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RESEARCH PAPER

Technical Efficiency of Superior Varieties of Rice Farming in Tidal Lands Barito Kuala Regency Data Envelopment Analysis (DEA) Approach

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ABSTRACT

Barito Kuala Regency is one of the tidal swampland type districts consisting of land types A, B and C. The area of rice production land in Barito Kuala Regency is the largest planting area among other districts in South Kalimantan. Rice production in Barito Kuala Regency is 219,962.68 tons, with a harvest area of 57,873 ha. Although the rice production of Barito Kuala Regency is larger than other districts, judging from the productivity value, it is in a fairly low position, even below the productivity of South Kalimantan. Low productivity is suspected to indicate a lack of efficiency in the use of production inputs, because the higher the productivity of eating, the more optimized the ability of the production factor. The objectives of this study are: (1) Identifying the socio-economic characteristics of farmers; and (2) analyzing the level of technical efficiency of superior varieties of rice farmers in the ups and downs of Barito Kuala Regency. The location of this research was carried out in Barito Kuala Regency, with a implementation time of March 2025 – June 2025. The types and sources of data used in this study are primary data. Data collection by *simple random sampling*, on 100 sample farmers in Mandastana and Rantau Badauh Districts. The analysis used is *Data Envelopment Analysis* to measure relative technical efficiency, which is processed using DEAP 2.1 software. The results of the study stated that the socio-economic characteristics of the respondents in this study were having an average age of 42.35 years, with an average education at junior high school graduation, armed with superior rice farming experience of an average of 5 years and the number of dependents as many as 4 people. The results of *the Data Envelopment Analysis* show that as many as 23% of farmers have operated technically efficiently based on the VRS model. So that 23% of farmers who operate efficiently become references (peer farmers) for other farmers (77%) to streamline their production inputs.

HIGHLIGHTS

- The study found that most superior rice farmers in Barito Kuala Regency are in their early 40s, with junior high school education, an average of 5 years of farming experience, and households averaging 4 dependents. This demographic context shapes their farming practices and efficiency.
- Only 23% of farmers were technically efficient under the Variable Return to Scale (VRS) model, compared to 12% under the Constant Return to Scale (CRS) model. Efficient farmers serve as benchmarks for the majority (77%) who operate inefficiently, highlighting significant room for improvement in input use.
- Farmers used an average of 0.85 ha of land, 30.73 kg/ha of seeds, 259 kg/ha of solid fertilizer, 302 kg/ha of lime, and 105 HKO/ha of labor. Scale efficiency analysis revealed that 44% of farmers operated under increasing returns to scale, 43% under decreasing returns to scale, and only 13% at an optimal constant scale, suggesting mismatches between input use and production scale.

Keywords: Data envelopment analysis (DEA), technical efficiency, rice, tides, superior varieties

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Tidal swamp farmland is a unique ecosystem that has great potential in supporting food production, especially rice, but it also faces specific challenges. Suryana (2016), in his study on the development of swampland agriculture, stated that tidal land has characteristics in the form of fluctuations in the water level influenced by the tides of seawater, and often has acidic soil due to high pyrite content. According to Noor (2022), tidal land is classified into overflow types A, B, C, and D.

Barito Kuala Regency is one of the tidal swampland type districts consisting of land types A, B and C. The area of rice production land in Barito Kuala Regency is the largest planting area among other districts in South Kalimantan.

In order to increase food availability, the government has made various efforts to meet the amount of food availability. One of the efforts made is through the use of superior varieties of rice seeds, to increase rice production. The use of superior varieties of rice seeds in tidal swamp land has many challenges ranging from the socio-cultural aspects of the community, to the characteristic conditions of tidal swampland as marginal land.

Rice production in Barito Kuala Regency is 219,962.68 tons, with a harvest area of 57,873 ha. The production of Barito Kuala Regency is indeed the largest compared to other districts, but judging from its productivity value, Barito Kuala Regency is in a fairly low position, even below the productivity of South Kalimantan. Mandastana and Rantau Badauh sub-districts are two sub-districts that are the main contributors to superior rice production in Barito Kuala Regency (BPS, 2025).

Low productivity is suspected to indicate a lack of efficiency in the use of production inputs technically, because the higher the productivity of eating, the more optimized the ability of the production factor. The *Data Envelopment Analysis* (DEA) approach is a very appropriate methodology to analyze the technical efficiency of superior rice farming in tidal swamp land in Barito Kuala Regency. As explained by Coelli *et al.* (2005), that DEA is a non-parametric method capable of evaluating the relative performance of decision-making units (in this case, farmers) with multiple inputs and outputs, without requiring the assumption of an explicit functional form of the input-output relationship. The conditions of rice farming in swampland are very complex, involving various inputs such as seeds, fertilizers, lime, pesticides/herbicides, and labor, all of which interact in producing grain output. The DEA allows for the identification of farmers who are at the “frontier”, i.e. those who operate most efficiently, and at the same time measures the extent to which other farmers deviate from that boundary.

