Analysis Efficiency of Rice Production in Satar Mese District, Manggarai Regency, East Nusa Tenggara

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Abstract. The Integrated Village Economic Transformation (TEKAD) program focuses on Satar Mese District, Manggarai Regency, East Nusa Tenggara Province, which produces the superior commodity of lowland rice. Many factors influence the production of lowland rice, and it remains necessary to identify the most significant and efficient ones. In addition, the effectiveness of pesticide and non-pesticide use in rice production is still a mystery. The aim of the research is to analyse the influence of paddy production factors on production, the level of efficiency in using production factors, and compare farmers who use and do not use pesticides. The sample consisted of 60 farmers. The analysis methods are multiple linear regression of the Cobb-Douglas function, economic efficiency analysis, and comparative productivity analysis. The results of the partial regression analysis show that land area, seeds, fertilizer, and pesticides have a significant effect, while labor factors do not. A simultaneous regression analysis confirms the significant influence of all production factors. Furthermore, analysis of the economic efficiency of lowland rice production shows that the production factor of land area is efficient, while seeds, fertiliser, pesticides, and labour are economically inefficient. There is no difference in production between lowland rice farming with pesticides and non-pesticides.

1 Introduction

The food commodity most widely grown in Indonesia is rice [1], with production reaching 55.67 million tons in 2022 [2]. Meanwhile, 97% of the Indonesian population consumes rice daily [3], or 114.6 kg per capita per year [4]. The high demand for rice has not been matched by rice production, so the government imports from several Asian countries. For example, in 2021, rice imports amounted to 407,741.4 tons [5]. The government continues to strive to build and develop agriculture, especially rice barns in the regions of Sumatra, Kalimantan, Java, Sulawesi, Papua, Bali, and the Nusa Tenggara Islands, including East Nusa Tenggara (NTT).

One of the agricultural developments and development activities is IFAD (International Fund for Agriculture Development), with the Integrated Village Economic Transformation

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(TEKAD) program, which aims to accelerate village economic development in underdeveloped areas of Eastern Indonesia based on selected village superior commodities [6]. NTT is one of the locations for the TEKAD program based on food crop commodities, namely lowland rice.

The NTT region produces 756,050 tonnes of lowland rice from a harvested area of 273.46 hectares [2], making rice the second largest staple food commodity after corn. Some of the leading rice-producing districts are West Manggarai, with a production of 124,087 tons; Manggarai at 88,359 tons; and East Manggarai at 77,979 tons [2]. Manggarai Regency became the second largest rice-producing center in 2018, with a land area of 22,470 ha, producing 107,061 tonnes of rice production, spread across 12 sub-districts [7]. The three largest rice-producing sub-districts are Satar Mese (30,080 tons), West Satar Mese (20,572 tons), and Ruteng (12,022 tons).

Satar Mese District is the largest rice producer, with production sources from Lolang, Ngaker, and Papang villages. The rice fields in Lolang Village are 89.4 hectares, Ngaker Village is 650 hectares, and Papang Village is 640 hectares [7]. The three villages are close together and carry out lowland rice cultivation activities by managing agricultural production factors such as land, seeds, fertilizer, labor, and pesticides. In managing these production factors, farmers in the village do not yet know the factors that greatly and efficiently influence lowland rice production. Apart from that, it is known that there are differences in the use of production factors, such as Lolang Village not using pesticides, while Ngkaer and Papang Villages use pesticides.

Based on this, research was carried out to analyse the influence of lowland rice production factors on production, analyse the efficiency level in the use of production factors, and compare production between farmers who use pesticides and those who do not use pesticides.

2 Research method

The research was carried out at the end of 2023. The research location was in Satar Mese District, Manggarai Regency, West Nusa Tenggara, Indonesia. The research location was chosen because it is a rice production center with high rice productivity, and farmers are active in farming activities as well as participating in farmer groups. This research collected both primary and secondary data. Primary data was obtained from questionnaire answers to farmers using a list of questions. The primary data includes the respondent's identity and the allocation of production factors such as land area, varieties, fertilizers, pesticides, and labor. Secondary data was obtained from the Manggarai Regency Central Statistics Agency, the Manggarai Regency Food Crops and Horticulture Department, as well as from literature and other supporting sources. The survey method used to collect data on lowland rice farmers was carried out purposefully with a total of 60 farmers as respondents. The criteria for respondents are active farmers with lowland rice production and at least five years of farming experience. Furthermore, the data that has been obtained is then combined, recorded, tabulated, and analyzed.

