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Efficiency of Lowland Rice Farming In the Tiloan District of Buol Regency

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Abstract: **This research aims to analyze Technical Efficiency, Price Efficiency, and Economic Efficiency by examining the Production Function of Wetland Rice Farming and its impact on the income of Wetland Rice Farming in the Tiloan District of Buol Regency. This research was quantitative. The data for this study were obtained from rice farmers in the Tiloan District of Buol Regency. Hypothesis testing was conducted using multiple regression analysis and stochastic frontier estimation with the Maximum Likelihood Estimate (MLE) method. The analysis results, measured in terms of the Allocation of Production Factors, indicated that the partial use of the land area, urea fertilizer, family labor, and pesticides had a significant effect on production, while seed, ponska fertilizer, and external labor did not have a significant partial effect on production. On average, wetland rice farmers in the research location did not use production factors efficiently, as indicated by technical efficiency, price efficiency (allocative), and economic efficiency values less than 1, which are 0.74, 0.31, and 0.22. The sources of inefficiency that affected production were farming experience, production costs, and extension frequency. The income of wetland rice farmers in the research location can be considered relatively high, with a total income of IDR 913,373,600 or IDR 13,786,771.32 per hectare or an average of IDR 4,963,237.68 per respondent per harvest season. The comparison ratio between revenue and costs was 2.56, indicating that by spending IDR 1,000,000,-, one could earn IDR 2,560,000,-. Therefore, it can be said that wetland rice farming in the research location is worth pursuing because the R/C ratio is greater than 1 (R/C > 1). The role of agricultural institutions in improving farm efficiency in the research area was still relatively low. It could continue to be enhanced to motivate farmers to achieve higher levels of farm efficiency, as explained by the results of simple regression analysis, which showed that the coefficients of technical efficiency, price (allocative) efficiency, and economic efficiency were 0.098, 0.003, and 0.032, respectively.**

Keywords: **Production Factors, Social Characteristics, Efficiency, Income.**

I. INTRODUCTION

As a developing country, Indonesia is a nation where the agricultural sector plays a crucial role in its economy[1], [2] This is supported by its vast geographical expanse, which is highly suitable for cultivating various agricultural commodities, such as rice, crops, livestock farming, tea plantations, oil palm cultivation, agribusiness ventures, and more[3], [4].The development of agriculture needs to be continuously expanded and directed towards achieving resilient agriculture[5], [6]. The reality of achieving resilient development has led to three main objectives to be achieved by the agricultural sector: improving farmers' livelihoods, achieving self-sufficiency in food production, and increasing the government's revenue from agricultural exports[7], [8] The development goals of agriculture in Indonesia deserve to be placed as the top priority to achieve food self-sufficiency[9], [10]

At the macro level, the development of the agricultural sector is analyzed by examining the extent to which this sector can fulfill domestic and global food needs[11], [12] This macro-level analysis can also be carried out by assessing the contribution of the agricultural sector to the national income, its capacity to absorb labor, and other factors [13], [14]. This macro-level analysis has given rise to a new breakthrough known as agricultural revitalization[15], [16] Agricultural revitalization is a government policy aimed at improving the performance of agriculture with the goal of reducing unemployment, poverty, and enhancing national economic competitiveness[17], [18] Through agricultural revitalization, it is hoped that ideal achievements can be obtained, such as the elimination of food shortages, a reduction in unemployment rates, and increasing national competitiveness[19], [20]

The majority of the population in Buol Regency is engaged in the agricultural sector. Out of the total population of Buol Regency aged 15 and above who are employed, 35,795 individuals, or approximately 55.01 percent, work in the agricultural sector. From an economic perspective, the agricultural sector contributes 49.75 percent to the Gross Regional Domestic Product (GRDP) based on current prices in Buol Regency in the year 2017 (Buol Regency in Figures 2018).