The advantage of DEA compared to other analytical tools such as linear programming analysis tools or partial efficiency analysis tools is that it can show the relative efficiency level of each DMU to other DMUs that are more efficient and can indicate inefficient DMUs (Sudaryanto, 2006; Abidin and Endri, 2009). Based on this description, the researcher felt the need to conduct research on the technical efficiency of superior varieties of rice farming in tidal land in Barito Kuala Regency Data *Envelopment Analysis* (DEA) Approach.

Research Objectives and Benefits

The objectives of this study are: (1) Identifying the socio-economic characteristics of superior varieties of rice farmers in tidal swamps in Barito Kuala Regency; and (2) Analyzing the level of technical efficiency of superior rice farmers in the tidal swamps of Barito Kuala Regency using the *Data Envelopment Analysis* approach. The benefits of this research consist of: (1) For academics, this research is expected to provide information on the analysis of the technical efficiency of rice farming, so that it can be used as material for future research literature; (2) For the government, this research is expected to be considered in decision-making in the agricultural sector; and (3) For the community, this research is expected to be information for people who carry out superior rice farming.

RESEARCH METHODS

Place and Time of Research

The research was conducted in Barito Kuala Regency, South Kalimantan Province. The location was chosen with the consideration that Barito Kuala Regency is the center of rice production and has the largest tidal land in South Kalimantan. The research will be conducted from March 2025 to June 2025. The stages of research start from preliminary surveys, literature review, proposal making, research preparation, data collection, analysis and preparation of research reports.

Data Types and Sources

The types and sources of data used in this study are primary data. Primary data is data collected in order to answer questions asked in research. Primary data was obtained by conducting interviews with decision making unit farmers using a list of questions that had been prepared beforehand.

Sampling Method (*Decision Making Unit*)

Sampling of Barito Kuala Regency based on the consideration process used in the context of sampling is carried out through stages, namely:

The first stage: choose the sub-district that produces the most superior rice, namely Rantau Badauh District and Mandastana District.

The second stage: selecting a sample of Superior Varieties of Rice farmers in tidal land in each selected sub-district with the number of samples to be taken as many as 100 respondents, with the consideration that the 100 respondents have been able to describe the population of superior varieties of rice farmers in the tidal lands of Barito Kuala Regency.

Data collection is done by *simple random sampling*, namely by simple random using an arisan system. This method is done by compiling the names of farmers who are included in the population per village, then drawn to find a sample to be selected.

Data Analysis

The primary data used was analyzed quantitatively using *Data Envelopment Analysis* to measure the relative technical efficiency of various farms that were used as decision making units. The data collected from each decision making unit will be processed using DEAP 2.1 software. *The output* of the software will show the relative efficiency level of each *decision-making unit* to other respondents in the agriculture being studied. *Microsoft Excel* is used to process data on the analysis of the socio-economic characteristics of superior rice farmers.

The technical efficiency approach used is *Data Envelopment Analysis*. This approach is used because it is simple and does not require many variables. The *Return to Scale* and *input-oriented* variable assumptions are used because these observations are only made over a period of time, so the possibility of changes in production factors as a result of time development can be ignored. The timing of one planting season of Superior Variety Rice is relatively short (about 240 days) increasing the possibility that there are no technological differences that affect farming during the planting season. This study uses *input oriented* because input variables (production factors) are variables that are easier to control by the *decision making unit*. Multistage analysis is used to minimize errors as a result of not calculating errors in the calculation results.

The DEA model in this study generally consists of two models, namely: *Constant Return to Scale Technical Efficiency* (CRSTE) and *Variable Return to Scale Technical Efficiency* (VRSTE). The CRSTE model is a CCR model that is used on the assumption that each addition of inputs will increase output proportionally, while the VRSTE is a BCC model that is used to analyze technical efficiency assuming that under certain conditions productivity in a production process can be considered efficient because other factors that affect it are different. Berkut is a DEA calculation using CRSTE to get technical efficiency values:

$$\text{Min } \theta, \lambda\ \theta$$

Subject to: $-q + Q\lambda \geq 0$;

$$\theta xi - X\lambda \geq 0;$$

$$\lambda \geq 0 \qquad \ldots(1)$$

Information

θ = The value of technical efficiency

λ = Weight/Weight

$-q$ = output to the first DMU

Q = Total output multiplied by weight

X = Total input multiplied by weight

Eq. 1 is a general model of the CCR model for CRSTE where the equation uses a minimization orientation to reduce the amount of excess inputs. The use of these equations can be applied in this study so that the following calculations can be formed:

$$\text{Min } \theta, \lambda\ \theta 1$$

Subject to :

$$-Q_1 + (Q_1\lambda_1 + Q_2\lambda_2 + Q_3\lambda_3 + ...+ Q_{100\lambda100}) \geq 0;$$
$$\theta x_{11} - (x_{11}\lambda_1 + x_{12}\lambda_2 + x_{13}\lambda_3 +... + x_{1\ 100\lambda100}) \geq 0;$$
$$\theta x_{21} - (x_{21}\lambda_1 + x_{22}\lambda_2 + x_{23}\lambda_3 +... + x_{2\ 100\lambda100}) \geq 0;$$
$$\theta x_{31} - (x_{31}\lambda_1 + x_{32}\lambda_2 + x_{33}\lambda_3 +... + x_{3\ 100\lambda100}) \geq 0;$$
$$\theta x_{41} - (x_{41}\lambda_1 + x_{42}\lambda_2 + x_{43}\lambda_3 +... + x_{4\ 100\lambda100}) \geq 0;$$
$$\theta x_{51} - (x_{51}\lambda_1 + x_{52}\lambda_2 + x_{53}\lambda_3 +... + x_{5\ 100\lambda100}) \geq 0;$$
$$\theta x_{61} - (x_{61}\lambda_1 + x_{62}\lambda_2 + x_{63}\lambda_3 +... + x_{6\ 100\lambda100}) \geq 0;$$
$$\theta x_{71} - (x_{71}\lambda_1 + x_{72}\lambda_2 + x_{73}\lambda_3 +... + x_{7\ 100\lambda100}) \geq 0;$$
$$\lambda \geq 0 \qquad ...(2)$$

where $\lambda = (\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7,... \lambda_{100})$

Eq. 2 is the CCR model of DMU number 1. The CCR model used in this study consists of one output (q), namely superior rice production and seven inputs (x), namely: land area (x_1), seed use (x_2), solid fertilizer use (x_3), liquid fertilizer use (x_4), agricultural lime (x_5), pesticide use (x_6), labor use (x_7), to find out the technical efficiency of each DMU, the calculation in equation 2 needs to be repeated i-times according to the number of samples/DMUs, which are 100 respondents. To find out the VRSTE model, the model in equation 1 has an additional *convexity constraint* so that the following model is formed:

$$\text{Min } \theta,\lambda\ \theta$$

Subject to : $-q + Q\lambda \geq 0;$

$$\theta x_i - X\lambda \geq 0;$$
$$N'\lambda = 1$$
$$\lambda \geq 0 \qquad ...(3)$$

Additions to the equation will provide the BCC assumption used for VRSTE. The addition of the convexity constraint $N'\lambda = 1$ ensures that the existing DMU can be compared with other DMUs of similar size, so that there is a difference in results when compared to CRSTE where the existing DMU has the possibility to be compared with other larger DMUs (Coelli *et al.* 2005). The next calculation that needs to be done is to find the value of scale efficiency obtained by performing the following calculations:

$$SE = \frac{TE_{CRS}}{TE_{VRS}} \qquad ...(4)$$

Information:

ONE = Efficiency of scale

THE CRS = CRS Technical Efficiency

THE RSS = VRS Technical Efficiency

The SE value in equation 4 is the scale efficiency value of the existing DMU. The above calculation is obtained if the VRSTE has been obtained, the scale efficiency (SE) value is the value of comparison between DMUs carried out on each DMU to find out the condition of the production scale. This means that each DMU can be efficient, but not necessarily according to the scale of production, if the production scale is too small, there will be *an increasing return to scale* and if it is too high, there will be *a decreasing return to scale*. The solution to both of these things is to adjust the scale of DMU production which is at the highest level of efficiency of CRSTE.

RESULTS AND DISCUSSION

Socio-economic Characteristics of Superior Rice Farmers

Age

Productive age will provide a better picture of physical condition compared to non-productive age. This means that age will play an important part in determining the amount and production capacity of a farmer.

The results of the analysis show that the majority of rice farmers with superior tidal land are in the age group between 41 – 45 years, which is as much as 38%. Meanwhile, superior rice farmers in the age group < 35 years are the least, which is only 10%. The average age of the respondents in this study was 42,355 years. This shows that there is a tendency that rice farmers in tidal fields have a tendency to be dominated by older age groups.

Formal Education

Formal education is a well-structured systematic education. This is because formal education has a clearly measurable level of education, through applied educational qualifications, and has a quality control of education that has been very clearly handled by the government. Good formal education will play an important role in a farmer, both in facing problems in his farming and in the wider aspects of life.

