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TECHNICAL EFFICIENCY AND PRODUCTION FACTORS OF RAINFED RICE FARMING IN SOUTH SULAWESI

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ABSTRACT

Efficiency in the use of production factors is an indication of the success and sustainability of a farm. If farming has been done efficiently and at a certain level of input, then production will be optimal and maximum profit will be obtained. The allocation of efficient and effective use of production factors will determine the achievement of farming efficiency. The objective of this research is to analyze the technical efficiency of rainfed rice farming and to analyze the factors that affect the production of rainfed rice farming. Data were collected from rice farmers in Maros and Pangkep Regency, 100 farmers were taken as respondents using a multi-stage cluster random sampling technique. The analysis used is descriptive quantitative to measure technical efficiency and multiple regression for factors that affect the production of rainfed rice farming. The results showed that rainfed lowland rice farming in South Sulawesi is not yet technically inefficient. The average technical efficiency value obtained is 0.77 or 77%, meaning that farmers have the opportunity to increase their technical efficiency value to get higher yields of 16.91%. The factors that significantly affect the production of rainfed lowland rice farming in South Sulawesi are land area, number of seeds, amount of fertilizer, and amounts of pesticides.

Keywords: *technical efficiency*, *production factors*, *rainfed rice farming*

BACKGROUND

Many efforts to increase rice production have been carried out, one of which is through the intensification of rice plants (Adrianto et al., 2016). However, in practice, it is found that the potential yield of rice production is different from the actual yield obtained by farmers. The difference in results is caused by two factors, namely non-technical factors and technical factors. These non-technical and technical factors will affect the consideration of farmers to make decisions in the use of inputs such as seeds, fertilizers, labor, and pesticide, which determine the level of production and productivity of rice farming (Wahyuningsih et al., 2018; Yusuf, 2015).

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Maximum production and profits that have not been achieved due to the use of inefficient and inefficiency production factors in farming (Setiawan & Bowo, 2015; Yoko et al., 2014; Khai & Yabe, 2011). Increased productivity can be done by using production factors efficiently so that optimal production is achieved with maximum profit (Kachroo et al., 2010; Indah et al., 2015; (Rahnanita & Syamsyah, 2018; Arifin et al., 2018). Productivity and efficiency have an interrelated relationship between the two. Low productivity causes inefficient rice farming (Nafisah & Fauziyah, 2020). Rainfed lowland rice production is still low due to constraints in cultivation technology, weather changes, water availability, and reliance on rainwater as a source of irrigation (Novia & Satriani, 2020).

The harvested area of rice plants in South Sulawesi in 2019 was 1,010,188.75 ha with rice production of 5,054,166.96 tons, while the productivity was 5,003 tons/ha (BPS Provinsi Sulawesi Selatan, 2020). Based on the harvested area of rice, the irrigated rice fields were 391,147 ha and the non-irrigated fields were 262,799 ha. Maros Regency has an area of 26,114.06 ha of rice fields, consisting of 17,072.56 ha of irrigated rice fields and 9,041.50 ha of non-irrigated rice fields. Lowland rice production in Maros Regency is 324,323.11 tons with a productivity of 4.70 tons/ha (BPS Kabupaten Maros, 2019). Meanwhile, Pangkajene Kepulauan (Pangkep) Regency has an area of 16,764 ha of rice fields, consisting of 9,929 ha of irrigated rice fields and 6,835 ha of non-irrigated rice fields. Lowland rice production in Pangkep Regency is 120,903.74 tons with a productivity of 4.60 tons/ha (BPS Kabupaten Pangkajene Kepulauan, 2019).

Efficiency is an action that can minimize the loss of resources in carrying out an activity or producing something in this case the agricultural sector (Setyaningrum et al., 2020). Efficiency in the use of production factors is one indication of the success and sustainability of a farm (Sukayat & Pranamulia, 2018; Melati & Mayninda, 2020). Farming carried out by farmers, is very dependent on the ability of the farmer's management (Puspitasari, 2017). With management skills, farming can be done efficiently, not yet, or inefficient (Sularso & Sutanto, 2020). If farming has been done efficiently and at a certain level of input, then production will be optimal and maximum profit will be achieved (Wardana et al., 2018; Narala & Zala, 2010; Konja et al., 2019). The allocation of efficient and effective use of production factors will determine the achievement of farming efficiency (Murniati et al., 2014; Pudaka et al., 2018; Achandi, 2018).

