in South Lampung Regency can increase. Farmers are advised to use purchased or certified seeds so achieve high production. Provide counselling to farmers that do farming on land is not owned by farmers to achieve the level of technical efficiency.

REFERENCES

[1] Jamalludin J. 2016. Analisis Faktor-Faktor Yang Mempengaruhi Produksi Padi Varietas Unggul Nasional Pada Sawah Tadah Hujan Di Kecamatan Bangkinang Kabupaten Kampar. Din Pertan. 32(2):107–114.

[2] Suparyono. 2009. PADI. Jakarta: Penebar Swadaya.

[3] Badan Pusat Statistik. 2020. Statistik Indonesia 2020. In: Jakarta: Badan Pusat Statistik.

[4] Asnawi R. 2013. Analisis Faktor-Faktor Yang Mempengaruhi Produksi Padi Sawah Inbrida dan Hibrida di Provinsi Lampung. J Sepa. 10(1):11–18.

[5] Soekartawi. 2011. Ilmu usahatani dan penelitian untuk pengembangan petani kecil. Jakarta: Universitas Indonesia.

[6] Kune SJ, Muhaimin AW, Setiawan B. 2016. Analisis Efisiensi Teknis dan Alokatif Usahatani Jagung (Studi Kasus di Desa Bitefa Kecamatan Miomafo Timur Kabupaten Timor Tengah Utara). J Agribisnis Lahan Kering. 1(2502):3–6.

[7] Badan Pusat Statistik Kabupaten Lampung Selatan. 2019. Kabupaten Lampung Selatan Dalam Angka 2019. In: Kalianda: BPS Kabupaten Lampung Selatan.

[8] Coelli TJ. 1998. A Multi-Stage Methodology for The Solution of Orientated DEA Models. Oper Res Lett. 23(3–5):143–149.

[9] Soekartawi. 1990. Teori Ekonomi Produksi Dengan Pokok Bahasan Analisis Fungsi Cobb-Douglas. Jakarta: Rajawali.

[10] Ogundari K, Ojo S. 2007. An Examination of Technical Economic and Allocative Efficiency of small Farms: The Case Study of Cassava Farmers in Osun State of Nigeria. Bulg J Agric Sci Nas Cent Agrar Sci. 13:185–195.

[11] Novitaningrum R, Supardi S, Marwanti S. 2019. Efisiensi Teknis Pengelolaan Tanaman Terpadu Padi Sawah di Kabupaten Karanganyar, Provinsi Jawa Tengah. J Agro Ekon. 37 (2):123–140.

[12] Noer SR, Zakaria WA, Murniati K. 2020. Analisis Efisiensi Produksi Usahatani Padi Ladang di Kecamatan Sidomulyo Kabupaten Lampung Selatan. J Ilmu Ilmu AgribisnisJournal Agribus Sci. 6(1):17–24.

[13] Novia RA, Satriani R. 2020. Analisis Efisiensi Teknis Usahatani Padi Sawah Tadah Hujan di Kabupaten Banyumas. MEDIAGRO. 16(1):48–59.

[14] Aziz N, Syakir F, Siswadi B. 2019. Analisis Efisiensi Ekonomi Penggunaan Faktor Produksi Padi Sawah di Desa Sukorejo Kecamatan Sukorejo, Kabupaten Ponorogo. J Sos Ekon Pertan dan Agribisnis. 7 (3).

[15] Burhansyah R. 2016. Efisiensi Teknis Usahatani Padi Tadah Hujan di Kawasan Perbatasan Kabupaten Sambas dengan Pendekatan Stochastic Frontier Fungsi Produksi (Kasus di Desa Sebubus, Kecamatan Paloh). Inform Pertan. 25 (2):163–170.

[16] Rahayu HS, Suwitra IK. 2018. Faktor Produksi dan Efisiensi Teknis Usahatani Padi Sawah pada Sistem Tanam Jajar Legowo dan Sistem Tegel di Desa Sidondo Sulawesi Tengah. Semin Nas Peran Keanekaragaman Hayati untuk Mendukung Indones sebagai Lumbung Pangan Dunia. 2 (1):100–108.