The results of the analysis show that the majority of superior rice farmers are mostly educated at junior high school graduation, which is as much as 40%. Then there are also quite a lot of farmers with a high school education as much as 28%. While the rest are in the group of elementary school graduates (19%), not graduating from elementary school/not in school (11%) and undergraduate college (2%). Overall, the respondents' education is still relatively low, this is based on data that the highest education of the respondents is junior high school graduation.

A Wealth of Knowledge of Farming

Experience is one of the ways of learning for a person, in this case also for a farmer. Through experience, farmers will learn a lot to deal with various situations.

The results of the analysis showed that most respondents had superior rice farming experience in the 3-year < group as much as 36%. Meanwhile, in the 9-year > experience group, only 13%. Overall, the experience possessed by the respondents in superior rice farming activities in tidal land is an average of 5 years.

Number of Household Members

The number of family members can be seen from two sides, namely in terms of expenses and family income. When viewed in terms of family expenses, the more family members will result in a lot of expenses that must be borne by the family. But when viewed in terms of income, the more family members will be able to increase the family income, with the note that the family members help with the work of the head of the family or work in different scopes of work.

The results of the analysis showed that most of the respondents in this study had a family member between 3 – 4 people, which was as much as 42%. Meanwhile, respondents who have a total of 6 family dependents > 14%. The average number of family members who are dependents is 4 people.

Production and Production Factors of Superior Rice Farming

A Land of Superior Cultivation

Land area is one of the main and most basic production factors in superior rice farming in tidal swampland. In this unique ecosystem, land size has significant implications for operational scale, yield potential, and production efficiency. In general, the larger the land cultivated, the greater the potential for total rice production that can be achieved, as long as it is supported by proper management and the availability of other inputs. The average land area based on respondent farmers in this study area is 0.85 ha.

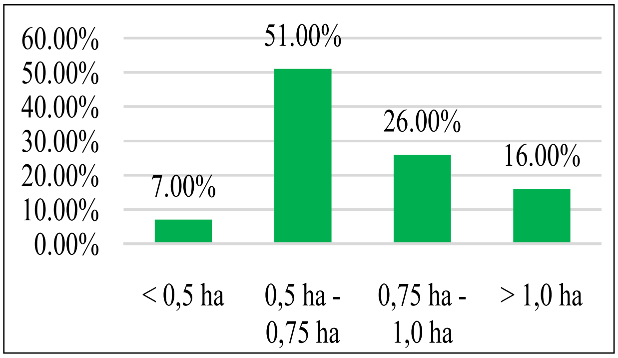

Fig. 1: Distribution of farmers based on the area of superior rice farming land

Superior Rice Farming Production

Superior rice production in tidal lands offers great potential for improving food security, especially in areas such as Barito Kuala Regency which has large expanses of tidal swampland. However, cultivation in this unique ecosystem demands adaptive and specific strategies. High fluctuations in water level, salinity, and potential soil acidity are the main challenges that must be overcome. The average superior rice production per farmer in the study area was 3,241.5 kg / farmer (0.85 ha). If calculated based on land area, rice productivity is superior based on land area, which is 3,859.76 kg / hectare.

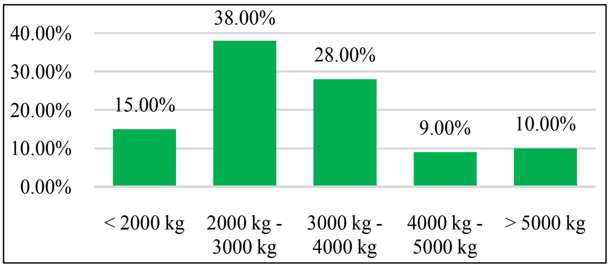

Fig. 2: Distribution of farmers based on production level per farm

The Use of Superior Rice Seeds

The amount of use of superior rice seeds as a production factor in paddy rice farming in tidal swampland is a crucial consideration that has a direct impact on cost efficiency, crop density, and ultimately, productivity. Although superior seeds have high yield potential, the determination of the right number of seeds is greatly influenced by the unique characteristics of the tidal swampland and the planting methods used. The average use of superior rice seeds by farming companies is 26.24 kg per farm. If calculated based on the needs per hectare of farmland, the demand for superior rice seeds is 30.73 kg / ha.

