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Technical Efficiency of Rice Farming In Batu Mandi District, Balangan Regency

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Abstract: *The food crops sub-sector is one of the sub-sectors that has a very important and strategic role in supporting the lives of the majority of the Indonesian population, because food crops have a role in food availability. Rice is one of the main food crops in Indonesia that produces the largest staple food, namely rice. The aims of this study are (1) to analyze the technical efficiency of lowland rice farming in Batu Mandi District, Balangan Regency (2) to analyze factors -Factors that affect the technical efficiency of rice farming in Batu Mandi District, Balangan Regency. The research was conducted in the Batu Mandi District, Balangan Regency, South Kalimantan Province. The sampling method used is simple cluster sampling which consists of two stages. In the first stage, samples were taken from the two villages with the largest area for rice cultivation, namely Batu Mandi Village and Gunung Manau Village. In the second stage, a simple random sample of farmers was selected with a sample size of 30% of the total population of lowland rice farmers on LP2B land in the sample village, as many as 138 respondents from a population of 459 farmers. Data analysis in this study used the Stochastic Frontier Analysis (SFA) approach. In the operation of the SFA approach, the Cobb Douglas production function is used. The estimation of production function parameters and inefficiency functions is carried out simultaneously with the FRONTIER 4.1c software program. The results of the estimation of the production function show that the inputs that have a significant effect at the 95% level on rice production are the input variables of land area (X1), number of seeds used (X2) and number of workers (X6). For other variables, such as the amount of N fertilizer (X3), the amount of NPK fertilizer (X4) and the amount of drugs (X5) did not have a significant effect on rice production at the study site. Most of the farmers in rice farming in Batu Mandi District have been technically efficient because the average level of technical efficiency that has been achieved is more than 0.7 (ET 0.7). That is 0.86. Referring to (Coelli et al. 2005) that a farm is said to be efficient if its efficiency is greater than or equal to 0.70. Factors that affect technical inefficiency in this study are the variables of age (Z1), education (Z2), experience (Z3), land ownership (Z4), seed labels (Z5) and land cultivation (Z6) and harvesting (Z7) have a significant effect on inefficiency of rice cultivation in the study area.*

Keywords: *Technical efficiency, lowland rice, Stochastic Frontier Analysis*

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I. Introduction

A. Background

Food crops sub-sector is one of the sub-sectors that has a very important and strategic role in supporting the lives of most of the Indonesian population, because food crops have a role in food availability. Rice is one of the main food crops in Indonesia which produces the largest staple food, namely rice. Rice production is influenced by two things, namely land area and productivity. Based on data from (Central Bureau of Statistics of South Kalimantan Province 2020), South Kalimantan in 2019 was recorded to have harvested rice area of 356,245.95 ha with production reaching 1,342,861.82 tons (3.77 tons/ha productivity). However, in 2020, the harvested area decreased by 18.64%, namely 289,836 hectares, so that production also decreased by 1,150,307 tons (productivity 3.97/ha). Rice productivity in South Kalimantan is still quite far from the national rice productivity figure in 2020, which is 5.13/ha.

Balangan Regency is a district in South Kalimantan which has the smallest rice harvest area (excluding municipalities) which is only 5,061 ha which is capable of producing 19,923.66 tons (3.94 tons/ha productivity) in 2019. Then in 2020, the harvested area decreased. namely 4,610 ha with a production of 16124 tons (productivity 3.5 tons/ha).

The decline in rice productivity can be caused by several things, such as inefficiency in the use of production factors, land conditions that are increasingly damaged due to excessive use of pesticides and drugs. , as well as the suitability of the varieties used with regional conditions. Efficient allocation of resources by rice farmers is expected to increase the amount of production.

Efforts to increase production through technical efficiency are currently an important alternative, because they can increase the potential output of farmers (Kusnadi et al. 2011). Efforts to improve technical efficiency by using existing resources are expected to increase productivity and reduce farming costs, so that farmers' incomes will increase.

The strategy that has been carried out by the Regional Government of Balangan Regency in order to ensure the availability of food in the region as well as the protection of agricultural land by issuing Regional Regulation Number 24 of 2013 concerning Spatial Planning of Balangan Regency in 2013-2032, and Regional Regulation Number 20 of 2014 concerning Protection of Food Agricultural Land Sustainable (LP2B).