The novelty of this research is that there is no research specifically discussing the problem of rainfed rice farming in terms of technical efficiency and the use of influencing production factors. Likewise, it can be used as evaluation material for policymakers in implementing the use of inputs and production factors in terms of the technical efficiency of rainfed lowland rice farming. The objectives of this study were 1) to analyze the technical efficiency of rainfed lowland rice farming, and 2) to analyze the factors that affect the production of rainfed lowland rice farming.

RESEARCH METHODS

This research was conducted in Maros Regency and Pangkep Regency. Maros Regency, namely Marusu district (Mate'ne Village), and Tompobulu district (Tompobulu Village), while Pangkep Regency is Labakkaang district (Kanaungan Village), and Bungoro district (Boriappaka Village). The research locations were chosen purposively, namely Maros Regency and Pangkep

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Regency, with the consideration that they are regencies that have extensive rainfed rice fields in South Sulawesi. The study was carried out from October to November 2020.

This study uses a quantitative approach with a survey method design. The data collected in this study include primary and secondary data. To collect data using three kinds of techniques, namely observation, recording, and interviews. The population in this study are farmers who cultivate rice farming in rainfed rice fields at the research location. The total population of this study is 1,021 people. The number of sample farmers who became respondents was 100 people. To get the number of samples using a multi-stage cluster random sampling technique. The stage is to determine that four districts have extensive rainfed rice fields, namely Marusu and Tompobulu Districts for Maros Regency, and Pangkajene and Bungoro Districts for Pangkep Regency. Then for each district, one village was selected, namely Bonto Mate'ne Village (Marusu District), Tompobulu Village (Tompobulu District), Kanaungan Village (Labakang District), and Boriappaka Village (Bungoro District). Furthermore, each village was taken as a rice farmer respondent by random sampling of 25 respondents, so the total number of respondents was 100 rice farmers.

The measurement of the technical efficiency of the production of rainfed lowland rice farming for farmer i is estimated by the following equation model (Novia & Satriani, 2020):

$$TE_i = \frac{Y_i}{Y_i^*} = \frac{exp(x_i\beta + v_i - u_i)}{exp(x_i\beta + v_i)} = exp(-u_i)$$

Information:

TE_i : Farmer's technical efficiency i

Y_i : Actual production from observation i

Y_i^* : The production estimate is obtained from the stochastic frontier production function

Three possibilities occur related to technical efficiency Rahnanita & Syamsyah (2018), namely:

1. Efficiency value = 1. This means that the effort made is efficient, and for that, the use of production factors needs to be maintained to achieve efficient conditions.
2. Efficiency value > 1. This means that the efforts made have not reached efficiency, and for that, the use of production factors needs to be increased to achieve efficient conditions.
3. Efficiency value < 1. This means that the effort made is not efficient, and for that, the use of production factors needs to be reduced to achieve efficient conditions.

The t-test decision criteria are:

1. If $t_{count} \geq t_{table}$ then reject H_0, meaning that the efficiency value is greater and less than 1, in other words, the use of production factors has not been and is not efficient.
2. If $t_{count} < t_{table}$ then accept H_0, meaning that the efficiency value is equal to 1, in other words, the use of production factors is efficient.

The technical efficiency of farming ranges from 0 to 1 (TE value is located at $0 \leq TE_i \leq 1$). Farming activities are said to be fully efficient if the value of the level of technical efficiency is equal to 1 (Hardiyanti et al., 2022; Mukwalikuli, 2018). The closer to the value of 1 the technical efficiency of a farm, the more efficient the farm is in the use of production factors (Novia & Satriani, 2020). If the value of technical efficiency > 0.8 then it can be categorized as efficient farming (Nafisah & Fauziyah, 2020).