Measuring the influence of production factors on rice farming, was analyzed using multiple linear regression analysis which was transformed into the Cobb-Douglas model production function. American scientists introduced the Cobb-Douglas Production Function Model, Charles W. Cobb, and Paul H. Douglas [8]. Musaba and Mukwalikuli (2019) used the Cobb-Douglas Function Model for research on small farmers in Zambia regarding the influence of socioeconomic variables on rice production results [9]. They found that the variables significantly and positively related to rice production were the number of seeds, land area, labour, gender, agricultural chemicals, access to extension services, and row cropping systems. In econometrics, the model is sometimes used to explain the results of two or more physical inputs [10]. Furthermore, according to Salam's 2019 research, the Multiple

Linear Regression Analysis Model (MLRAM) is a good model for predicting lowland rice farming income [11]. Next, this equation is changed to linear equation form as follows:

$$Y = aX_1^{b1}.\ X_2^{b2}.\ X_3^{b3}.\ X_4^{b4}.\ X_5^{b5}.e^{u} \quad (1)$$

The equation is then transformed into a linear equation as follows:

$$LnY = Lna + b_1 LnX_1 + b_2 LnX_2 + b_3 LnX_3 + b_4 LnX_4 + b_5 LnX_5 + \cdots \quad (2)$$

Information :
Y = rice production (kg)
A = Constant
$b_1...b_5$ = Regression coefficient $X_1...X_{12}$
X_1 = land area (ha)
X_2 = Seed usage (kg)
X_3 = fertilizer use (kg)
X_4 = pesticide (kg)
X_5 = labor (cost)
e = natural logarithm (e=2.178)
u = error/error

Calculation of economic efficiency by calculating the marginal product value (NPM) is the same as the Marginal Casualty Cost (BKM), which is formulated as follows:

$$\frac{NPM_{xi}}{BKM_{xi}} = \frac{B_{xi}.Y/X_i.P_y}{P_{xi}}\ atau\ \frac{MPP.P_y}{P_{xi}} \quad (3)$$

Marginal product (MPP) can be calculated from the Cobb-Douglas function using the b coefficient multiplied by Y/X, and the calculation of the efficiency value is carried out for each production factor and not simultaneously [12].

Comparative testing was carried out using the independent sample t-test to compare the averages of two groups with different sample sizes. The following is the independent t-test formula:

$$t_{hit} = \frac{M_1 - M_2}{\sqrt{\frac{SS_1+SS_2}{n_1+n_2-2}\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} \quad (4)$$

Information:
M_1 = average score of groups 1
M_2 = average score of groups 2
SS_1 = sum of square group 1
SS_2 = sum of square group 2
n_1 = number of subjects/sample group 1
n_2 = number of subjects/sample group 2

3 Results and discussion

After selecting the incoming data, the data that could be processed further was 48 respondents, with the identity of male respondents being 88%, with an average age of 46 years, high school education level, owning lowland rice farming land, and experienced farmers in rice farming.

The seed varieties used consist of Ciherang (65%), IR 64 (21%), Cibogo (10%), and Inpari (4%); this will affect the quality and quantity of the product produced. Varieties are often developed to increase quality, productivity, resistance to pests and diseases, or adaptability to different environmental conditions [13]. The fertilizer used is an inorganic

fertilizer consisting of Urea and NPK Phonska. Inorganic fertilizers have the advantage of high nutrient content, where the nutrient composition can be known and is easily dissolved in the soil [14]. The types of pesticides farmers use include Eprin, Danke, Arivo, Metafurom, Regen, and Sprin. The use of pesticides is adjusted to the needs and conditions of the rice plants on the land. However, farmers in Lolang Village do not use pesticides. Labor comes from family labor and from outside; there is a difference in wages between male workers of IDR70,000.00 and wages of female workers of IDR50,000.00.

3.1 Linear Regression Analysis

Before a data analysis is carried out, it is necessary to test the normality of the data and the classical assumptions. The data normality test used is the Kolmogorov-Smirnov test (Table 1). The Kolmogorov-Smirnov model test obtained a value of 0.144 ≥ 0.05, meaning the data is usually distributed, as shown in the following table.

Table 1. Kolmogorov-Smirnov Test.

		Unstandardized Residual
N		48
Normal Parameters [a,b]	Mean	.0000000
	Std. Deviation	1.04326659
Most Extreme Differences	Absolute	.115
	Positive	.115
	Negative	-.052
Test Statistic		.115
Asymp. Sig. (2-tailed)		.144[c]

Meanwhile, the heteroscedasticity test via scatter plot (Fig. 1) showed that the distribution of the dependent variable was spread randomly and did not form waves or other patterns, so heteroscedasticity did not occur.