Based on data from the Directorate of Land Administration, Director General of Agrarian Arrangements, Ministry of Agrarian and Spatial Planning / National Land Agency of the Republic of Indonesia (2019), the area of rice fields that is highly recommended for Sustainable Food Agricultural Land (LP2B) in Balangan Regency is 3,793 Ha, while the recommended area is conditional. covering an area of 3,249 ha. So the total recommended area is 7,042 Ha. However, in 2020, the area of raw rice fields as LP2B from the Balangan Agriculture Service is 7,925 Ha with details as shown in Table 1 below:

Table 1. *Area of Raw Rice Fields in Balangan Regency 2020*

No.	District	Land Area (Ha)
1	Awayan	1,138
2	Batu Mandi	1,721
3	Halong	354
4	Juai	914
5	Lampihong	1,837
6	Paringin	1,020
7	South Paringin	852
8	Tebing Tinggi	89
	Total	**7,925**

Based on Table 1, it is known that the largest area of >1,500 Ha of paddy fields is 2 (two) sub-districts, namely Lampihong District and Batu Mandi District. To note, almost all rice fields in Balangan Regency are rainfed rice fields, and a small part of irrigated rice fields. While the paddy fields in Lampihong District are mostly swampy rice fields. For rice fields in the Batu Mandi District, it is rainfed/non-irrigated rice fields (BPP Batu Mandi District 2019). So that the location of Batu Mandi District is more representative of the picture of rice fields in Balangan Regency in general. Moreover, the Batu Mandi District is planned to be the largest food crop agricultural area in Balangan Regency (DPRD and Balangan Regent 2013).

Based on the description above, it is necessary to research on the analysis of the technical efficiency of rice farming in Batu Mandi District, Balangan Regency.

B. Problem Formulation

Based on the background that has been described previously, the problems in this study can be formulated as follows:

1. Is lowland rice farming in Batu Mandi District, Balangan Regency, technically efficient?
2. What factors affect the technical efficiency of rice farming in Batu Mandi District, Balangan Regency?

C. Objectives and Benefits

Objective:

1. To analyze the technical efficiency of lowland rice farming in Batu Mandi District, Balangan Regency.
2. Analyzing the factors that affect the technical efficiency of rice farming in Batu Mandi District, Balangan Regency.

Benefits:

1. For rice farmers, this study provides knowledge about increasing production and productivity through rice farming efficiency;
2. For the government, this research useful as a basis for decision-making related to the policy of intensification and expansion in order to increase the productivity and efficiency of rice farming specifically, especially in the district of Batu Mandi Balangan
3. for other researchers as well as for the general reader, this study can be one of the reference materials for research related to farming efficiency.

II. Research Methods

A. Time and Place of

Research This research was carried out starting from the preparation of the proposal in June 2020 until its completion. The location of the research was carried out in the Batu Mandi District, Balangan Regency, South Kalimantan.

B. Types and Sources of Data The

data to be used are primary and secondary data. Primary data was collected by survey method through interview technique using a list of questions or questionnaires. Data collection was carried out by conducting interviews with farmers who carried out rice farming in the 2020 planting season.

In addition, this study also utilized secondary data from other sources such as the Central Statistics Agency (BPS), Data and Information Center (Pusdatin) of the Ministry of Agriculture, District Agriculture Office. Balangan, the District Extension Centers Batu Mandi and literature books, journals, as well as data from electronic articles that are relevant to other related research

C. sampling method

the sampling method used was simple cluster sampling which consists of two stages. In the first stage, samples were taken from the two villages with the largest area for rice cultivation in sustainable food crops (LP2B), namely Batu Mandi Village and Gunung Manau Village.

In the second stage, a simple random sample of farmers was selected with a sample size of 30% of the total population of lowland rice farmers on LP2B land in the sample village, as many as 138 respondents from a population of 459 farmers.

Sampling in this study was carried out using a probability sampling technique with the selection of sampling using the simple random sampling method (simple random sample. By using this method, each unit in the sample has the same opportunity to be selected. The selection of this method is based on the consideration that the population is assessed relatively homogeneous.