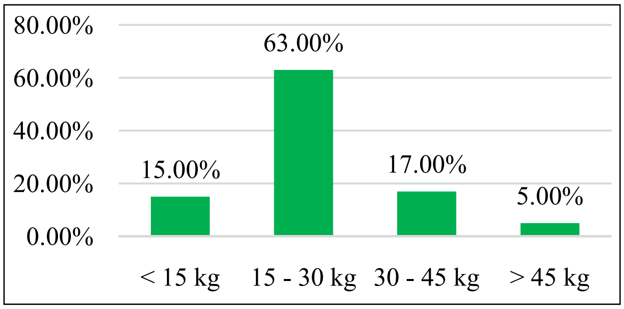

Fig. 3: Farmers' distribution based on the use of superior rice seeds

Use of Solid-Shaped Fertilizers

In rice farming in tidal swampland, solid fertilizers are crucial production inputs used by farmers to meet plant nutrient needs. Commonly applied fertilizer types include Urea, SP-36 or TSP and NPK phonska. The application of solid fertilizers is generally carried out through direct spreading (*broadcasting*) on the surface of the land when the water recedes or is not too deep, ensuring that the fertilizer can be absorbed by the roots without being washed away by the tidal current.

Fig. 4: Distribution of farmers based on the amount of solid fertilizer use

The timing of application is very important, with basic fertilizers applied before or immediately after planting, and follow-up fertilizers in the active and primordial phases to support optimal growth and grain filling. The average use of solid fertilizers in superior rice farming in tidal land is 218 kg per farm. Meanwhile, its use is based on the area per hectare, which is 259 kg.

Uses of Liquid Fertilizer

In rice farming in tidal swamp land, in addition to solid fertilizers, the use of liquid fertilizers is also starting to be looked at as a promising production input, although it is not as popular as solid fertilizers. Liquid fertilizers offer an advantage in terms of faster nutrient absorption by plants because nutrients are already in dissolved form. Liquid fertilizer applications are usually done through direct spraying to the leaves (*foliar application*) or watering into the soil around the roots, often in combination with fungicides or insecticides.

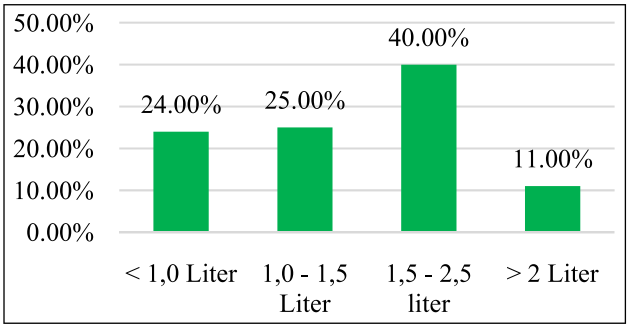

Fig. 5: Distribution of farmers based on the use of liquid fertilizers

This method allows farmers to deliver essential micro or macro nutrients at more controlled doses and faster plant responses, especially at critical moments of growth or when plants are showing symptoms of nutrient deficiencies. The average use of liquid fertilizer in superior rice farming in tidal swamp land is 1.76 liters per farm. Meanwhile, if calculated based on the land area per hectare, the use of liquid fertilizer is 2.1 liters per hectare.

Uses of Agricultural Lime

In rice farming in tidal swampland, agricultural lime (often in the form of dolomite) plays a very important production input to overcome the problem of acidity in highlands. Tidal swamp soils generally have a low pH due to their high pyrite content, which when oxidized will form sulfuric acid. These acidic soil conditions severely inhibit the availability and absorption of essential nutrients for rice plants, such as phosphorus, and can increase the toxicity of aluminum and iron that are detrimental to growth. With the application of agricultural lime, the pH of the soil can be increased (assessed), creating a more conducive environment for plant roots to absorb nutrients from fertilizers, so that the effectiveness of fertilizing solid and liquid fertilizers becomes much more optimal. The average use of agricultural lime in superior rice farming in tidal swamp land is 256 kg per farm. Meanwhile, if calculated based on the land area per hectare, the use of agricultural lime is 302 kg per hectare.

