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MEASURING TECHNICAL EFFICIENCY OF DRY-SEASON RICE FARMING USING A STOCHASTIC FRONTIER APPROACH: EVIDENCE FROM DILEM VILLAGE, MALANG, INDONESIA

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Abstract. Rice farming in Indonesia is strongly influenced by seasonal conditions, particularly the contrast between the rainy and dry seasons. Climate change has altered the timing and patterns of these seasons, with the dry season becoming shorter and more irregular, affecting input utilization and the technical efficiency of rice farming. This study aims to analyze the production factors influencing rice output, estimate technical efficiency levels, and identify the determinants of technical efficiency in dry-season rice farming. A quantitative approach was employed using a Stochastic Production Frontier (SPF) model to estimate technical efficiency, while a Tobit regression model was applied to examine factors influencing efficiency levels. The study used primary data collected from 93 rice farmers selected by random sampling. The empirical results indicate that land area, seed, and urea fertilizer have a positive and significant effect on rice production during the dry season. The estimated mean technical efficiency score of 0.792 suggests that rice farmers operate at a relatively efficient level, although there remains potential to improve efficiency through better input management further. Furthermore, farming experience and farmers' participation in agricultural extension and training programs were found to positively and significantly influence technical efficiency. These findings imply that effective management of production inputs and human capital development are important for enhancing efficiency in dry-season rice farming. Therefore, strengthening agricultural extension services and promoting continuous learning and technology adoption among farmers are essential to improve the overall efficiency and productivity of rice farming systems under changing climatic conditions.

Keywords: dilem; technical efficiency; dry season; Hapless; Rice

INTRODUCTION

The agricultural sector, especially the food crop subsector, has an important role in maintaining national food security. Among food crops, rice is the primary source of carbohydrates for most of Indonesia's population (Deras & Gultom, 2022; Kusnadi et al., 2011; Syam & Taher, 2023). However, rice productivity is strongly influenced by climatic conditions and the growing season. One of the main challenges farmers face is the decline in irrigation water availability during the dry season, which directly affects input use efficiency and production outcomes. Seasonal changes affect the rice planting season; the rainy season is longer than the dry season (Putri et al., 2025; Ramadani et al., 2024; Salampessy, 2018; Sudirah et al., 2020).

Rice farming in Indonesia is greatly influenced by seasonal conditions, particularly between the rainy and dry seasons. In the rainy season, abundant water supports rice growth, but the risk of pest and disease attacks increases due to high humidity. In contrast, during the dry season, water scarcity is a major challenge, although pest infestation rates tend to be lower. Research shows that productivity and income from rice farming in the dry season are higher than in the rainy season because the risk of pest and disease attacks is lower. Farmers' income in the dry season is higher than in the rainy season (Lukman et al., 2021; Bride, 2020; Salampessy, 2018). Other opinions expressed by Ramadani et al. (2021) are that the risk to rice farmers' income in the rainy season is lower than that in the dry season. Caso et al. (2019; Putri et al. (2025), it also states that rice farmers' production and income are higher in the rainy season than in the dry season. Therefore, farmers must manage water resources wisely and apply proper cultivation techniques to maximize yields during the dry season.

Changes in seasons characterize climate change. Changes in the rainy and dry seasons affect agriculture, especially rice. Production will decrease if water management during the rainy and dry seasons is not properly implemented. The types of rice fields in Indonesia are mostly irrigated and rainfed. The irrigation flowing through the rice fields has not been sufficient, so some farmers use pump machines to irrigate their fields (Sau et al., 2024; Mekse & Arisena, 2020; Bride, 2020). According to Putri et al. (2025) strategies to reduce production declines in the two seasons include preventing pest and disease attacks, using superior varieties, season-sensitive cultivation techniques, balanced fertilization, and proper water management.