D. Analysis of Data

Analysis of the production function stochastic frontier

analysis of the data in this study using the approach Analysis of stochastic Frontier (SFA). in the operational approach of SFA used Cobb Douglas.

Specifications production function stochastic frontier Cobb-Douglas used in this study are as follows :

$$\ln Y = \ln\beta_o +_1 \ln X_1 +_2 \ln X_2 +_3 \ln X_3 +_4 \ln X_4 +_5 \ln X_5 +_6 \ln X_6 + + (v_i\text{-}u_i)$$

Where :

Y = Rice Production (Kg)

β_o = constant

X_1 = area of land under cultivation (Ha)

X_2 = Number of Seeds (Kg)

X_3 = Total fertilizer N (kg)

X_4 = Number of NPK (Kg)

x_5 = Drug-o ty (Liter)

X_6 = Labor (HOK)

$\beta_{1,}\beta_{2,}\beta_{3,}\beta_{4,}\beta_{5,}\beta_6$= coefficient

$(v_i\text{-}u_{i)}$= *error term* (v_i is the *noise effect,* and u_i is the technical inefficiency effect in the model.

Technical Efficiency Analysis

To answer the research objective number 1, namely to analyze the technical efficiency of rice farming in Batu Mandi District, Balangan Regency, the technical efficiency analysis was measured using the formula by Coelli *et al*. (Darmawan 2016):

TE_i = exp (-E[u_i $|_i$])

Where :

TE_{iith} $_=$ Technical Efficiency of theFarmer

exp (-E[u_i | ε_i]) = Expected Value or (mean) of ui with condition$_i$

0 TE_i 1 The

value of technical efficiency is in the range of 0 to 1. If the technical efficiency of rice farming is 1, then the farming is technically efficient 100%.

Analysis of technical inefficiency The

analysis of factors that affect technical efficiency in this study is to answer the research objective number 2, namely to analyze the factors that affect the technical efficiency of rice farming in Batu Mandi District, Balangan Regency.

The sources of technical inefficiency are estimated simultaneously with the analysis of the stochastic frontier production function using the technical inefficiency effects model aka the Technical Eefficiency (TE) Effects Model developed by Battese and Coelli (1998) and Coelli et al. (2005).

To determine the distribution parameter value (μi) of the technical inefficiency effect, the following formula is used.

$U_i={}_0 +{}_1Z_1 +{}_2Z_2 +{}_3Z_3 +{}_4Z_4 +{}_5Z_5 +{}_6Z_6 +{}_i$

Where:

u_i = *Effect* of technical inefficiency
δ = coefficient; expected where$_{1 \text{ is}}$ assumed to be > 0 while$_{2,3,4,5}$, and$_6$, are assumed to be < 0
Z_1 =age *Farmer's* (years)
Z_2 = *education* Farmer's formal(years)
Z_3 = *Farming experience* (years)
Z_4 = *Dummy* land ownership status (own ownership=1, not own=0)
Z_5 = *Dummy seed* (1=labeled seed, 0=unlabeled)
Z_6 = *Dummy* land treatment (1 = tractor, 0 = other)
Z7 = *Dummy* Harvesting(1 = Combine harvester, 0 = more
ε_i = *Random error term*, which is assumed to be free and the distribution istruncated normallywith $N(0,\sigma^2)$

The coefficient value which is positive will have a positive effect on the value of technical inefficiency, so if the coefficient value is positive, the greater the coefficient value will cause the inefficiency value technical aspects are getting bigger too, so farming becomes inefficient. A negative coefficient value will have a negative effect on the value of technical inefficiency and vice versa will have a positive effect on the level of technical efficiency. A negative coefficient value means that the greater the coefficient value, the smaller the level of technical inefficiency, so that the level of technical efficiency of farming will increase.

Estimation of production function parameters and inefficiency functions is carried out simultaneously with the FRONTIER 4.1c software program (Coelli, 1996).