The Tiloan District is a center for developing rice cultivation in Buol Regency. In the year 2020, the rice field harvest area amounted to 2,378.7 hectares, with a production of 9,960 tons and a productivity of 4,187 tons per hectare. All of this information can be seen in the following table:

TABLE 1. Planting Area, Harvest Area, Productivity, and Production of Wetland Rice Crops in Buol Regency, Year 2020

No.	District	Cultivated Area (Ha)	Harvested Area (Ha)	Productivity (Tons/Ha)	Production (Tons)
1	Lakea	834.1	746.8	4.1872	3,127.0
2	Bian	286.3	223.9	4.1860	954.0
3	Karamat	339.4	174.3	4.1882	730.0
4	Momuru	1,237.7	1,319.2	4.1866	5,523.0
5	Tiloan	2,314.6	2,378.7	4.1872	9,960.0
6	Bokat	918.7	916.6	4.1872	3,838.0
7	Bukal	1,465.1	1,464.6	4.1868	6,132.0
8	Bunobogu	349.1	263.7	4.1866	1,104.0
9	Gadung	354.3	278.7	4.1873	1,167.0
10	Paleleh	684.5	425.7	4.1860	1,782.0
11	Paleleh Barat	584.0	515.0	4.1864	2,156.0
	Total	9,367.8	8,711.2	46.0556	36,473.0

The productivity of wetland rice crops in Buol Regency, which stands at 4,187 tons/hectare, is still below the national average for wetland rice productivity, which is 5,114 tons/hectare. The productivity of wetland rice in the Tiloan District, at 4,187 tons/hectare, is still relatively low despite having a larger cultivation area compared to other districts[21], [22] Many factors contribute to this low productivity, including farmers' inefficient use of production factors and their behavior in facing risks[23], [24]. The most influential factor is the suboptimal role of farmer institutions[25], [26].

Based on the description above, efforts to increase productivity as a source of improving wetland rice production in the Tiloan District through farm efficiency and the development of farmer institution capacities have become highly essential and should be prioritized.

Problem Formulation

From the background presented, several research questions can be formulated as follows:

1. How is the allocation of production factor usage in wetland rice farming in the research location?
2. How is the efficiency level of wetland rice farming in the research location?
3. How do wetland rice farmers achieve income in the research location?
4. How is the role of institutions in influencing the efficiency of wetland rice farming in the research location?

Research Objectives and Utility

The objectives of this research are as follows:

1. To analyze the production factors influencing wetland rice farming in the research location.
2. To test and analyze the efficiency level in wetland rice farming in the research location.

3. To test and analyze the income levels achieved by wetland rice farmers in the research location.

4. To analyze the role of farmer institutions in influencing the efficiency of wetland rice farming in the research location

The utility of this research includes:

1. Academic Contribution to Agricultural Economics: This research contributes academically to the field of agricultural economics by advancing the concept of production, particularly in the context of wetland rice farming. It emphasizes efficiency aspects and the strengthening of farmer institutions.

2. Practical Contribution: This research is expected to have practical utility as it can be used as a basis for policymakers to formulate strategies for developing wetland rice farming and empowering farmer institutions.

3. Additional Reference for Further Research: Furthermore, this research serves as an additional reference for future studies aimed at advancing knowledge, especially in the realm of wetland rice farming efficiency.

II. RESEARCH METHODOLOGY

Research Type

Based on its type, the conducted research is of the descriptive research type. Descriptive research aims to depict the critical issues under investigation in a clear, factual, systematic, and meticulous manner and subsequently seeks solutions to the encountered problems.

Research Location and Timing

This research was conducted in the Tiloan District of Buol Regency and was purposively selected, considering that the Tiloan District was a central hub for the development of wetland rice cultivation, with the largest cultivation area compared to other districts in Buol Regency. The research was carried out for approximately four months, from November 2019 to February 2020.

Population, Sample, and Sampling Technique

The population is defined as the generalized area that possesses specific qualities and characteristics established by the researcher for the study and from which conclusions were drawn. Examples of a population could include the residents in a specific area, the productivity levels of goods in a particular company, or the number of employees and customers in a specific store, among others[27], [28]

A sample is a portion of the total population and possesses its characteristics. When the population is significant, and it's not feasible for the researcher to study every element within the population, perhaps due to limitations in funding, manpower, and time, the researcher can use a sample taken from that population. What is learned from the sample can then be generalized to the entire population. Therefore, selecting a sample from the population must be genuinely representative ([29]).

