Technical Efficiency of Rice Farmers in Pante Piyeue

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Abstract. This study aims to analyze the technical efficiency of landowner farmers and sharecroppers of rice farming in Gampong Pante Piyeue, Peusangan sub-district, Bireuen Regency. This study uses primary data obtained from the distribution of questionnaires to 37 respondents who are landowner farmers and sharecroppers in Gampong Pante Piyeue, Matang Glumpang Dua, Bireuen Regency. The samples are taken using the Purposive sampling method. The Data Envelopment Analysis (DEA) is used to analyze the data. The results show that the landowner farmers are more technically efficient than sharecroppers, where the number of farmers who have reached the level of efficiency as many as 19 respondents.

Keywords: DEA · Technical efficiency · Rice

1 Introduction

Indonesia is the third-largest rice producer in the world and the highest rice consumer in the world. The rice consumption capita in Indonesia was recorded at almost 150 kilograms (rice, per person, per year) in 2017. Only Myanmar, Vietnam, and Bangladesh have higher per capita rice consumption than Indonesia. Food dependence on rice has made the national food supply of Indonesia increased by 75% in 2017.

Even though Indonesia is the third-largest country that produces the most rice in the world, Indonesia still needs to import rice almost every year (although usually only to maintain the level of rice reserves). This situation is caused by the lack of optimal agricultural techniques used by farmers, while the consumption per capita of rice continues to increase due to the increase of population.

Rice production in Indonesia is dominated by small scale farmers, not by large private or state-owned companies. Small scale farmers contribute around 90% of the total rice production in Indonesia. Each farmer has an average land area of fewer than 0.8 hectares.

Agriculture should no longer be seen as a traditional small-scale business. If it is run and managed well, it will be very profitable so that the products will have a competitive quality. So, farming does not only require agricultural technology that can improve quality, but also requires good management.

One of the 10 highest rice-producing provinces in Indonesia is Aceh (NAD). The rice production of Aceh province reaches 2.5 million tons per year and increased by 13.5 percent in 2017 or 300.000 tons compared to 2016 (BPS Aceh Province, 2017).

There are 69 villages in the Peusangan sub-district, and Pante Piyeue is one of the

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villages that has the largest area of rice land or 60 hectares of rice land with a population of 3,320 people, and 365 people are working on the agricultural sector that consists of owner farmers and sharecroppers.

Landowner farmers are farmers who own land and work on it themselves, whereas sharecroppers are farmers who work on other people's land with a production sharing system (BPS Aceh Utara, 2016).

Differences in agricultural land ownership often lead to differences in the motivation of farmers to do their farming business. In terms of efforts to increase production, for example, between landowner farmers far and landless farmers, there can be different motivations, where the landowner farmers will run their business as well as possible, both in obtaining maximum production results and in maintaining soil nutrients so that the process can occur sustainable agriculture, and of course will always try more to get maximum results because all the benefits will be fully enjoyed without having to share the results.

Meanwhile, sharecroppers are not as motivated as landowner farmers because they feel that not all products will be enjoyed by themselves because they must be shared with landowner farmers. But the sharecroppers will also make maximum efforts to increase their yields, regardless of the condition of soil nutrients for the future. Therefore, it is necessary to use production facilities (fertilizers, insecticides, and seeds) that are on target and on time to increase production yields.

However, due to differences in motivation that will affect the performance of farmers, it will lead to the use of different production facilities. Therefore, some preliminary observations are needed to examine the efficiency of rice farming in the Pante Piyeue.

The following table presents the use of fertilizers, insecticides, seeds, and the results of the production of landowner farmers and sharecroppers with an area of 2000 m.

Table 1. The Use of Fertilizers (x1), Insecticides (x2), Seeds (x3) and Production Results (y) of Landowner farmers and Sharecroppers with a Land Area of 2000 m^2.

Types of Farmers	Name	y (kg)	X1			X2 (ml)	X3 (kg)
			Urea (kg)	NPK (kg)	Sp-36 (kg)		
Sharecroppers	Umar	2000	50	25	25	200	20
	Harlini	2400	50	50	50	284	20
	Masyitah	2400	50	30	30	172	10
Landowner Farmers	Salamah	2000	50	50	50	314	20
	Ibrahim	2800	30	30	30	142	10
	M.Amin	2400	50	50	30	254	20

Data Source: Preliminary Observation Results using Questionnaires.

Based on the above table, we can see that there are variations in production from the use of production facilities so that it will cause different levels of efficiency such as Harlini and Salamah with the use of the same fertilizer consisting of 50 kg urea fertilizer, 50 kg NPK, 50 kg Sp-36, and 20 kg seeds. However, they obtain different production results where Harlini gets 2400 kg, while Salamah gets 2000 kg. Besides, Masyitah and Ibrahim use the same 2 types of fertilizers that consist of 30 kg NPK, 30 kg Sp-36, and 10 kg seeds, but they get different results of production in which Masyitah gets 2400 kg, and Ibrahim gets 2800 kg.