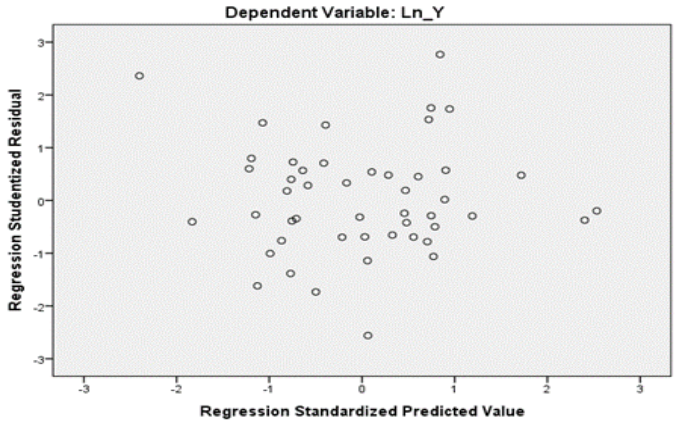

Fig. 1. Scatterplot

Based on the Durbin-Watson autocorrelation test (dw) showing a figure of 1.836 with 48 respondents and five variables used, the limits obtained were dl = 1.346 and du = 1.7708, which means there is no autocorrelation. The VIF value for each variable obtained is X_1= 1.056 X_2= 1.362; X_3= 1.259; X_4= 1.085; X_5= 1.136 means the VIF value for each variable is <10, so there is no multicollinearity in the data.

The results of the analysis obtained regression coefficient values for each land area variable (X_1), seed (X_2), fertilizer (X_3), pesticide (X_4), Labor (X_5), and constants with the following linear equation:

$$LnY = 3.460 + 0.360LnX_1 + 0.437LnX_2 + 0.405LnX_3 + 0.265LnX_4 + 0.028LnX_5 \quad (5)$$

Next, change it to the Cobb Douglas production function to become:

$$Y=31.81698\, X_1^{0.360}.\ X_2^{0.437}.\ X_3^{0.405}.\ X_4^{0.265}.\ X_5^{0.028}.e^{u} \quad (6)$$

The coefficient of determination (R^2) obtained is 0.480 (Table 2), meaning that 48.0% of the variation in production results can be explained by land area variable, seed, fertilizer, pesticide, Labor, while the remaining 52.0% is explained by other factors outside the regression model used. The influence of the use of production factors on rice production in Satar Mese District, Manggarai Regency, can be seen through the F test and t-test.

The results of the F test obtained a significant value of 0.000; this shows that the production factors, including land area variable, seed, fertilizer, pesticide, Labor, simultaneously influence rice production. Next, change it to the Cobb Douglas production function to become:

Table 2. Factors that Influence Rice Farming.

Variable	Coefficient (B)	Standard error	T counts it	Significant
Constant	3.460	3.566	0.970	0.337
Land area	0.360	0,127	2.837	0.007*
Seed	0.437	0.226	1.932	0.060ns
Fertilizer	0.405	0.149	2.723	0.009*
Pesticide	0.265	0.096	2.760	0.009*
Labor	0.028	0.276	0.101	0.920ns
R^2 = 0.480				
F_{count} =7.760 p=0.000				

In particular:

Land area has a highly significant impact on rice production; the land area variable has a significance value (Sig.) of 0.007<0.05, indicating that land area influences rice production. Lowland rice production is positively impacted by land area, with a coefficient value regression of 0.360. A larger land area will result in a higher quantity of rice production since the land area has a favourable and significant impact on rice production [15].

Rice production is greatly affected by seeds. The statistical significance value (Sig.) of the seed variable is 0.060<0.10, meaning that there is a correlation between seeds and rice production, with a positive impact on lowland rice production and a regression coefficient value of 0.437.

Fertilizer has an extremely significant influence on output; the fertilizer variable has a significance value (Sig.) of 0.009<0.05. Based on this, it can be concluded that fertilizer influences rice production; its positive impact on lowland rice production is indicated by a regression coefficient value of 0.405. The yield of rice or its productivity per unit area will be greatly boosted through the use of fertilizer at the prescribed dose [16].

With a coefficient of regression of 0.265, it can be concluded that pesticides have a positive impact on lowland rice production. Pesticides have a very significant effect on production; the significance value (Sig.) of the Pesticides variable is 0.009<0.05. The application of pesticides has a significant effect on improving output levels considerably [17].

The labour variable has a significance score (Sig.) of 0.902 >0.05, indicating that labour has no effect on rice production. Therefore, labour has no effect on rice production. The outpouring of labor in lowland rice farming influences increasing production; however,

adding excess labor is no longer efficient and can no longer increase rice production to the optimal level [18].