According to Saeri et al. (2024 and Sudrajat (2020), production problems related to farming practices, which are always dependent on the environment, are exacerbated by risk factors that create high opportunities for production failure, thereby increasing the risk of low income for farmers. The risks faced by rice farmers can include yield, production, selling price, and income risks. The risk of yield or production may be caused, among other things, by pest and disease attacks, weather or other natural conditions, problematic water supply, and variations in inputs. Natural conditions are known to have a significant influence on yield variations; for example, very large or very small rainfall can cause crop failure. Unpredictable weather conditions are often the cause of declines in the production and productivity of rice crops grown by farmers. In addition to natural conditions (weather), the land, seed, Urea, Herbicides, and workforce, it is also indicated to have a real effect on rice field agricultural production (Anugrah et al., 2024; Azis & Shafriani, 2024; Mamilianti et al., 2024).

The agricultural sector is the backbone of the economy in many rural areas of Indonesia, including in Malang Regency, East Java Province. Rice commodities are one of the main commodities that play an important role in maintaining food security and farmers' welfare. Kepanjen District, as one of the rice production centers in Malang Regency, has a fairly wide agricultural land potential, supported by a technical irrigation system and generations-old rice cultivation. However, rice productivity in this region still fluctuates, especially during the dry growing season, when water availability is the main limiting factor (Hidayatullah & Akbar, 2023).

The dry season poses challenges for farmers in efficiently managing resources. The limited supply of irrigation water often forces farmers to adjust planting patterns, change planting times, and reduce the intensity of the use of certain inputs such as fertilizers and labor. These conditions can affect the level of technical efficiency, namely the ability of farmers to utilize production inputs (land, labor, seeds, fertilizers, and water) to produce output optimally (Kusumaningsih et al., 2023; Anang et al., 2016; Yang et al., 2018; Zulkarnain et al., 2022). Inefficiencies in input use result in suboptimal productivity and higher production costs, especially during drought-prone dry seasons.

Technical efficiency in rice farming is influenced by various factors, including farmers' characteristics and the use of production inputs (Heryono et al., 2016; Jalilov et al., 2019; Widyantari et al., 2023). The age of farmers affects technical efficiency, with younger farmers being more adaptable to modern agricultural technology than older ones (Bozoğlu & Ceyhan, 2007; Ramadani et al., 2024). Education level is also an important factor because farmers with higher education are more likely to understand and adopt agricultural innovations that can increase productivity (Anam et al., 2025; Ihsan et al., 2021; Wijaya et al, 2022). In addition, experience in farming enhances land management skills and strategies, thereby improving technical efficiency. Other factors, such as the use of organic fertilizers and the family dependency ratio, also affect technical efficiency: organic fertilizers have been shown to increase soil fertility and crop yields, while the high economic burden on families can lead to inefficiencies in the management of agricultural resources.

The efficiency of farming is determined by the work of production factors such as the quantity and quality of production, the price of production products, the quantity and quality of inputs and the price of production inputs. The size of the input depends on the technical conditions of farming, such as the adequacy of water, weather, pests/diseases and other forms of maintenance. The problem of this study is how the production factors affect the productivity of paddy rice in the dry season, how is the level of technical efficiency of paddy rice farming in Dilem Village in the dry season, how are the factors that affect the technical efficiency of paddy rice farming. The purpose of this study is to analyze the production factors that affect the productivity of paddy rice in the dry season, analyze the level of technical efficiency of paddy rice farming in Dilem Village in the dry season, and analyze the factors that affect the technical efficiency of paddy rice farming in the dry season.

This research can provide a clear picture of farmers' technical efficiency in using production inputs during the dry season. This kind of research can also help identify production factors that significantly affect crop yields, such as land area and fertilizer use. The results of this study are expected to provide a clear picture of technical efficiency at the farmer level and to serve as a basis for local governments, agricultural extension workers, and related parties in formulating strategies to improve the efficiency and sustainability of rice farming in the region. In addition, the analysis can reveal the average technical efficiency level among farmers. By understanding the obstacles and opportunities, farmers can optimize resource use during the dry season, thereby increasing their welfare and maintaining regional food security.