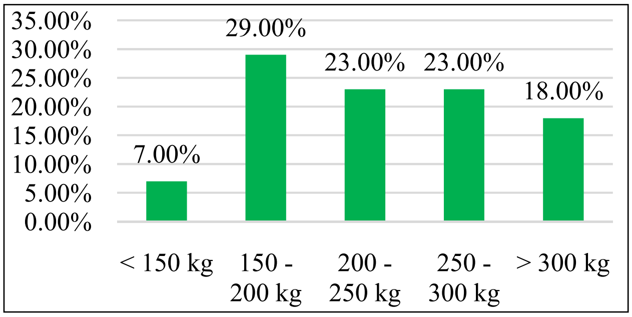

Fig. 6: Distribution of farmers based on the amount of agricultural lime use

Pesticide Use

In superior rice farming in tidal swamp land, pesticides are a type of production input that is often used to protect crops from plant pest organism (OPT) disturbances and weeds. The conditions of the swamp land that are moist and rich in organic matter create an ideal environment for the development of various pests, diseases, and weeds that can significantly reduce rice productivity. Pesticides, including insecticides to control pests such as leafhoppers and stem borers, and fungicides to control diseases such as blast and bacterial leaf blight, are applied to suppress OPT populations, as well as herbicides are used to control weed growth that competes with rice in the fight for nutrients, water, and sunlight, ensuring superior rice plants can grow optimally and produce full grains. The average use of pesticides in superior rice farming in tidal swampland is 5.11 liters per farm. Meanwhile, if calculated based on the land area per hectare, the use of pesticides is 5.98 liters per hectare.

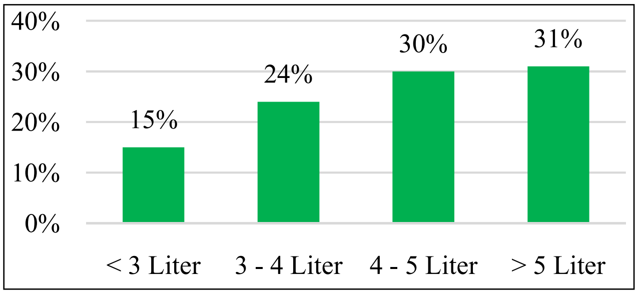

Fig. 7: Farmers' distribution based on pesticide use

Labor Usage

In superior rice farming in tidal swamp land, labor is a very dominant and fundamental production input. The typical condition of the swampland, with its fluctuating waterlogging and hard-to-access topography, makes manual labor the first, even irreplaceable, option for completing various jobs in the field. The availability and expertise of local workers who are familiar with the characteristics of tidal swampland are the main determinants of the smooth and successful of each phase of rice cultivation. The average use of labor in superior rice farming in tidal swamp land is 88.57 HKO per farm. Meanwhile, if calculated based on the land area per hectare, the labor use is 105 HKO per hectare.

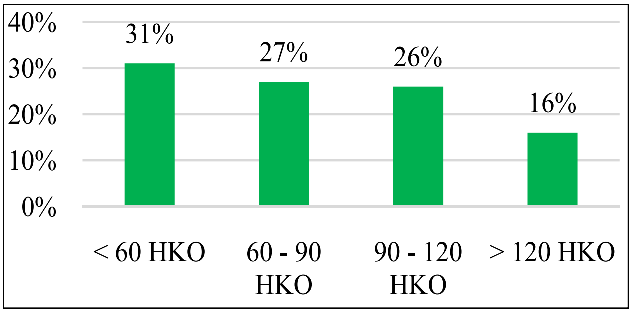

Fig. 8: Distribution of farmers based on labor consumption

Technical Efficiency

The technical efficiency value in this study used DEA VRS. The DEA CRS (*Constant Retum to Scale*) and DEA VRS (*Variable Retum to Scale*) models were used to determine the trend trends of rice farmers in *conditions of increasing retum to scale* (IRS), *decreasing return to scale* (DRS), or *constant retum to scale* (CRS). Farmers who are in a position to increase their retum *to scale* are in a position where the increase in output is greater than the increase in input. Farmers who are in a position of *decreasing return to scale* are in a position where the increase in output is smaller than the increase in production inputs.

Assuming that rice farmers operate at an optimal scale, using the CRS model, farmers who have achieved a technical efficiency value of 12%, while if it assumes that not all farmers operate at an optimal scale, then the VRS model shows that 23% have achieved a technical efficiency value. The condition of rice farmers with both VRS and CRS models is presented in Table 1.

Table 1: Percentage of rice farmers with CRS and VRS efficiency scales

Efficiency Scale	Percentage (%)	Farmer
CRS	12%	1, 4, 9, 10, 15, 16, 17, 26, 28, 29, 47, 55
VRS	23%	1, 2, 3, 4, 9, 10, 15, 16, 17, 20, 26, 27, 28, 29, 30, 38, 47, 55, 81, 83, 95, 99, 100

Rice farmers who operate efficiently in the VRS model are 23% greater than the number of efficient farmers in the CRS model of 12%. This shows that assuming not all farmers operate under optimal conditions, yielding more efficient farmer results compared to the CRS model.

The use of the CRS model when not all farmers operate at their optimal scale will result in a *Technical Efficiency* (TE) value that reflects their efficiency scale (SE). The technical efficiency value based on VRS was 1.00 (100 percent), there were 13% of respondents operating on the CRS (*constant return to scale*) scale, 44% operating on the IRS (*increasing return to scale*) scale, and 43% of the other respondents operating on the DRS (*decreasing return to scale*) scale. The comparative proportions of the three efficiency scales are presented in Fig. 9.