This study aims to determine the comparison of the level of technical efficiency of rice farmers and sharecroppers in Pante Piyeue, Peusangan Sub-district, Bireuen Regency.

2 Literature Review

2.1 Production

According to Lopang (2016), production is the result of an economic process or activity by utilizing several inputs. It means that production activities are combining various inputs to produce outputs.

Production can be defined as the result of a process of economic activity by utilizing several inputs. Thus, production activity is to combine various inputs to produce outputs (Yull, 2014). In simple terms, production is an activity that aims to produce and add value to an item.

The research by Nurung (2002) provides that the results of the use of urea fertilizer and pesticides do not provide real effectiveness on production. Therefore, the role of agricultural extension is necessary for providing information to farmers in using inputs appropriately.

2.2 Seeds

Seeds are the number of rice seeds used by all farmers in the farming process of all regencies and cities, expressed in kg units (Triyanto, 2006).

The seed is a plant material derived from generative and vegetative that is used for breeding forest plants (Permenhut P.1/ Menhut-II / 2009).

The use of good seeds and by the rules will produce good quality and quantity of cultivated plants. The use of too many seeds causes a high perforated population so that there is competition in the absorption of nutrients, oxygen, and sunlight that results in decreased production (Respikasari et al., 2014).

Seed is a planting medium that will be used by the farming process of all regencies and cities, expressed in kg units. The use of good seeds and by the rules will produce good cultivation plants.

The results of the study (Muhaimin, 2012) show that the seeds input significantly influences organic rice production in Pakis Sub-district. Another research (Darwanto, 2010) also shows results that seed input has a positive effect on rice production in Central Java Province.

2.3 Fertilizer

Fertilizer is a material added to the planting media or plants to meet the nutrient requirements needed by plants so that they can produce well (Anonymous, 2012).

Organic fertilizer is fertilizer derived from nature in the form of the remains of living organisms, both the remains of plants and animals. Organic fertilizers contain both macro and micronutrients needed by plants so that they can flourish. Organic fertilizer consists of manure, green manure, compost, and guano fertilizer (Handayani et al, 2011).

Fertilizer is a nutrient or food given to plants. Fertilizer is a means and key to the success of soil fertility and the success of farmers in increasing crop production, so fertilizer is very influential on production.

The types of fertilizers consist of urea fertilizer, NPK fertilizer, and SP-36 fertilizer. Fertilization is done a week after planting for Urea and SP-36 fertilizers, while NPK fertilizer is used two weeks after planting.

The results of the study by Fajar Firmana et al., (2014), the variable that has a significant influence on the technical efficiency of rice farming is the use of organic fertilizer at a real level of 15%. The coefficient value of the use of organic fertilizer has a positive value. This shows that the more use of organic fertilizer, it will increase the technical efficiency of farming carried out by farmers. The results of this study are in line with research by Patil et al., (2013) and Oraye et al., (2012), where the use of organic fertilizers can reduce the use of inorganic fertilizers and have an effect on soil fertility with the application of balanced fertilization.

2.4 Insecticides

According to Sudarmo (2005), insecticides are chemical substances used to kill or control pests. Insecticides are needed by farmers to prevent and eradicate pests and plant diseases.

Insecticides can benefit farming. On the other hand, insecticides can harm farmers and can be a loss for farmers if there is a misuse of both the way and composition applied to the plants. Excessive use can cause excessive production costs (Purwono, 2007).

An insecticide is a toxic chemical that can be used to kill all types of insects or pests that are a nuisance to plants. In using insecticides, the dosage and size must be considered. The use of insecticides is done 7 or 10 days after planting using the lowest dose and then carried out when the rice begins to appear to experience interference from pests.

The results of the study (Ambarawati et al., 2012) show that the input of Urea fertilizer, NPK fertilizer (Phosnka and Pelangi), organic fertilizer, and labor is efficient. Whereas economically, the use of pesticides is inefficient, and need to reduce the use in the right type, dosage, time, and the way to give to produce optimal rice production, and farmers get the maximum profit.

2.5 Hypothesis

The hypothesis of this study is as follow:

> "It is suspected that the use of seeds input, fertilizers, and insecticides is efficient in producing production output in Pante Piyeue, Peusangan District, Bireuen Regency".

3 Research Methodology

3.1 Population and Sample

The population in this study are all landowner farmers and sharecroppers in Pante Piyeue as many as 365 farmers (Source: Statistik Kecamatan, 2017).