However, despite the extensive literature on technical efficiency in rice farming, most previous studies focus on average production conditions or the rainy season, with limited attention given to dry-season rice farming under increasing climate variability. Moreover, empirical evidence at the micro level, particularly at the village scale, remains relatively scarce, even though farmers' production decisions are highly context-specific. This study addresses this gap by examining the technical efficiency of dry-season rice farming using a Stochastic Frontier Analysis approach at the farm level in Dilem Village, Malang, Indonesia. By incorporating socio-economic factors and extension participation into the efficiency analysis, this research provides empirical evidence that is relevant for designing location-specific policies to improve input efficiency, farmers' adaptability, and the sustainability of rice farming under dry-season conditions.

METHODS

2.1 Research Location

This research was conducted in Dilem Village, Kepanjen District, Malang Regency, East Java, where rice farming is the main livelihood, and the village is one of the rice production centers in Malang Regency. The selection of this location is expected to provide an accurate picture of the technical efficiency of paddy rice farming during the dry season.

2.2 Population and Sampling Technique

The population of this study consists of 120 rice farmers in the research location who were actively farming at the time of data collection. The sample size was determined using the Slovin formula with an error tolerance (α) of 0.05, resulting in 93 respondents. The respondents were selected using a simple random sampling technique.

2.3 Types and Sources of Data

The data used are both primary and secondary. Secondary data are obtained from the Agriculture Office, the Central Statistics Agency (BPS), and Farmer Groups. The secondary data collected included regional agricultural statistics, farmer data, land productivity, climate and rainfall information, and other related data that support the analysis of the technical efficiency of paddy rice farming during the dry season. Primary data was obtained through face-to-face interviews with rice farmers using a structured questionnaire.

2.4 Data Analysis Method

The information collected covers various aspects of farming, such as the area of land cultivated and the number and types of production inputs. The inputs used include land, fertilizers, pesticides, and labor. In addition, to see the factors that affect the technical efficiency of the information collected, among others, the socio-economic data of farmers. This study uses a quantitative approach. The quantitative approach applied includes the analysis of frontier production functions, the measurement of technical efficiency levels, and the analysis of factors affecting technical efficiency in paddy rice farming in Dilem Village, Kepanjen District, Malang Regency. To analyze the influence of production factors on rice productivity during the dry season, this study uses a Cobb-Douglas production function with Stochastic Frontier Analysis (SFA). The Cobb-Douglas production function was chosen because it is flexible, can show a non-linear relationship between inputs and outputs in logarithmic form, and makes it easier to estimate the production elasticity of each input used by farmers. Production function model Cobb-Douglas with the stochastic frontier approach, it is formulated as follows:

$$Y_{i=}\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \varepsilon \text{ .... (1)}$$

Where Yi = output or rice production when observed in kg units, X_{1i} is land area measured in hectares (ha), X_{2i} is seeds measured in kilograms, X_{3i} is urea fertilizer measured in kilograms, X_{4i} is ponska fertilizer measured in kilograms, X_{5i} is labor measured in units of working days (HOK), X_{6i} is a pesticide measured in liters, β_0 is a constant or intercept, β_1 to β_6 is the parameter coefficient of each input and Ɛ is a normally distributed error term.

The level of technical efficiency of rice farming is measured through the Stochastic Production Frontier approach. Output-oriented technical efficiency measurements are the most commonly observed ratio of output to stochastic frontier output. The basic equation of rice production function at the research site using the stochastic frontier approach is as shown in the following equation.

$$TE = \frac{y_i}{y_i^*} = \frac{\exp(x_i\beta + v_i - u_i)}{\exp(x_i\beta + v_i)} = \exp(-u_i) \text{ .... (2)}$$

Where TE is the value of the technical efficiency of the farmer to $-i$ with a range of 0 to 1, if the TE value is close to 1 indicates that the farmer is efficient in using inputs to produce output and TE that is far from 1 indicates that there are still technical inefficiencies in the production process. The parameter estimation of the SFA model is carried out using statistical software such as Frontier 4.1 can calculate the value of the production function parameter as well as the technical efficiency value for each respondent farmer.