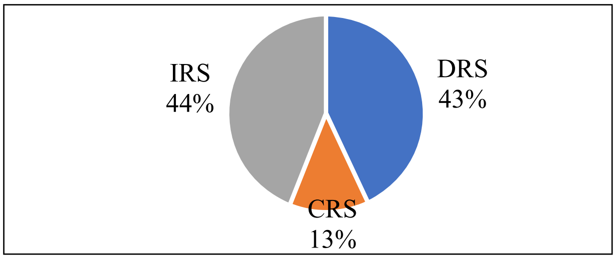

Fig. 9: The proportion of the efficiency scale of rice farmers is superior

Respondents who operate on the CRS scale and have a technical efficiency value of 1.00 are 13%, meaning that the proportion of additional production inputs is equal to the proportion of additional outputs. The technical efficiency value obtained from the CRS assumption is the same as the VRS assumption, so the efficiency scale obtained is 1.00.

Respondents who have achieved technical efficiency and operate on an IRS scale are 44%, where the proportion of additional agricultural inputs will result in a larger proportion of output. Respondents who achieve the technical efficiency of the IRS scale even though the efficiency value is 1.00 can still increase the inputs used because the ratio of the additional output to be received may be greater than the input output for the farmer.

Respondents who are efficient on the DRS scale there are 43% of farmers who are in the DRS efficiency should not add inputs, because the addition will result in a smaller proportion of additional production yields than the additional inputs made.

Comparison of Technical Efficiency Between Farmers

The Data *Envelopment Analysis* (DEA) analysis method can see comparisons among the respondent farmers studied. Farmers who have been efficient can be used as a reference for farmers who are not yet efficient by making comparisons between the use of their inputs. Farmers who have an efficiency value equal to one are farmers who have the best performance relative compared to farmers who have an efficiency value of less than one. Inefficient farmers can improve the use of their production inputs.

Comparisons between farmers can be seen in the peer distribution of DEA analysis. Farmers who

Table 2: Results of efficiency analysis for superior rice farmers number 5

Variable	Initial Value	Slack	Farmer-Based Efficiency Values 26, 29 and 1
Output (Production)	1 550,000	0,000	1 550,000
Land Area (x_1)	0,400	-0,076	0,324
Seed Usage (x_2)	10,000	-0,525	9,475
Use of Solid Fertilizer (x_3)	100,000	-7,346	92,654
Liquid Fertilizer Usage (x_4)	0,750	-0,277	0,472
Agricultural Chalk Usage (x_5)	120,000	-22,777	97,222
Pesticide Usage (x_6)	2,000	-0,105	1,895
Labor Consumption (x_7)	45,000	-4,074	40,926

have achieved efficiency are the most efficient input allocation reference among farmers who have not been efficient in using their inputs. Farmers who are peers are 23% of respondent farmers.

To explain the mechanism of farmers who have achieved efficiency and become a reference for the allocation of inputs for farmers who are not yet efficient, it can be explained as follows: suppose farmer 5 has not achieved 100% technical efficiency (farmer technical efficiency 5 is 94.8%). To increase the technical efficiency of farmer 1 to 100%, it is necessary to compare other farmers who have been efficient (100%). The farmers who became the comparison were farmers 26, 29 and 1. The complete results of the efficiency analysis for farmers 5 are presented in Table 2.

Based on the data presented in Table 2, it shows that the comparison between 5 farmers and two other farmers (26, 29 and 1 farmers). To get the same output value, 5 farmers used excess input allocation, where excess land use was 0.076 ha, excess seeds were 0.525 kg, excess solid fertilizer was 7.346 kg, excess liquid fertilizer was 0.277 liters, agricultural lime was excess 22.777 kg, overused pesticides were 0.105 liters, and excess labor was 4.074 HKO.

When viewed from a peer perspective, some farmers become peers against other farmers with different frequencies. The farmers who have the highest frequency of being peers against other farmers are 55 farmers with a frequency of 60 times, as well as farmer 1 with a frequency of 41 times and farmers 95 with a frequency of 29 times.

Excess Input (*Slack Input*)

Input slack shows inputs that can be reduced by respondent farmers due to overuse of inputs to produce the same level of output. The input slack occurs in farmers who are inefficient compared to their peers, namely efficient farmers. Reducing slack input is necessary to improve the efficiency of farmers relative to efficient farmers (peers). Meanwhile, slack output is an output that can be increased without increasing the number of inputs. Output slack occurred in a research case that used an output-oriented DEA model. Therefore, in this study, the output of slack did not occur because it used an input-oriented DEA model.