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The Cobb-Douglass production function is used with a stochastic frontier production approach to estimate technical efficiency, and to determine the factors that affect the production of rainfed lowland rice (Rahnanita & Syamsyah, 2018), with the following equation model:

$$\text{Ln } Y = \beta_0 + \beta_1 \text{Ln } X_1 + \beta_2 \text{Ln } X_2 + \beta_3 \text{Ln } X_3 + \beta_4 \text{Ln } X_4 + \beta_5 \text{Ln } X_5 + \beta_6 \text{Ln } X_6 + (V_i - U_i)$$

Information:

Y	: Rice production (kg)
X_1	: Land area (ha)
X_2	: Amounts of seeds (kg)
X_3	: Amount of fertilizer (kg)
X_4	: Amount of pesticide (L)
X_5	: Farming experience (year)
X_6	: Level of education (year)
β_0	: Constant
$\beta_1 - \beta_6$	: Regression coefficient
$V_i - U_i$	: Error term

RESULT AND DISCUSSION

Technical Efficiency of Rainfed Rice Farming

The technical efficiency of rainfed lowland rice farming is intended to measure the level of production that can be achieved from the potential products that can be achieved by farmers. Efficiency analysis is needed to help farmers allocate production factors so that there is no waste. Efficiency in the use of inputs is very important and affects production results and profits (Sukayat & Pranamulia, 2018). Technical efficiency reflects the ability of farmers to obtain maximum output from a certain number of inputs. Technical efficiency is a combination of the ratio between inputs and outputs used by farmers to get maximum results (Rahnanita & Syamsyah, 2018).

The results of the technical efficiency analysis of rainfed lowland rice farming are shown in Table 1. The value of farming efficiency is categorized as not efficient if the value is less than 0.8 and is categorized as efficient if the value is more than 0.8 (Nafisah & Fauziyah, 2020). The difference in the results of technical efficiency between Maros Regency and Pangkep Regency can be known by using an independent sample t-test analysis.

Table 1 shows that Maros and Pangkep Regency are not more efficient than those that are technically efficient in rainfed lowland rice farming. Meanwhile, in terms of the comparison of the two regencies related to technical efficiency, Maros Regency is more technically inefficient than Pangkep Regency. The difference is in the use of production inputs, namely urea, and phonska fertilizers. Farmers in Pangkep Regency use more of this fertilizer according to the recommended dosage and recommendations compared to Maros Regency. Based on the results of the independent samples t-test, shows that there is a difference in the technical efficiency of rainfed lowland rice farming between Maros Regency and Pangkep Regency. Maros Regency is more technically inefficient than Pangkep Regency. This can happen because the use of a combination of production

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inputs carried out by rainfed rice farmers in Maros Regency and Pangkep Regency is still not optimal so farmers have not achieved technical efficiency.

Table 1. Results of Technical Efficiency Analysis of Rainfed Rice Farming in Maros and Pangkep Regencies

Efficiency Level	Maros Regency		Pangkep Regency	
	Amount of Farmers (person)	Percentage (%)	Amount of Farmers (person)	Percentage (%)
< 0,8	38	76	28	56
> 0,8	12	24	22	44
Amount	50	100	50	100
Average	0.74		0.80	
Minimum	0.50		0.41	
Maximum	1.00		1.36	
Technical Efficiency t-Test: T_{count} (Maros Regency with Pangkep Regency)	2.151**			
t_{table} (α = 5%)	(1.682)			

Source: Processed Data, 2021
Note: **) significant at α = 5%

The level of achievement of technical efficiency of rainfed lowland rice farming in Maros and Pangkep regencies have different results, this is affected by among others, the ability of farmers to master and apply technology, use of production inputs, and the ability to obtain production inputs. (Nafisah & Fauziyah, 2020), states that the level of farmers' ability to master technology can be affected by factors that are tied to the farmers, namely the farmer's age, farmer experience in farming, education, and external factors that affect the extension.