After obtaining the technical efficiency value of each farmer through model estimation *Stochastic Frontier Analysis (SFA*), the next stage is to analyze the factors that affect the level of technical efficiency. This analysis is performed using multiple linear regression or tobit regression, depending on the characteristics of the technical efficiency data (which are between 0 and 1). In this study, the approach used is tobit regression, because the value of technical efficiency () is limited (censored) between 0 and 1. The tobit model allows for appropriate estimation for dependent variables with such constraints. The tobit model is written as follows:

$$ETi_1^* = \alpha_0 + \alpha_1 Z_{1i} + \alpha_2 Z_{2i} + \alpha_3 Z_{3i} + \alpha_4 Z_{4i} + \alpha_5 Z_{5i} + \varepsilon_i \text{ .... (3)}$$

Where ETi is the value of technical efficiency with the condition $0 < ET_i \leq 1$, Z1i is the farmer's age measured by years, Z_{2i} is the level of formal education measured by years, Z_{3i} is farming experience measured by years, Z_{4i} number of family members is measured by people, Z_{5i} access to agricultural extension/training is seen the number of times farmers follow it in a year. α_0 constant, α_1 to α_5 parameter coefficients and Ɛi is an error term that is normally distributed. This analysis aims to find out whether socioeconomic factors such as age, education, experience, number of family dependents, and extension intensity have a significant influence on the level of technical efficiency of farmers. Parameter estimation is done with the help of statistical software such as EViews, which is able to handle censored data in the tobit model.

RESULTS AND DISCUSSION

3.1 Description of variable statistics

Statistical descriptions of variables provide an overview of the data used in the study. This analysis aims to explain the distribution, central tendencies, and variations of each research variable before further analysis is carried out. Using descriptive statistics, researchers can determine the mean, maximum, and minimum values, as well as the level of dispersion (standard deviation) for each observed variable. The statistical description of the variables in this study is presented in Tables 1 and 2.

Table 1. Statistical description of factors of production

Variable	Variable Size	Statistical Description of Production Variables			
		Minimum	Maximum.	Mean	Std. dev.
Production	Kilogram	750	10.000	3.596,67	2.594,33
Land	Hectares	0,1	1,7	0,645	0,471
Seed	Kilogram	2	60	15,633	17,305
Urea	Kilogram	50	600	182,083	147,801
Ponska	Kilogram	20	400	107,416	100,551
Pesticides	Litre	0,5	12,5	3,29	2,437
Workforce	Workers' Day (HOK)	6	156	37,45	31,357

Source: Primary Data, 2024 (Processed)

Table 1 shows that the distance between the minimum and maximum in agricultural production is rather far, because rice production follows the area of land that farmers are trying to cultivate rice. However, the standard deviation relative to the average is not much different; it indicates that the data has high variation. Meanwhile, the farmers' rice fields average 0.645 hectares, with a standard deviation of 0.471, ranging from 0.1 to 1.7 hectares. It shows that the area of rice fields used for rice farming has diversity among respondent farmers. The average rice seed is 15,633 kg per planting season, with a standard deviation of 17,305, a minimum of 2 kg, and a maximum of 60 kg. The mean and standard deviation are very close, indicating that the data are heterogeneous. The use of fertilizers by farmers, both urea and ponska, also indicates the variation/diversity of this data, as shown by the standard deviation, which is close to the average. The average urea fertilizer is 182,083 kg, with a standard deviation of 147,801; the minimum is 50 kg, and the maximum is 600 kg. Ponska fertilizer averaged 107,416 kg, with a standard deviation of 100,551, a minimum of 20 kg, and a maximum of 400 kg.

Meanwhile, the pesticide variable averaged 3.29 liters per planting season, with a standard deviation of 2.437 liters, a minimum of 0.5, and a maximum of 12.5 liters. Pesticide use is adjusted to pest and plant disease pressure during the planting season; when HPT is high, farmers tend to use higher doses. Pesticide application is carried out regularly, including during HPT attacks. Labor inputs average 37.45 HOK/ha, with a standard deviation of 31.357 HOK/ha, a minimum of 6 HOK/ha, and a maximum of 156 HOK/ha. It shows that there is variation in the number of workers; farmers still rely on labor, even though some farming activities use agricultural tools such as tractors and harvesting equipment.