Input slack in inefficient farmers has varying values and is spread across all input variables. The average slack input value for the planting area is 0.019 ha. In detail, the average value of slack input from all farmers on the input variable can be seen in Table 3.

Table 3: Value *Input Slack* The average rice farmer is superior

Variable	Average Slack Value	Unit	Farmer Frequency
Land Area (x_1)	0,035	Ha	74
Seed Usage (x_2)	0,845	Kg	42
Use of Solid Fertilizer (x_3)	5,594	Kg	36
Liquid Fertilizer Usage (x_4)	0,161	Litre	62
Agricultural Chalk Usage (x_5)	11,692	Kg	66
Pesticide Usage (x_6)	0,328	Litre	60
Labor Consumption (x_7)	1,738	HKO	36

Based on the data presented in Table 3, it shows that the use of land area has an average slack of 0.035 ha, so that farmers can still reduce the average land area by 0.035 ha without reducing the results of superior rice farming, namely in a total of 74 farmers. The use of seed inputs has an average slack of 0.845 kg. Farmers who are still able to reduce the use of seeds by an average of 0.845 kg without reducing the results of their rice farming are 42 people. In this case, it indicates that there are farmers who behave efficiently (efficiency level = 1,000) who are peers for 42% of farmers for the use of superior rice seed inputs.

The use of solid fertilizer inputs has an average slack of 5,594 kg. Farmers who are still able to reduce the use of solid fertilizers by an average of 5,594 kg without reducing the yield of their rice farming are as many as 36% of farmers. In this case, it indicates that there are farmers who behave efficiently (efficiency level = 1,000) who are peer for 36% of farmers for the use of solid fertilizers in superior rice farming.

In the use of liquid fertilizer, there are 62% of farmers who behave inefficiently with an average of 0.161 liters of liquid fertilizer that can be saved. The same applies also to the use of agricultural lime where the average use of agricultural lime that can be saved is 11,692 kg without reducing the rice yield obtained by 66% of farmers so that the production target is the same as that of their peer farmers.

The use of pesticides shows that there are 60% of farmers who behave inefficiently with an average slack input of 0.328 liters. Thus, farmers can save the use of pesticides by 0.328 liters. The workforce has an average slack value of 1,738 HKOs. This shows that at 36% of farmers can still reduce their average labor usage by 1,738 HKO to get the same output as their peers.

Distribution Technical Efficiency Levels

The distribution of technical efficiency levels using the DEA model in rice farmers has varying values. The variation in the level of efficiency of farmers assuming using the DEA VRS model can be presented briefly in Table 4.

Farmers with the level of technical efficiency of the VRS model that have a maximum value of 1 are 23 people, where the farmer is an efficient farmer who is a peer for other farmers. The farmers are the 1st, 2nd, 3rd, 4th, 9th, 10th, 15th, 16th, 17th, 20th, 26th, 27th, 28th, 29th, 30th, 38th, 47th, 55th, 81th, 83th, 95th, 99th and 100th. Meanwhile, the lowest level of technical efficiency is 0.565. The farmer with the lowest efficiency score is the 60th farmer.

Table 4: Distribution of the technical efficiency level of superior rice farmers

No.	Technical Efficiency Level	Number (People)	Percentage (%)
1	< 0.7	7	7%
2	0,7 - 0,9	36	36%
3	>0.9	57	57%
Total		100	100%
Minimum		0,565	
Maximum		1,000	
Average		0,891	

The distribution with the largest proportion based on the level of technical efficiency in farmers with the VRS model is at the efficiency level of >0.9, which is 57% of farmers. The farmer has an efficiency level above the average efficiency level. The distribution of technical efficiency levels that are below the average efficiency level amounted to 59% of farmers. The farmers are distributed in three levels of range, namely between the range >0.9, as many as 57% of farmers, between the range of 0.7 – 0.9 as many as 36% of farmers and <0.7 as many as 7% of farmers.

CONCLUSIONS AND SUGGESTIONS

Conclusion

The conclusions that can be drawn from the results of this study are as follows:

1. The socio-economic characteristics of the respondents in this study were that they had an average age of 42.35 years, with an average education at junior high school graduation, armed with superior rice farming experience of an average of 5 years and the number of dependents as many as 4 people.
2. The results of the Data Envelopment Analysis show that as many as 23% of farmers have operated efficiently based on the VRS model. So that 23% of farmers who operate efficiently become references (peer farmers) for other farmers (77%) to streamline their production inputs.

Suggestion

It is better for farmers who are not efficient to reduce the use of their production inputs by slack inputs based on the farmers who are their peer farmers. So that farmers who are not efficient can save the use of production inputs without having to experience a decrease in production.

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