The sampling is conducted using a purposive sampling method based on certain considerations, especially the considerations given by a group of experts (Sanusi, 2011). The Specific characteristics of the sample are as follows:

1. Sharecroppers who have a land area of 2,000 m2.
2. Landowner farmers who have a land area of 2,000 m2.
3. Farmers who have both of the above characteristics, and use Urea, NPK, and SP-36 fertilizers.

Based on preliminary observations and information from village officials, only 37 farmers in Pante Piyeue fulfill the above characteristics, so the number of samples in this study are 37 farmers.

3.2 Data Analysis Methods

This study uses DEA analysis tools in analyzing data with DEAP 2.1, and uses the Variable Return to Scale (VRS) approach which is oriented on the input approach. The results of the calculation of efficiency using DEA on the efficiency levels of sharecroppers and landowner farmers in Pante Piyeue indicate that there are 11 efficient sharecroppers from 19 samples, and there are 14 efficient landowner farmers from 18 samples.

DEA designed by Cooper, Seiford, and Tone (2000) aims to measure the efficiency or productivity of a particular DMU (Decision Making Unit) (Ramanathan, 2003).

DEA is a methodology used to evaluate the efficiency of a decision-making unit (work unit), which is responsible for using a number of inputs to obtain a targeted output. DEA is a fractional programming model that can include many inputs and outputs without the need for an explicit explanation of the functional relationship between inputs and outputs.

The measurement of efficiency using the DEA method can be done by determining the input and output variables and then determining the orientation of the model to minimize input or maximize output. The relationship between input and output variables, whether it is a Constant return to scale (CRS) or Return to scale variable (VRS) is an important aspect of the DEA techniques. This research uses VRS.

3.3 Efficency Testing using Variabel Return to Scale (VRS) Approach

This approach assumes that the ratio between the addition of inputs and outputs is not the same (variable return to scale). It means that adding inputs by n times will not cause the output to increase by n times, and it can be smaller or greater than n times.

Increasing the proportion can be increasing the return to scale (IRS) or can also be decreasing return to scale (DRS).

The results of this model add a convexity condition for the values λ, by including in the following limitation models:

$$\sum_{j=1}^{n} \lambda j = 1$$

Furthermore, the BCC model can be written with the following equation: λ Max π (Efficiency of DMU Model VRS)

Subject to:

$\sum_{j=1}^{n} xij_{\lambda ij \geq \pi io}$ i = 1,2,....,m

$\sum_{j=1}^{n} yrj_{\lambda j \geq yio}$ r = 1,2, ...,s

$\sum_{j=1}^{n} \lambda j \geq 1$ j = 1,2,....,n

Where:
π = Effciecy of DMU Model VRS
n = Number of DMU
m = Number of Inputs
s = Number of Outputs
xij = Number of Inputs to-i DMU j
yrj = Number of Outputs to- r DMU j
λj = Weight of DMU j for calculated DMU

4 Results and Discussions

4.1 The Results of Data Analysis of Variable Return to Scale (VRS) – Input Oriented of Sharecroppers

The following table presents the results of VRS-input-oriented data processing for 19 sharecroppers in Pante Pinuee.

Table 2. The Results of Data Envelopment Analysis (DEA) for Sharecroppers using a Return to Scale Variable (VRS) Approach.

No	Respondents	Efficiency Levels
1.	Umar	1.000
2.	Harlini	0.600
3.	Masyitah	1.000
4.	Nursiah	0.808
5.	Usman	0.990
6.	Nazaruddin	1.000
7.	Nilawati	0.965
8.	Lindawati	1.000
9.	Maulina	0.667

Table 2. The Results of Data Envelopment Analysis (DEA) for Sharecroppers using a Return to Scale Variable (VRS) Approach (cont.).

No	Respondents	Efficiency Levels
10.	Zuraida	0.737
11.	Juliana	1.000
12.	Amirullah	1.000
13.	Nur Aini	1.000
14.	Abdul Manan	1.000
15.	Fatimah Zuhra	1.000
16.	Raziah Hasyim	0.627
17.	Muhammad Yusuf	0.882
18.	Aurizawati	1.000
19.	Marni	1.000
	Average	**0.900**

Table 2 above shows that 11 sharecroppers in Pante Piyeue have been efficient in the use of inputs, while 8 of them have not been efficient.

4.2 The Results of Data Analysis of Variabel Return to Scale (VRS) – Input Oriented of Landowner Farmers

The following table presents the data analysis results of VRS - input-oriented for 18 landowner farmers in Pante Piyeue.

Table 3. The Results of *Data Envelopment Analysis* (DEA) of Landowner farmers using *Variabel Return to Scale* (VRS) Approach.