The number of sample members in this research was determined using the Slovin Sampling technique. The population in the research area consists of all wetland rice farmers on irrigated land in the Tiloan District, totaling 693 individuals. This represents a standard error rate of 10%. To calculate the sample size for the research, the calculation is as follows:

$$S = \frac{\chi^2 \mathrm{NP}\,(1-\boldsymbol{P})}{d^2(\mathrm{N}-1)+\chi^2\mathrm{P}(1-\boldsymbol{P})}$$

Explanation:

S = required sample size

N = population size

P = population proportion 0.5➔

d = level of accuracy 0.➔5

χ2 = chi-square table value according to the confidence level

χ^2 = chi-square table value according to the confidence level

0.99 6,634, ➔0,95 3,841 0,9➔ 2,706 ➔

Based on the formula provided, and considering the population in the research area is 693 individuals with a confidence level of 5%, you can calculate the required sample size as follows:

$$S = \frac{3{,}841 \times 693 \times 0{,}5(1 - 0{,}5)}{0{,}05^2(693 - 1) + 3{,}841(1 - 0{,}5)}$$

$$S = 182$$

The calculation results indicate that the total sample size in the research area is 182 individuals distributed across three villages and 24 farmer groups. Since the population size of farmer groups varies, proportional sampling is carried out to determine the samples accordingly.

The data analysis techniques used in this research consist of descriptive data analysis and inferential data analysis techniques

Multiple Linear Regression Analysis

Multiple linear regression analysis is employed to estimate the production factors of wetland rice farming, considering the output and influencing factors and analyzing price efficiency. Multiple linear regression analysis is used in this research with SPSS version 26.0[30], [31] This analysis of the linear function can explain the influence of production factor usage, including land (X_1), seed (X_2), urea fertilizer (X_3), phonska fertilizer (X_4), pesticides (X_5), family labor (X_6), and external labor (X_7) on the total production of wetland rice farming (Y)

1. $Y = aX_1{}^{b1}.X_2{}^{b2}.X_3{}^{b3}.X_4{}^{b4}.X_5{}^{b5}.X_6{}^{b6}.X_7{}^{b7}.e$
2. The equation is then transformed into a linear equation as follows:
3. $LnY = Lna + b_1LnX_1 + b_2LnX_2 + b_3LnX_3 + b_4LnX_4 + b_5LnX_5 + b_6LnX_6 +$
4. b_7LnX_7 .... (1)
5. Explanation:
6. Y = rice production (kg/ha)
7. a = constant
8. b1....b7 = regression coefficients for X_1.....X_7
9. X_1 = land area (ha)
10. X_2 = seed usage (kg/ha)
11. X_3 = urea fertilizer usage (kg/ha)
12. X_4 = phonska fertilizer usage (kg)
13. X_5 = pesticide usage (ltr/ha)
14. X_6 = family labor (HOK)
15. X_7 = external labor (HOK)

Analysis of Stochastic Frontier Cobb-Douglas Model

The analysis employed to estimate the level of technical efficiency in wetland rice farming, considering both output and influencing factors, is the Stochastic Frontier Cobb-Douglas production function[32], [33] This choice is based on several considerations: 1) it is homogenous, allowing for the derivation of the dual cost function from the production function; 2) it has a simpler and more manageable form; 3) it can be represented in a linear additive form; and lastly, it is less prone to issues [34], [35].

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III. RESULTS AND DISCUSSION

Results of Multiple Linear Regression Analysis on Production Factors

This analysis is used to determine the extent of the influence of independent variables (X) on the dependent variable (Y). In this study, an analysis is conducted to assess the magnitude of the effect of variables X, namely, Land Area (X1), Seed (X2), Urea Fertilizer (X3), Phonska Fertilizer (X4), In-Family Labor (TKDK) (X5), External Labor (TKLK) (X6), and Pesticides (X7) on the variable Y, which is the production of farmers in the Tiloan District, Buol Regency. Below are the results of the multiple linear regression analysis based on the processed data from SPSS 25:

TABLE II. Results of Multiple Linear Regression Analysis

Coefficients						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	T	Sig.
1	(Constant)	4.564	.375		12.159	.000
	LuasLahan	.646	.188	.328	3.439	.001
	Benih	.034	.083	.032	.408	.684
	PupukUrea	.283	.066	.263	4.283	.000
	PupukPonska	.086	.064	.049	1.342	.181
	TKDK	.090	.018	.162	4.918	.000
	TKLK	.044	.052	.035	.862	.390
	Pestisida	.377	.118	.310	3.197	.002

a. Dependent Variable: Produksi

Based on Table 2 above, the panel data regression equation is obtained as follows:

$$Y = 4.56412 + 0.64634\,(X_1) + 0.03434\,(X_2) + 0.28313\,(X_3) + 0.08632\,(X_4) + 0.09001\,(X_5) + 0.04423\,(X_6) + 0.37743\,(X_7) + e$$

The significance values in Table 4.3 indicate that at a 5 percent significance level, four variables are below this significance level. Therefore, it can be concluded that these four variables, namely Land Area (X_1), Urea Fertilizer (X_3), In-Family Labor (TKDK) (X_5), and Pesticides (X_7), have a significant impact on the Production (Y) variable. This demonstrates that these four variables play a crucial role in rice production factors, ensuring high-quality rice production for farmers to sell.

The significance values above the 5 percent significance level indicate that these variables do not have a significant impact on Production (Y). Three variables are above this significance level, namely Seed (X_2), Phonska Fertilizer (X_4), and External Labor (TKLK) (X_6), which demonstrates that these three variables do not have a significant influence on rice production.

Results of Technical Efficiency, Price Efficiency, and Economic Efficiency Analysis in Wetland Rice Farming

Technical efficiency is analyzed using the stochastic frontier production function model with the Maximum Likelihood Estimate (MLE) estimation method using the Frontier 4.1 program. Meanwhile, the levels of price and economic efficiency are analyzed using the dual cost frontier. The results of the analysis of technical, price, and economic efficiency can be seen in the following table.

TABLE III. Frequency Distribution of Technical Efficiency, Price Efficiency, and Economic Efficiency

Range	Technical Efficiency		Price Efficiency		Economic Efficiency	
	Count	%	Count	%	Count	%
≤ 30	2	1.1	48	26.4	156	85.7
0.31-0.40	11	6.0	134	73.6	26	14.3
0.41-0.50	19	10.4	0	0	0	0
0.51-0.60	15	8.2	0	0	0	0
0.61-0.70	29	15.9	0	0	0	0
0.71-0.80	26	14.3	0	0	0	0
0.81-0.90	23	12.7	0	0	0	0
0.91-1.00	57	31.4	0	0	0	0
Max	0.99		0.34		0.34	
Min	0.25		0.28		0.07	
Average	0.74		0.31		0.22	

The table above shows that the average technical efficiency is 0.74, with the lowest value being 0.31 and the highest value being 0.22. This indicates that wetland rice farming in Buol Regency, Tiloan District, is not yet technically efficient. The maximum technical efficiency in rice farming is 74%, leaving a 26% opportunity to reach its potential production. The minimum technical efficiency in rice farming is 25%, which means that farmers need to work harder to increase production by 75% to achieve maximum technical efficiency. However, even though it is considered inefficient, the majority of farmers have already achieved a certain level of efficiency.

TABLE IV. Income Analysis in Tiloan District

No.	Description	Notation	Value
1	**Cost Items:** **1. Fixed Costs** - Taxes - Depreciation **- Total** **2. Variable Costs** - Seed Costs - Fertilizer Costs - Pesticide Costs - Labor Costs - Tractor Rental **- Total**		 IDR 3,098,500 IDR 39,000,000 **IDR 42,098,500** IDR 31,297,500 IDR 91,495,000 IDR 38,979,000 IDR 292,984,000 IDR 86,775,000 **IDR 541,530,500**
	Total Cost	**TC**	**IDR 583,629,000**
2	**Revenue:** **Production x Average Price**	**TR**	**IDR 1,497,002,600**
3	**Income**	**TR - TC**	**IDR 913,373,600**
4	**R/C (Revenue to Cost Ratio):**	**TR/TC**	**2.56**

