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The efficiency of use of production factors for rice through mechanization in Sukoharjo

The efficiency of use of production factors for rice through mechanization in Sukoharjo

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Abstract. Paddy was a staple food ingredient to produce rice. Rice contains nutrients for the human body as an energy source. Rice contains strengthening substances such as carbohydrates, protein, fat, crude fiber, ash, and vitamins. Sukoharjo Regency has implemented a corporate farming system since 2018. The level of use of the mechanization system of production factors was not yet known. The objective of this study was to know the level of efficiency of the use of the corporate farming system in the Sukoharjo Regency. The method of determining the location of the study uses a purposive. The method of determining the sample in this study is the purposive sampling method. That is, sampling from the population was done randomly without regard to the existing strata in the population. The results showed that The use of production factors in lowland rice farming had not reached the maximum efficiency level. The factors of production needed to increase their use were land area and organic fertilizer. In comparison, the inefficient factors were labor, seeds, urea fertilizer, sp36 fertilizer, spontaneous pesticides, and furadan pesticides, so their use does not need to be added.

1. Introduction

Indonesia was one of the nations with a sizable population, as seen by the 1.17% population growth rate between 2020 and 2022 [1]. The government is concerned about this since a huge population will affect food availability. Rice, corn, and soybeans are the principal food crops grown in Indonesia. The Indonesian population's primary diet is rice, which has a significant position among the many other forms of cuisine. Additionally, because rice is a vital good for the Indonesian economy, a fair price shortage threatens economic and political stability [2]. The Indonesian population still consumes a significant amount of rice. In 2016, 44.0% of the calories consumed by Indonesians came from grains [3]. Meanwhile, it was reported that the average per capita intake of meals containing rice was 98.05%, based on the 2015 national socio-economic survey findings.

An increase followed this large consumption of grain food in Indonesia's rice production. During the last five years, rice production in Indonesia has increased; from 2014-2015, it increased by 4,552 tons, in 2015-2016 by 3,957 tons, in 2016-2017 by 1,794 tons, and in 2017-2018 by 1,888 tons. The total production of Indonesian rice farming is the contribution of rice farming in all provinces in Indonesia. It is known that East Java Province is the largest rice producer, with a production of 13,000,475 tons, followed by West Java, Central Java, South Sulawesi, and South Sumatra, with each province producing 12,494,919 tons, 11,401,821 tons, 6,196,737 tons and 5,076,831 tons. Central Java Province is the third largest rice producer in Indonesia and one of the regions that act as a national rice granary and national food buffer; therefore, rice productivity is prioritized to continue to be developed [4].

The Central Java government seeks to increase the production and productivity of rice commodities in the region. Increased production, land area, and rice productivity must be maintained every year to increase food availability for the community. The increase in rice production in Central Java Province is not only to meet regional needs, but it is hoped that this increase can contribute to increasing national rice production. Sukoharjo Regency is one of the food buffer districts in Central Java, so the productivity of food crops, especially rice, continues to be boosted. In 2019 Sukoharjo Regency had the highest rice productivity of 6.92 tons/ha, with a production of 339,445 tons and a harvested area of 49,061 hectares [5].

From 2014-2018 rice production in Sukoharjo Regency fluctuated, and rice production and productivity have decreased over the last two years. The government makes a program policy for providing support and assistance for agricultural tools and machines to increase agricultural production and productivity in Sukoharjo Regency. The assistance is also intended to address the decreasing availability of agricultural labor. The scarcity of labor in the agricultural sector in Sukoharjo Regency can be caused by the lack of interest in the workforce working in the agricultural sector or switching to more promising sectors. The agricultural sector at the rural level is currently being abandoned, especially by young people. Most prefer to work outside the agricultural sector and migrate to urban areas.

Ratnawati [6] stated that it is difficult in several rice production centers to find workers for land processing, seed planting, and harvesting. The three stages of rice cultivation require large amounts of energy. Simultaneous planting in one area is challenging due to the local workforce, which makes it more challenging to eradicate pests simultaneously. A mechanized pattern of agriculture that starts with land preparation and seed planting and ends with harvesting is one technique to get around this. As a result of the labor shortage in rural regions, numerous research has concluded that agricultural implements and machinery are the immediate demands of the agricultural industry [6]. According to Gamlath [7], farming tools and machines serve various purposes, such as reducing labor costs and increasing labor productivity. They also increase farm efficiency by reducing energy, time, and other production-related expenses, increasing yields, and enhancing agricultural product quality. According to Firouzi [8], adopting agricultural mechanization technology raised farming profits by 81.61% compared to manual technology. Rice production is increased by 33.83% when agricultural mechanization is fully utilized, while labor and production expenses are also reduced.