The other factors that cause differences in the application of technology are the use of production inputs, the ability of farmers to obtain production inputs, and the number of family members who have a role in using labor inputs of productive age (Nafisah & Fauziyah, 2020). Different levels of efficiency for each farmer are farmers' knowledge in applying various technologies, experience in farming, land ownership status, and education so which affects farmers' decisions in using production inputs. Sularso & Sutanto (2020), stated that the level of education describes the ability of organic rice farmers who can absorb information technology, adopt new technology, and are easy to apply the new technology received to develop their farming.

Table 2. Results of Technical Efficiency Analysis of Combined Rainfed Rice Farming in South Sulawesi Province

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Efficiency Level	Amount of Farmers (person)	Percentage (%)
< 0,8	66	66
> 0,8	34	34
Amount	100	100
Average	0.77	
Minimum	0.41	
Maximum	1.36	

Source: Processed Data, 2021

Table 2 shows that the combination of regencies (Maros + Pangkep) of South Sulawesi is more technically inefficient than technically efficient in rainfed lowland rice farming. Therefore, it is still possible to add several production factor variables to increase the amount of rice production produced. Increasing the production of rainfed lowland rice by adding several production factors until it is close to the optimum point that can be used.

The minimum technical efficiency value of combined rainfed lowland rice farmers in South Sulawesi Province is 0.41. It can be interpreted that farmers have the opportunity to increase the value of their technical efficiency to get higher yields of 43.38% of the potential output obtained from the combination of production inputs sacrificed to increase rice production. Meanwhile, the average technical efficiency value of combined rainfed lowland rice farmers in South Sulawesi Province is 0.77. It can be interpreted that farmers have the opportunity to increase the value of their technical efficiency to get a higher yield of 16.91% of the potential output obtained from the combination of production inputs sacrificed to increase rice production. Farmers can increase these opportunities by upgrading their skills and adopting more efficient rice farming technologies.

Differences in the level of technical efficiency achieved by farmers besides being caused by internal and external factors are also caused by differences in adaptation strategies carried out by farmers to the impact of climate change and farmers' good perceptions of climate change (Murniati et al., 2014). The high level of technical efficiency reflects that the managerial skills of the farmers are quite good. Lowland rice farming still has the opportunity to increase productivity by optimizing the use of farming inputs, technological innovation, and improving farm management (Yoko et al., 2014).

Production Factors for Rainfed Rice Farming

The use of production factors to determine the production of rainfed rice farming can be analyzed using the Cobb-Douglass production function model. To show the effect of production factors on rainfed lowland rice farming, it can be seen in Table 3. Based on the results of the analysis presented in Table 3, it is known that the coefficient of determination (R^2) is 0.770. This means that as much as 77% of the variation in rainfed lowland rice production can be explained by variations in the independent variables in the model. The results of the F test show that the calculated F_{count} (α: 1%), which is 51,873 is greater than the F_{table} (3,208) meaning that the independent variables jointly have a significant effect on the production of rainfed lowland rice.

Table 3. Factors Affecting Rainfed Rice Farming Production

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Variables	Regression Coefficient	t-count	Sig
Constant (C)	1.747	1.307	ns
Land area (X_1)	0.732	7.786	***
Amount of seeds (X_2)	0.255	2.473	**
Amount of fertilizer (X_3)	0.396	4.103	***
Amount of pesticide (X_4)	0.262	6.426	***
Farming experience (X_5)	0.041	0.372	ns
Education level (X_6)	0.050	0.450	ns
R^2		0.877	
R-squared		0.770	
S.E. of regression		0.447	
F-statistics		51.873 ***	

Source: Processed Data, 2021
Note:
***) : significant at 99% confidence level
**) : significant at 95% confidence level
ns : non-significant

The results of the t-test on the independent variables show that the independent variables that significantly affect the production of rainfed lowland rice are land area, number of seeds, amount of fertilizer, and amounts of pesticides. The variables of farming experience and education have no significant effect on the production of rainfed lowland rice. The coefficients of land area, number of seeds, amount of fertilizer, and amounts of pesticides are positive. This means that each addition of these production factors to a certain extent will increase the production of rainfed lowland rice.