III. Results And Discussion

A. Characteristics Respondents

Characteristics of rice farmers in the study area are described in Table 2 below:

Table 2. *Characteristics of rice farmers in Batu Mandi District, Balangan Regency*

No.	Range of	Rice Farmers	
		Total (persons)	Percentage (%)
1	**Age (Years)**		
	a. 15-24	0	0.00
	b. 25-34	8	5.80
	c. 35-44	38	27.54
	d. 45-54	59	42.75
	e. 55-64	28	20.29
	f. > 64	5	3.62
Average age of farmers (Years)		**47.86**	
2	**Education (years)**		
	a. Did not finish SD	2	1.45
	b. SD (6)	44	31.88

	c. Junior High School (9)	42	30.43
	d. SMA (12)	48	34.78
	e. Bachelor (17)	2	1.45
Average education of farmers (years)		**9.14**	
3	**Rice Farming Experience (years)**		
	a. 1-10	43	31.16
	b. 11-20	49	35.51
	c. 21-30	33	23.91
	d. 31-40	7	5.07
	e. >40	6	4.35
Average experience of rice farming (years)		**19.44**	

B. Use of Factors of Production

The use of factors of production greatly influences the level of efficiency and production. The independent variables in this study were land area, number of seeds, amount of N fertilizer, amount of NPK fertilizer, amount of medicine, and number of workers, while the dependent variable was rice production cultivated by farmers in one growing season.

The average recapitulation of the use of production factors per pie growing season in this study can be seen in Table 3 below:

Table 3. *Recapitulation of the average use of production factors for rice farming in Batu Mandi District, Balangan Regency.*

Production Factors	**Minimu m**	**Maximum**	**Average**
Land Area (ha)	0.34	3.83	0.972899
Number of Seeds (kg)	8	75	31.37681
Fertilizer N (kg)	50	200	88.26087
Fertilizer NPK (kg)	40	300	154.3478
Medicines (liter)	2	20	7.289855
Labor (HOK)	25	145	61.72826

Primary data source processed

C. Function stochastic frontier production and technical efficiency

Analysis of the stochastic frontier production function and technical efficiency using the FRONTIER Version 4.1c program requires the availability of three files in text format, namely (a) data file (pro-dta.txt) (dependent and independent variables have been transformed into the form logged), (b) instruction file (pro-ins.txt), and (c) output file to accommodate analysis results (pro-out.txt). In the instruction file the Technical Efficiency Effects Frontier (aka TE Effects Model) is selected (Battese and Coelli, 1993) so that at the same time information is obtained about (a) the estimation of the stochastic frontier production function model, both with the OLS method and the MLE method, factors (sources) managerial capacity that affects technical efficiency, (c) and estimates of technical efficiency, both per individual and on average (mean efficiency).

The estimation results of the stochastic frontier production function model in this study with the choice of the TE Effect Model using 6 regressor variables (Xs = 6) and 7 TE Effects Regressors (Zs = 7), can be seen in Table 4 below:

Table. 4. *The estimation results of the stochastic frontier production function with the TE effects model*

Parameter	variabel	coefficient	standard-error	t-ratio	sign.
beta 0	konstanta	8.5352933	0.54189213	15.750908	
X1	Luas lahan	1.0518678	0.10587067	9.9354031	*
X2	Jumlah Benih	0.22688175	0.074564586	3.0427548	*

X3	Jumlah Pupuk N	0.005871717	0.06492049	0.0904447	ts
X4	Jumlah Pupuk NPK	0.068688502	0.045902606	1.4963965	ts
X5	Jumlah Obat-obatan	-0.003147326	0.030924237	-0.101775	ts
X6	Jumlah Tenaga Kerja	-0.30493496	0.13372186	-2.280367	*
delta 0	konstanta	0.14062856	0.50461947	0.2786824	
Z1	Usia Petani	0.015061706	0.009429251	1.5973385	ts
Z2	Pendidikan Formal	-0.07900804	0.029950393	-2.637963	*
Z3	Pengalaman	-0.026004991	0.010107605	-2.572814	*
Z4	dummy status kepemilikan lahan	-0.085249474	0.12925855	-0.659527	ts
Z5	dummy status benih	-1.6505958	0.42262882	-3.905545	*
Z6	dummy cara pengolahan lahan	0.80262907	0.14789398	5.427057	*
Z7	dummy cara pemanenan	0.27812744	0.13243989	2.1000277	*
sigma-squared		0.10989212	0.02221762	4.9461699	
gamma		0.92226	0.022852997	40.356194	*
log likelihood function =		58.898776			
LR test of the one-sided error		106.55892			
with number of restrictions =		9			

Note:
* = significant = 5%.
ts = insignificant = 5%.