Based on the table 4, the total rice production is 189,494 kg, equivalent to 2,860.29 kg/ha or an average of 1,029.70 kg/respondent. The total revenue is IDR 1,497,002,600 or IDR 22,596,265.66/ha or an average of IDR 8,134,655.64/respondent per harvest season. Meanwhile, the total expenses incurred by farmers amount to IDR 583,629,000 or IDR 8,809,494.34/ha or an average of IDR 3,171,417.96/respondent per harvest season. Therefore, the total income of rice farmers in the research area is IDR 913,373,600 or IDR 13,786,771.32 or an average of IDR 4,963,237.68/respondent. The ratio of total revenue to total expenses is 2.56. This can be concluded that by spending IDR 1,000,000, farmers can generate a profit of IDR 2,560,000. Thus, wetland rice farming in the research area is profitable because of R/C > 1.

The Role of Farmer Groups in Economic Efficiency

To address the issues and test the hypotheses in this research, the researcher employed a simple linear regression analysis method to examine these hypotheses. Ghozali (2018) states that simple regression analysis "aims to determine the direction of the relationship between the independent and dependent variables." In this study, simple regression analysis was used to determine the influence of farmer groups' institutional role on the economic efficiency level in wetland rice farming in Tiloan Sub-district, Buol Regency. The results of the simple regression analysis in this study can be seen in the table below:

TABLE V. Simple Regression Analysis of the Role of Farmer Groups on Economic Efficiency

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,181	,014		13,362	,000
	Peran Kelompok Tani	,032	,009	,247	3,425	,001
a. Dependent Variable: Efisiensi Ekonomi						

The regression coefficient value of B is 0.032, indicating that if the role of farmer groups increases by one unit, it will also increase the economic efficiency, assuming other variables remain constant. The data processing results also show a significant probability value for the variable of the farmer groups' role, which is 0.001 < 0.05. Therefore, it can be concluded from these results that the presence of farmer groups has a significant effect on the economic efficiency of wetland rice farming.

IV. CONCLUSION

This research aimed to analyze the efficiency of wetland rice farming based on the production function of wetland rice farming and its impact on the income of wetland rice farming in Tiloan Sub-district, Buol Regency. Furthermore, this study is expected to serve as a reference for optimizing the production and revenue of wetland rice farming while considering technical efficiency, price efficiency, and economic efficiency. Based on the test results and discussions in this research, several conclusions can be drawn as follows:

1. Production factors such as Land, Seeds, Urea Fertilizer, Phonska Fertilizer, Pesticides, Family Labor, and External Labor simultaneously have a positive impact on wetland rice production. Partially, land, urea fertilizer, pesticides, and family labor significantly affect wetland rice production, while seed, phonska fertilizer, and external labor do not significantly influence wetland rice production. The most responsive variable is land area, as indicated by the most significant coefficient value.

2. On average, wetland rice farmers in the research location have not been using production factors efficiently, as evidenced by technical efficiency, price efficiency (allocative), and economic efficiency values less than 1, precisely 0.74, 0.31, and 0.22, respectively. The sources of inefficiency affecting production include farming experience, farming costs, and the frequency of extension services.

3. The income of wetland rice farmers in the research area can be considered relatively high, with a total revenue of IDR 913,373,600 or IDR 13,786,771.32 per hectare, or an average of IDR 4,963,237.68 per respondent per harvest season. The income-to-cost ratio is 2.56, indicating that by investing IDR 1,000,000, farmers can earn IDR 2,560,000. Therefore, wetland rice farming in the research location is economically viable as the R/C ratio is greater than 1 (R/C > 1).

4. The role of farmer institutions in improving farming efficiency in the research location is still relatively low. It has the potential for further improvement to encourage farmers to achieve higher levels of farming efficiency. This is evident from the results of simple regression analysis, which showed coefficients of technical efficiency, price efficiency (allocative), and economic efficiency to be 0.098, 0.003, and 0.032, respectively.

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