The area of Sukoharjo Regency consists of 12 districts covering 167 villages; most people cultivate rice (*Oryza sativa* L.). The Tawangsari District, which is one of the rice-producing locations in Sukoharjo Regency, contains some agricultural land with good potential for the growth of food crops. One of the sub-districts of Sukoharjo Regency that has gotten the most help with agricultural machinery technology is Tawangsari District. The first hamlet in the Tawangsari District to employ agricultural mechanization or modern agriculture as a practice is Dalangan Village. In Tawangsari District's Dalangan Village, rice productivity has varied during the last five years. That is, it was 7.61 tons per hectare in 2015. It was 7.61 tons per acre in 2016. There was an increase of 8.20 tons per hectare in 2017, a fall of 6.81 tons per hectare in 2018 and a decrease of 6.87 tons per hectare in 2019.

According to data from the Department of Agricultural and Fisheries Extension in Tawangsari District regarding the use of machines, the area of land cultivated using modern agricultural machines since 2017 is 40 ha. Based on these findings, it is clear that some farmers in Dalangan Village, Tawangsari District, and Sukoharjo Regency are still not using modern agricultural machinery. The study by Reddy revealed that nearly half (45.00 %) of the paddy growers had a medium level of mechanization knowledge, followed by 31.67 and 23.33 percent of respondents who had high and low levels of knowledge, respectively [9]. This study aims to ascertain how effectively these farmers can use production factors for lowland rice farming by applying a modern farming system. The purpose of this study is to evaluate the economic effectiveness of lowland rice cultivation at Sukoharjo Regency using current farming techniques.

2. Methods

Sukoharjo Regency's Tawangsari District served as the site of this study. The Tawangsari district now serves as a test place for cutting-edge national agricultural equipment. 43 recipients of a corporate agricultural system made up the sample for this study. Purposive sampling was utilized as the sample method. The methods used to collect data are observation, interviews, and questionnaires. The farming analysis of the data used includes the following:

2.1. Cost Analysis of Paddy Rice Farming.

$$TC = FC + VC \quad (1)$$

Description:
TC = Total cost (*IDR*/ha/MT)
FC = Fixed cost (*IDR*/ha/MT)
VC = Variable cost (IDR/ha/MT)

2.2. Analysis of Rice Farming Revenue

$$TR = P \cdot Q \quad (2)$$

Description:
TR: Total Revenue (IDR/ha/ MT),
P: Output Price (IDR/Kg)
Q: Amount of production (Kg/MT)

2.3. Rice Farming Income Analysis.

$$Pd = TR - TC \quad (3)$$

Information :
Pd: Lowland rice farming income (IDR/Ha/MT)
TR: Total Rice Farming Revenue (IDR/Ha/MT)
TC: Total Cost of Cultivating (Total Cost) (IDR/Ha/MT)

2.4. Production Function Cob-Douglas

$$Y = b0.\ X_1^{b1}.\ X_2^{b2}.\ X_3^{b3}.\ X_4^{b4}.\ X_5^{b5}.\ X_6^{b6}.X_7^{b7}\ .X_8^{\ b8}.E \quad (4)$$

Information :
Y = Lowland rice production (kg)
bo = intercept
X1 = Land area (Ha)
X2 = Labor (HKO)
X3 = Seed (Kg)
X4 = Organic fertilizer (Kg)
X5 = Urea fertilizer (kg)
X6 = SP36 Fertilizer (Kg)
X7 = Spontaneous pesticide (ml)
X8 = Furadan pesticide (kg)
b1 - b8 = Regression coefficient
e = Error

The equation is converted into a linear form through a logarithm as follows:

$$LnY= Ln\ a + bl\ Ln\ X1 + b2\ Ln\ X2 + b3\ Ln\ X3 + b4\ Ln\ X4 +b5\ Ln\ X5 + b6\ Ln\ X6 - b7LnX7 - b8LnX8 + e \quad (5)$$

To obtain good regression results, it must meet the following statistical criteria R^2, F-test, and t-test [10].

2.5. Efficiency Analysis of the Use of Production Factors
Price efficiency can be used to calculate efficiency in the use of production factors; that is, the value of the marginal product input (NPMxi) equals the input price (Pxi)[11]. The formula for calculating price efficiency using the Cobb-Douglass production function technique is as follows:

Bi. Y.Py/Xi =Px or

NPMxi = Pxi or NPMxi/Pxi = 1 [12] (6)

Information :
Bi: regression coefficient of production factor (input) i
Py: the unit price of output
Xi: the average use of the input of production i,
Pxi: the unit price of the input i

Note:
a. NPMx /Px < 1: Production factors need to be reduced.
b. NPMxi/Px = 1: The use of production factors (inputs) has reached the optimal combination.
c. NPMxi/Pxi > 1: The use of production factors (inputs) needs to be increased.