Overall, the results of this descriptive statistical analysis show that each production factor variable exhibits variation, or heterogeneity. Variables with low standard deviation indicated relatively uniform use of inputs among respondent farmers, while variables with high standard deviation indicated considerable differences in farming practices. This information is important for identifying the characteristics of the respondent farmers related to the use of production factors before analyzing technical efficiency levels using the frontier stochastic method.

Statistical descriptions of the variables that affect technical efficiency are presented in Table 2. The independent variables used in the tobit regression analysis are age, education, farming experience, number of family members, Access to agricultural extension/training, while technical efficiency is the dependent variable.

Table 2. Statistical description of factors affecting technical efficiency

Variable	Variable Size	Statistical Description			
		Minimum	Maximum.	Mean	Std.dev
Technical efficiency	Efficiency value	0,567	0,896	0,792	0,365
Age	Year	24	74	51,03	24,23
education	Year	5	18	8,49	3,83
Farming experience	Year	3	50	27,25	14,73
Number of family members	person	1	6	3,84	2,42
Counseling/training	Numbers 1, 2, 3...	0	5	3,84	1,41

Source: Primary Data, 2024 (Processed)

Table 2 shows the statistical description of variables that affect technical efficiency. Tobit regression analysis was used to examine these variables: technical efficiency, age, education, farming experience, number of family members, breastfeeding, and training. The average input technical efficiency is 0.792 with a standard deviation value of 0.365. The average age of farmers is 51.03 years, with a standard deviation of 24.23 years, a minimum of 24 years, and a maximum of 74 years. That shows the respondents' average age is lower, as most are over 45 and continue farming. The average farming experience of 27.25 years shows that, although the average age of farmers is over 45, they have sufficient experience in rice farming, with a maximum of 50 years. Not all farmers participated in counseling and training in 2024, as shown by a minimum value of 0, indicating that they did not participate.

Meanwhile, the number of family members ranges from 1 to 16, with an average of 2.84 and a standard deviation of 2.42. The number of family members is the number of family members who are still dependent on the farmer, whether they live in the same house or not. The maximum value of 5, with a standard deviation of 1.41, shows that the frequency of farmers participating in counseling and training varies, ranging from never participating (value 0) to 5 times in 2024. The results of this descriptive analysis, shown in Table 2, explain that each variable has a different level of variation. This information is important for understanding the characteristics of the farmers as a sample before the Tobit analysis is carried out.

3.2 Production factors that affect production

The Stochastic Frontier *production function model* is used in this study to determine the factors affecting rice production among farmers in Clumprit Village, Pagelaran District, Malang Regency. The *Stochastic Frontier* production function is also used to determine the level of efficiency achieved by each respondent farmer in producing rice. The parameter used in this study is *the Maximum Likelihood Estimate* (MLE) parameter. These parameters can describe the relationship between the maximum production (*output*) achievable at the level of use of existing factors of production (*inputs*). The MLE value in this study was obtained from data processing using the Frontier 4.1 program. The following are the results of estimating *the production function using the Stochastic Frontier* model with the MLE approach.

Table 3. Results of Stochastic Frontier Production Estimation with MLE Approach

Variable	Coefficient	*Standard-Error*	T-Ratio
Constant	***0,2775	0,5937	4.6747
Land Area (X1)	***0.6540	0,1722	3.7981
Seeds (X2)	*0,5460	0,8065	1,9463
Urea (X3)	*0,2064	0,2078	1,6272
Ponska (X4)	0,1471	0,6209	0.4294
Pesticides (X5)	0,4887	0,2112	0,8921
Labor (X6)	-0,4589	0,5623	-0.0161
Log Likelihood function MLE			-0.71245

Description: *significant at α = 0.1
**significant at α = 0.05
***significant at α = 0.01

Source: Primary Data, 2024 (Processed)

Table 3 shows the *log-likelihood values*. An MLE of -0.71245 means that a value close to 0 indicates a good match between the model and the data. Table 3 also shows that the land area production factor has a coefficient of 0.65408 and a T Ratio of 3.7981, indicating that land area has a significant effect on rice paddy production in Dilem Village. Mathematically, the coefficient is positive, indicating that every increase in land area will increase rice production. Field conditions indicate that most rice farmers in Dilem Village have relatively small landholdings, averaging < 0.5 hectares. Optimal increases in rice field production will follow increases in land area in Dilem Village. Research supports this result, which indicates that land affects production (Asmara et al., 2022; Bride, 2020; Utami & Mamilianti, 2021).