3.2 Economic Efficiency Analysis

Whether or not the use of rice production factors is economically efficient is determined by comparing the efficiency value of each production factor (≠ 1) (Table 3). It is known that the average rice production in one planting season is 908.07 kg (Y) per 0.4 ha with an average price per kg of IDR 4,000.00 (Py) in the form of Harvested Dry Grain (GKP). Input value (X), input price (Px), marginal product (MPP).

Table 3. Calculation of Economic Efficiency of Rice Farming in Satar Mese District, Manggarai Regency

Production factor	B	X	MPP	Px (IDR)	Economically efficient
Land area (hectare)	0.36	0.4	817.263	3,000,000	1.09
Seed (kilogram)	0.437	15	26.45	26,500	3.993
Fertilizer (kilogram)	0.405	139.5	2.63	26,700	0.3949
Pesticide (kilogram)	0.265	23	10.462	212,090	0.1973
Labor (cost)	0.028	8	3.178	60,000	0.211

The economic efficiency value of the land area is 1.09, meaning that the use of the land area is efficient; even though the land area is under 0.5 ha, it is technically more efficient than large land areas. Small land areas can encourage using more intensive and planned agricultural techniques with higher production results, thereby increasing production efficiency.

The economic efficiency value of seeds is 3.993, meaning that rice seeds are not economically efficient, so additional seed input is needed. The average use of seeds in one planting season is 15 kg per 0.4 ha or around 30 kg per 1 ha. The high use of seeds does not determine production results because the seeds used are of low-quality originating from previous planting results, so this occurs. Enhancing the quality of intensification through better seed technology use can help boost farming production [19].

The fertilizer efficiency value of 0.3949 means it is inefficient, so it is necessary to reduce fertilizer use. The average fertilizer use in one planting season is 139.5 kg per 0.4 ha or around 279 kg per ha. The use of fertilizer must be given according to the needs of the plant and soil as well as the stage of plant growth, and the recommended dose of NPK fertilizer should be between 150 and 250 kg per hektare [20]. The soil is deteriorating due to continuous rice cultivation with cereals in rotation and the overuse of synthetic fertilizers [21].

A pesticide efficiency value of 0.1973 means that economically, the use of pesticides is inefficient, so it needs to be reduced. The average use of pesticides is 23 liters per 0.4 ha or around 46 liters per 1 ha, whereas according to the Ministry of Agriculture's recommendations, it is around 10–20 liters per ha. Farmers need pesticides to prevent and eradicate pests and diseases of cultivated plants. However, pesticides can be detrimental to farmers if there is an error in the method or composition applied to the plants [15].

A labor efficiency value of 0.211 means that the use of labor is inefficient economically, so it is necessary to reduce labor. The average number of workers is between 7-8 people per 0.4 ha or 17-20 people per ha; too much labor will result in high costs. Farmers are urged to grow more rice fields, apply for more approved seeds, ZA, and NPK fertilizers, and utilize fewer laborers in order to increase output efficiency [22].

3.3 T-test Difference Test

The Levene's Test value (Table 4) is insignificant (because p = 0.954>0.05), meaning the variance in the two groups is the same. Therefore, the t value in the first row is 0.557, with a significance of 0.580. This means the t-value is significant (p = 0.580>0.005). This means that the production of the two villages using pesticides and non-pesticide users is significantly the same; there is no difference. The average rice production produced in one planting season with a land area of 0.4 hectares is 980.71 kg of dry-harvested grain and contains a water content of 21% up to 26%.

Table 4. Independent Sampel T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	T	df	Sig. (2-tailed)	95% Confidence Interval of the Difference	
							Lower	Upper
Input Pestisida	Equal variances assumed	.003	.954	.557	46	.580	-26015.05425	45901.49870
	Equal variances not assumed			.658	26.597	.516	-21064.99849	40951.44294

The criteria for testing the independent sample T-test using the SPSS program are as follows:
a. Sig. (2-tailed) > 0.05 = not significantly different (H_0 is accepted).
b. Sig. (2-tailed) < 0.05 = significantly different (H_0 is rejected).

4 Conclusion and recommendation

The results of multiple regression analysis with the Cobb-Douglas function can be concluded that production factors simultaneously have a significant effect on production. Meanwhile, production factors that partially significantly affect production are land area, seeds, fertilizers and pesticides. The production factor that has no real influence is labour. The economic efficiency analysis found that the land area production factor was efficient, the seed production factor needed to be more efficient, while the fertilizer and pesticide production factors and labour were economically inefficient. The comparative analysis of farming production results showed that lowland rice farming using pesticides and non-pesticides produced the same amount of food.

To achieve economic efficiency, it is necessary to increase seed production factors and reduce production factors for fertilizers, pesticides, and labor so that farmers obtain maximum profits. Farmers must also pay attention to pesticide dosages and the long-term impacts of pesticide use.

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