The low sigma-squared (σ2) value (0.109) in Table 4 indicates that the error term inefficiency (ui) is normally distributed. The gamma value (γ) is 0.9222 which is the ratio between the deviation of technical inefficiency (ui) to the deviation that may be caused by a random variable (vi). Statistically, the gamma value of 0.9222 indicates that 92.22% of the residual variation in the model comes from inefficiency in the production process (ui) and the rest (7.78%) is caused by random error in measurement (vi) (noise). If is close to zero, it is interpreted that all error terms come from noise (vi) (for example, weather and pests) and the production inefficiency coefficient becomes meaningless.

The LR test of the one-sided error (number of restrictions = 9) of the stochastic frontier production function model is 106.55892 and is greater than the value of the mixed chi-square distribution, X2(.05.9) = 16,274 which is listed in the Upper and Lower table. Bound fot The Critical Value for Jointly Testing Equality and Inequality Restrictions (Kodde and. Palm, 1986, pp. 1246). This means that the stochastic frontier production function can explain the technical inefficiency of producers in the production process. The interpretation of each production factor resulting from the estimation of the stochastic frontier production function model is as follows.

1. Variable area of land, number of seeds and labor are production factors that have a significant effect (at level = 5%) on production because the t ratio of each variable is greater than t(5%,132) = 1,978
2. The coefficient of the variable land, number of seeds and labor estimated by the MLE method, are 1.051, 0.226, and 0.304, respectively. The coefficient number is the elasticity which means that every 1% increase, for example, the variable area of land (ceteris paribus), can increase rice production by its elasticity, which is 1.051%.

D. Distribution of Technical Efficiency

Distribution of technical efficiency of the model can be seen in Table 5 below.

Table 5 distribution of technical

efficiency Technical Efficiency	Number of Respondents	Percentage (%)
<0.7	13	9.42
>0.7 0.8	13	9.42
>0.8 0.9	36	26.08
>0.9≤1.0	76	55.0

Total	138	100
Average	0.86	

The distribution of technical efficiency in Table 5 below shows that most farmers in rice farming in Batu Mandi District have been technically efficient because the average level of technical efficiency that has been achieved is more than 0.7 (ET 0.7). That is 0.86. Referring to (Coelli et al. 2005) that a farm is said to be efficient if its efficiency is greater than or equal to 0.70.

E. Factors influencing technical inefficiency The
interpretation of factors influencing technical inefficiency is as follows (see Table 4).
1. Education variable (Z2), farming experience (Z3), has a significant effect on the level of technical inefficiency, with the estimated coefficient marked (-) using the MLE method, respectively -0.0790, -0.0260, -1.650. This means that if farmer education and farmer experience are increased, the inefficiency will be reduced so that farming efficiency will increase.

2. The dummy variable of land ownership status (Z4) has no significant effect on the inefficiency of rice farming in the research area. This means that rice farmers who have their own land or those who do not own it do not really affect the efficiency of their farming.
3. The dummy variables of land management methods (Z6) and harvesting methods (Z7) have a significant effect on the level of technical inefficiency, with the estimated coefficient marked (+). This means that in this study, farmers who cultivate the land and harvest manually are more efficient than using tractors and combine harvesters. This is because the Combine Harvester Machine is more suitable for use in Rice Estates with large plots of land and road facilities to the rice fields have been prepared for it. Meanwhile, in the research location, farmers have an average land area of < 1ha and some locations are difficult to reach with a combine harvester machine.

IV. Conclusion And Suggestions

A. Conclusion

1. On average, the farmers in the study area were technically efficient with an average technical efficiency of 0.86.
2. Factors that affect technical inefficiency in this study are the variables of age (Z1), education (Z2), experience (Z3), land ownership (Z4), seed labels (Z5) and land cultivation (Z6) and harvesting (Z7) have a significant effect on inefficiency of rice cultivation in the study area.

B. Suggestions
1. Maintain the area of arable land, increase the use of superior seeds, NPK fertilizer and labor efficiency, as well as increase efficiency by reducing technical inefficiency in the use of N fertilizers and pesticides so that their use is not excessive.
2. Consistent and continuous activities are needed both in the use of inputs and the factors that affect rice production.

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