The estimation results showed that the seed variable had a positive coefficient value of 0.54608 and a T-Ratio of 3.7981. This shows that increasing the number of seeds used will positively affect paddy rice production. Using high-quality seeds at the right time and in the right amount is needed to increase rice production. In the dry season, seed use will be greater because it is used to replace dead plants. Urea Fertilizer has a positive coefficient value of 0.20649 with a T-Ratio 1,6272. That means, mathematically, that using urea fertilizer has a positive impact on production; increasing its use increases production. That indicates that fertilizer use in the dry season affects plant growth and can be readily absorbed by plants. The use of urea fertilizer affects this production, in line with previous research showing that urea fertilizer is essential for rice plants' proper growth and development, thereby affecting rice production (Novitaningrum et al., 2019; Yang et al., 2018; Zulkarnain et al., 2022). The Ponska fertilizer variable also shows a positive coefficient of 0.14714 with a T-Ratio of 0.4294, but its effect on production is not significant. Ponska fertilizer helps meet the macronutrient requirements of rice plants for optimal growth. The use of Ponska fertilizer at the respondent farmer level was below the recommended dose, due to high prices and the farmer not receiving subsidies. The average use of Ponska fertilizer by farmers was 240 kg/ha, lower than the recommended dosage of 300 kg/ha. The use of Ponska fertilizer, which contains NPK elements, can help rice plant growth during the vegetative phase. Therefore, if it is used less, rice growth will slow down, especially during the dry season. The dry season is short on water, so using Ponska at a lower than recommended dosage does not affect plant growth. The dry season is short of water, so the absorption of nutrients by rice plants from Ponska fertilizer is suboptimal, and growth slows, especially during the vegetative phase (Sau et al., 2024; Dirgantari et al., 2024).

The pesticide variable has a positive coefficient of 0.48870 with a T-Ratio of 0.8921. The proper use of pesticides can prevent pest and disease attacks, thereby supporting increased yields. However, this does not suggest that some farmers may not be using pesticides promptly or at the correct dose. The results of this study are in line with the research by Sularso et al. (2020), which found that the use of pesticides has no effect on increasing production. Pesticides do not directly impact rice production, especially during the dry season. Farmers focus more on providing water and nutrients to mitigate drought-related plant stress. Pesticide application depends on the severity of pest and disease attacks on the rice plants. Pesticide application during the dry season requires precise dosage and timing, especially during severe pest and disease outbreaks, which are more common in the dry season, such as those involving rats, brown planthoppers, and caterpillars.

The labor factor showed a negative coefficient value of -0.45897 with a T-Ratio of -0.0161. This means that, statistically, labor has no real effect on production, even though it appears to have a negative influence. It can occur due to inefficiencies in labor use, such as suboptimal task division or the use of family labor that is not economically calculated. During the dry season, farmers require labor to manage irrigation. This additional labor is not commensurate with the increase in rice production during the dry season. The average labor used for rice cultivation during the dry season by farmers is 102 HOK/ha. Rice cultivation work tends to decrease in intensity during the dry season, so the additional labor does not affect crop productivity.

Overall, the production factors that tend to have a positive effect on paddy rice production in Dilem Village are seeds, urea fertilizers, NPK fertilizers, and pesticides, although statistically some are not significant. Therefore, to increase the productivity of paddy field farming, farmers need to improve the efficiency of input use, supported by counseling and the adoption of appropriate technologies, so that the inputs used deliver maximum results.

3.3 The Technical Efficiency of Rice Farming

Technical Efficiency is the ability of farmers to combine inputs to produce the maximum output. In this study, the technical efficiency of rice production was analyzed using the Stochastic Frontier production function with the Maximum Likelihood Estimation (MLE) method. The estimation process was carried out using Frontier 4.1, yielding technical efficiency scores for each respondent.