No	Respondents	Efficiency Levels
1.	Nur Wahidah	0.531
2.	Nurdin	1.000
3.	Muslem	0.531
4.	M.Yusuf	1.000
5.	Sabidah	1.000
6.	Salamiah	1.000
7.	Halim	1.000
8.	Iskandar	1.000
9.	Nur Baidah	0.807
10.	Ibrahim Ali	1.000
11.	Safrina	1.000
12.	Aminah	1.000
13.	Zainab	1.000
14.	Halimah	1.000
15.	Aisyah	1.000
16.	Wardiah	1.000
17.	Sariyani	1.000
18.	Heriyati	0.717
	Average	**0.916**

The table above shows that 14 landowner farmers in Pante Piyeue have been efficient in the use of inputs, and the rest 4 of them are inefficient in the use of inputs because the value is <1,000.

So, it concludes that the landowner farmers are more efficient in using their inputs compared to the sharecroppers in rice farming in Pante Piyeu, Peusangan sub-district, because of the 18 landowner farmers used as the respondents, 14 landowner farmers are efficient, while from 19 sharecroppers used as the respondents, only 11 sharecroppers are efficient.

4.3 Discussions

The table above shows the results of DEA efficiency calculations, and the following presents how to handle inefficient inputs to be efficient. For example, Harlini has not reached an efficient scale due to the use of inputs that have not been maximized, so that the resulting output is also not optimal.

Table 4 below shows the efficiency level of Harlini based on each input variable used in rice farming.

Table 4. Original Value, Target, Radial Movement, and Slack Movement of inefficient Input-output of Harlini with an efficiency level of 0.600.

Variables	Original values	Target values	*Radial movements*	*Slack movements*
Production	2400.000	3400.000	0.000	600.000
Urea Fertilizer	50.000	30.000	-20.000	0.000
NPK Fertilizer	50.000	30.000	-20.000	0.000
SP-36 Fertilizer	50.000	10.000	-20.000	-20.000
Insecticide	284.000	84.000	-113.600	-86.400
Seed	20.000	10.000	-8.000	-2.000

Source: Results of data analysis, 2019

Table 4 above explains that the use of the input of Harlini has inefficiencies in all inputs that consist of urea fertilizer, NPK fertilizer, SP-36 fertilizer, insecticide, and seeds.

The first and second input variables are urea fertilizer and NPK fertilizer that have the original value of 50 kg with the target value of 30 kg. It appears that the original value is higher than the target value. Therefore, to make the use of urea and NPK fertilizer more efficient, the use of fertilizer must be reduced by 20 kg with a slack movement of 0.

The original value of the third input variable is SP-36 fertilizer of 50 kg and the target value of 10 kg. So, to make more efficient use of SP-36 fertilizer, it must be reduced by 20 kg.

The fourth input variable is an insecticide that has the original value of 284 ml and the target value of 84 ml. It shows that the original value is higher than the target value. So, to make the use of the insecticide more efficient, it must be reduced by 113.6 ml.

The fifth input variable is the seed that has the original value of 20 kg with the target value of 10 kg. It appears that the original value is higher than the target value. So, to make the use of seeds more efficient, it must be reduced by 8 kg.

5 Conclusions & Suggestions

5.1 Conclusions

Based on the results of previous studies and discussions, the conclusions of this study are as follows:

Farmers are categorized as technically efficient if they are able to use minimal input to obtain maximum production output. The average value of the technical efficiency of 37 farmers used as the respondents is 0.908. It means that 25 rice farmers in Pante Piyeue have been technically efficient, or 68% of the total respondents.

Based on the output target produced, the landowner farmers get more efficiency level, where 14 respondents have been technically efficient. While sharecroppers, only 11 respondents are technically efficient. The differences in the level of efficiency obtained are due to differences in the use of inputs or production facilities used, and the use of production facilities that are not yet on targets, such as excessive use of fertilizers, insecticides, and seeds.

5.2 Suggestions

Based on the results of the study, several suggestions can be put forward:

1. It is expected that respondents who have not reached the level of efficiency to pay more attention to the use of production facilities, such as fertilizers, insecticides and seeds that must be on time and on target, because using the production facilities on time and on target will increase rice production yields, for farmers who have not technically efficient can reduce the use of excessive input in order to achieve efficiency scale.
2. To increase agricultural production results, the Government intervention in agricultural extension is necessary so that farmers are more efficient in using seeds, fertilizers, and insecticides.
3. For further researchers, they can use other variables of production facilities, increase the number of villages and use more diverse methods and approaches to obtain the results of an assessment of the level of efficiency of rice farming, which is more diverse and more detailed.

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