The area of land (X_1) has a significant and positive effect on the production of rainfed lowland rice. This means that each additional land area will increase rice production. The addition of land area must be followed by good management so that it has an impact on increasing the production of rice produced. Likewise, by increasing the land area, farmers can increase the efficiency of their farming. Land area is a production factor that has a major role in increasing production because it affects the scale of farming (Puspitasari, 2021). If land expansion cannot be carried out, farmers can increase their productivity through agricultural intensification activities and improve land quality by using organic ingredients. Agricultural intensification aims to increase agricultural yields through the optimization of agricultural land (Sukayat & Pranamulia, 2018).

The amounts of seeds (X_2) had a significant and positive effect on the production of rainfed lowland rice. The average number of seeds used by farmers is 25-30 kg/ha per growing season. This condition shows that in terms of the number of seeds used, it is by the recommendations for the need for rice seeds per hectare. Generally, in the research location, the method of planting used by farmers is direct seed planting. The seeds used are the results of seed breeding carried out by farmers and purchased at the farmer's shop. Sularso & Sutanto (2020), seeds are very influential on the production of a farm and determine the results of quality products or not, and determine the level of productivity. High-yielding varieties will produce a quality product.

The amount of fertilizer (X_3) has a significant and positive effect on the production of rainfed lowland rice. This means that every increase in the amount of fertilizer to the recommended limit will

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increase rice production. Proper fertilization and according to the recommendations will increase the production of lowland rice. All farmers use urea fertilizer, while other types of fertilizers such as phonska fertilizer (NPK), SP_{18}, and potassium fertilizer are only additional or complementary fertilizers to support urea fertilizer. Puspitasari (2017), the benefits of urea fertilizer as a nutrient in the vegetative growth of plants such as leaves, roots, stems, shoots, and others. The amount of fertilizer used by rainfed rice farmers to increase the amount of production, and rational farmers to increase the amount of fertilizer used. In addition to providing nutrients, fertilization also helps prevent the loss of nutrients such as N, P, and K which are easily lost by evaporation (Faqih et al., 2020).

The amount of pesticide (X_4) has a significant and positive effect on the production of rainfed lowland rice. This means that every addition of pesticides within a certain limit by the recommendations will increase the production of rainfed lowland rice. These results indicate that the use of pesticides has not reached the maximum usage requirement so by increasing the number of pesticides to overcome pests and diseases on rice plants, production can be increased. Pesticides have a different role from other production factors. Pesticides do not increase production directly, but pesticides can save production from pests and diseases. The application of pesticides must be to the needs required by plants by the level of pest and disease attacks (Lailiyah et al., 2017).

Farming experience (X_5) had no significant effect on the production of rainfed lowland rice. The experience of farmers' farming in the research area has been long enough, but they are still lacking in terms of managing their farms with good governance. Farmers are more likely to use the old methods traditionally, although new technological innovations have been introduced and recommended for adoption. Farmers' experience in farming has no effect, because on average, in adopting and implementing rice cultivation activities, they are still passed down from generation to generation (Nurul et al., 2018).

Level of education (X_6) had no significant effect on the production of rainfed lowland rice. The average farmer in the study area is still dominated by a low level of education, namely only elementary school graduates. Formal education only learns about general knowledge and does not provide information about agriculture, so high levels of formal education are not necessarily able to manage farming well. Likewise, farmers with higher education do not necessarily have better experience in farming. Therefore, farmers can gain new knowledge and innovations related to farming management through printed media, mass media, social media, farmer groups, agricultural training centers, and agricultural extension workers (Sudalmi & Hardiatmi, 2018).

CONCLUSION AND SUGGESTION

Rainfed lowland rice farming in South Sulawesi is not yet technically inefficient. The average technical efficiency value obtained is 0.77 or 77%, meaning that farmers have the opportunity to increase their technical efficiency value to get higher yields of 16.91%. The factors that significantly affect the production of rainfed lowland rice farming in South Sulawesi are land area, number of seeds, amount of fertilizer, and amounts of pesticides.

To improve technical efficiency through the ability to manage the use of production factors, farmers are expected to be more active among farmers and also in farmer group activities. Farmers

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share knowledge or knowledge related to rice farming technology so that farmers who are not yet technically efficient can apply or imitate farmers who are already technically efficient.

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