To facilitate the interpretation of the results, the level of technical efficiency is classified into three categories, namely the high category if it has a technical efficiency value of $0.789 \leq ET \leq 0.896$, the medium category if the efficiency value is $0.678 \leq ET \leq 0.788$, and the low category if the efficiency value is in the range of $0.567 \leq ET \leq 0.677$. Based on the analysis, the highest technical efficiency is 0.896, the lowest is 0.567, and the average is 0.792. That shows that most farmers in the study site have managed their farms quite efficiently.

Table 4. Distribution of Respondents' Technical Efficiency

No.	Technical Efficiency Level	Category	Number of Farmers	Percentage
1.	0.567 ≤ AND ≤ 0.677	Low	2	2,15%
2.	0.678 ≤ AND ≤ 0.788	Keep	35	37,63%
3.	0.789 ≤ AND ≤ 0.896	Tall	56	60,22%
Sum			93	
Maximum ET		0,896		
Minimum AND		0,567		
Average		0,792		

Source: Primary Data, 2024 (Processed)

Table 4 shows that most respondents are in the high category (0.789 ≤ ET ≤ 0.896), namely 56 respondents, representing 60.22% of the 93 respondents. Respondent farmers in the medium category (0.678 ≤ ET ≤ 0.788) numbered 35, representing 37.63% of the total number of respondent farmers. The low technical efficiency category (0.567 ≤ ET ≤ 0.677) has the lowest number of respondents, namely 2 people, representing 2.15 percent of the total number of respondent farmers.

According to Hakim et al. (2021), if the efficiency value is close to 0, the technical efficiency is less efficient, and vice versa: if the efficiency value is close to 1, the technical efficiency is more efficient. The highest level of technical efficiency achieved by farmers in rice production, based on Table 4, is 0.792. That can be interpreted to mean that the respondent farmers can reach 79.2% of the potential production from the combination of production inputs and have the opportunity to increase rice production by a percentage. The lowest level of technical efficiency in rice production achieved by the respondent farmers was 20.2%. Low technical efficiency values can result from inefficient use of production factors, such as combining inputs in rice production at levels below recommended levels.

The difference in the level of technical efficiency achieved by farmers illustrates variation in the mastery and application of technology in farming. These variations are not only influenced by internal factors such as education level, farming experience, and age, but also by external factors such as the intensity of extension and access to agricultural information. A high level of technical efficiency indicates that farmers can manage their farming resources effectively and use inputs efficiently to produce optimal output (Hoang et al., 2021; Kusnadi et al., 2011; Ramadani et al., 2024). However, near-maximum technical efficiency suggests that opportunities for productivity improvements are still limited. That is because the gap between actual and potential productivity is quite narrow, so to increase production yields, new technological innovations or improvements in management quality are needed (Abate et al., 2019; Haile, 2018; Le et al., 2019).

The results of a study on the technical efficiency of paddy rice farming in the dry planting season in Dilem Village, Kepanjen District, Malang Regency show that most farmers are in the high-efficiency category. This condition shows that farmers in the region have been quite good at utilizing existing agricultural resources. However, there are still a small number of farmers who are in the low-efficiency category, which shows the need to increase the capacity of farmers in terms of knowledge, technical skills, and assistance from related parties so that production efficiency can continue to be improved.

Table 5. Factors that affect the technical efficiency of rice farming

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Constant	0.786751	0.051883	15.16382	0.0000
Age	-0.000645	0.000594	-1.087481	0.2768
Education	0.002720	0.002331	1.166888	0.2433
Farming Experience	*0.000173	0.000447	0.387146	0.0986
Number of Family Members	0.003067	0.001991	1.540274	0.1235
Counseling and training	**0.005296	0.012579	0.421070	0.0376

Description: *significant at α = 0.1
**significant at α = 0.05
***significant at α = 0.01

Source: Primary Data, 2024 (Processed)

3.4 Factors affecting technical efficiency

Based on the analysis in the Table 5, the land status variable has a coefficient of -0.003556 and a p-value of 0.7154. That shows that land status negatively affects the technical efficiency of paddy farming during the dry planting season in Dilem Village, Kepanjen District, Malang Regency. However, the effect is not significant at the real level of 5%. It means that whether the land is owned or leased has no real effect on technical efficiency. Farmers with leased and self-owned land have relatively the same technical efficiency.

The analysis showed that the age variable had a coefficient of -0.000645 and a p-value of 0.2768. This indicates that farmers' age negatively affects technical efficiency, but this effect is not significant at the 1%, 5%, dan 10% levels. The education variable has a coefficient of 0.002720 and a p-value of 0.2433. However, the influence is not significant at the 1%, 5%, and 10% levels of significance. That aligns with the finding that formal education is not always directly related to agricultural technical skills. The results of this study are consistent with those of Widyastiara et al. (2023), who found that education does not affect technical efficiency in rice farming. Farmers with higher education are likely to prefer non-farm work, resulting in less time, effort, and attention devoted to farming. Farming experience has a coefficient of 0.000173 with a probability of 0.0986. It shows that farming has a significant positive effect on technical efficiency at the 10% level. That means farmers with many years of experience can manage their farms even during the dry season. Farming experience is comparable to the managerial abilities or technical skills of farmers. Farmer experience is a crucial factor influencing technical efficiency, as the dry season requires strong managerial skills in input management to optimize output growth. Farmers face limited water resources, pest and disease dynamics, and extreme conditions associated with changing rainy and dry seasons. Farmer experience helps mitigate production risks during the dry season, reducing production uncertainty.

The analysis showed that the variable number of family members had a coefficient of 0.003067 and a p-value of 0.0376. It indicates a positive influence on the technical efficiency of paddy rice farming; this influence is significant at the 5% real level. In other words, the more family members, the more likely they are to increase technical efficiency, given the potential for family labor to be involved in production. However, statistically, this influence has not been proven to be significant. It can be caused by not all family members actively participating in farming activities, or by family members' work skills being inadequate to improve technical efficiency optimally.

Based on the analysis, the extension and training variables have coefficients of 0.005296 and probabilities of 0.6737. It shows that the use of alsinta has a positive effect on technical efficiency, but the effect is not significant at the 5% level. It means that farmers who participate in counseling and training tend to be more technically efficient. Farmers who participate in counseling and training have opportunities to adopt more innovative technologies. Knowledge and skills in farm management are better. Several studies have found that farmers who participate in counseling and training, both organized by PPL or the government or other agencies, will improve their ability to use technology and managerial skills so that their farming is more efficient (Haryanto et al., 2015; Jannah et al., 2024; Sun & Li, 2021). Among the variables, the ones with a significant effect on the technical efficiency of paddy rice farming in Dilem Village are farming experience and farmers' participation in counseling and training activities. Other variables, such as age, education, and number of family members, did not have a significant effect, although some showed a positive direction.

CONCLUSION

The conclusion of this study is that dry season rice farming at the study site shows that the factors that have a significant effect on rice production are land, seeds and urea fertilizer, other factors are influential but not significant. The average level of technical efficiency of farming shows that farmers are efficient in the use of inputs with an average technical efficiency of 0.792, meaning that farmers have been technically efficient in rice farming. Factors that affect the level of technical efficiency are farming experience and farmers' participation in extension and training activities. Based on the findings of this study, it is expected that extension and training activities for farmers will be strengthened, particularly in irrigation management, the use of mechanization and technology for water and other input management, and training on drought-tolerant cultivation technologies. Given the impacts of climate change on shifts in rainy and dry seasons, farmers are expected to become more adaptive in utilizing technology and improving managerial practices. Government attention is needed in providing production infrastructure and facilities, especially for water management, drought-tolerant varieties, and soil management using organic fertilizers.

The findings imply that agricultural policies should prioritize strengthening extension and farmer training programs focused on efficient input use and dry-season cultivation practices. Government intervention is particularly required to improve irrigation infrastructure, promote water-saving technologies, and facilitate farmers' access to drought-tolerant rice varieties. In addition, policies that support the adoption of mechanization and sustainable soil management practices, including the use of organic fertilizers, are essential to enhance technical efficiency and farmers' resilience to climate variability.

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