3. Results And Discussion

3.1. Characteristics of respondent
The average age of the sample of farmers in rice farming using modern machinery in Dalangan Village, Tawangsari District, Sukoharjo Regency, was still in the productive age (18-65 years). At the productive age, a farmer can improve his skills in farming by absorbing and adopting new technology in farming, where better farming skills are expected to increase farmers' income and productivity. The average land used by farmers is 0.35-0.4 ha, with a percentage of 66.67%. The larger the land area owned by farmers, the more production costs incurred and the more products produced in their farming.

3.2. Production, revenue, and Income
Total cost is the sum of fixed costs and variable costs. Dalangan Village, Tawangsari District farmers must pay the average total cost of running their farming. The average total cost incurred by farmers was 10,428,363 IDR per hectare. The average yield of rice per hectare was 66853.16 kg. The average price of paddy rice per kilogram is IDR 4200. After-sales, farmers receive 27,562,016 IDR on average per acre. The difference between receipts and total expenses or costs was referred to as revenue. Farmers made an average of 17,267,844 IDR per hectare on each farm. This value is lower than the average income of lowland rice farmers for one planting season in Gorontalo Regency of IDR 37,217,960 ha/MT with different dry grain prices [13].

3.3. Production Function Analysis of Rice Field Farming

Table 1. Factors influencing rice farming production through mechanization in 2020

Variable	Coefficient	t	Sig.
Land area(X1)	1.088	3.681	0.001*
Labor(X2)	-0.209	-1.205	0.242
Seeds(X3)	-0.056	-0.438	0.666
Organic Fertilizer(X4)	0.011	0.206	0.839
Urea fertilizer(X5)	0.008	0.079	0.938

Variable	Coefficient	t	Sig.
Sp36(X6) Fertilizer	0.019	0.206	0.839
Spontan Pesticide(X7)	-0.014	-0.378	0.709
Furadan Pesticide (X8)	-0.226	-1.621	0.120
R^2			0.661
Adjusted R^2			0.532
F-test			0.001*

The coefficient of determination value is a metric that illustrates how much the independent variable contributed to the dependent variable. Or, to put it another way, the coefficient of determination demonstrates how the linear influence of X causes variation in the Y derivative. The independent variable grows in size if the coefficient of determination, shown by the symbol R^2, is close to 1. Consider the relationship with the dependent variable to determine whether the model's application is appropriate. The table above shows that the Adjusted R Square value of 0.532 indicates that the production factors of land area, labor, seeds, organic fertilizers, urea fertilizers, sp36 fertilizers, spontaneous pesticides, and furadan pesticides can explain 53.2% of the variation of changes in lowland rice production, while other factors outside of this research model can explain the remaining 46.8%.

The simultaneous F test determines if every independent or independent variable in the model has an additive impact on the dependent variable. We accept the alternative hypothesis, which claims that all independent variables simultaneously and significantly affect the dependent variable because the F test is performed by comparing the estimated F findings with the F table. Table 1 reveals that the denominator was 21, and the numerator was eight. The F-count value was 5.116, meaning that the selected research model significantly affects rice production. The results of the t-test analysis showed that the land area factor had a very significant effect on production. The regression coefficient value is positive at 1.088, meaning that for every 1% increase in land area used, production increases by 1.088%. Assuming other variables are considered constant (*ceteris paribus*) [13]. The t-test analysis' findings demonstrate that the labor factor has no appreciable impact on output. In accordance with the findings of the t-test analysis, the seed component had a t-count (-0.438) with a significance level of 0.666 > 0.05, indicating that it had no discernible impact on production. According to the t-test analysis's findings, organic fertilizer had a t-count value of 0.206 and a significance level of 0.839 > 0.05, which indicates that it had no appreciable impact on productivity. Urea fertilizer had no discernible impact on production, according to the findings of the t-test study, which revealed that the urea factor had a t-count value (0.079) with a significance of 0.938> 0.05. The sp36 fertilizer component had a t-count value of 0.206 with a significance of 0.839 > 0.05, according to the findings of the t-test study, indicating that it had no discernible impact on production. Following the results of the t-test analysis, the spontaneous pesticide component had a t-count (-0.378) with a significance level of 0.709 > 0.05, indicating that it had no discernible impact on production. Furadan pesticides had no discernible impact on production, according to the findings of the t-test study, which revealed that the furadan factor had a t-value of (-1.621) and a significance of 0.120 > 0.05.

3.4. Efficiency Analysis of Production Factors for Paddy Rice Farming through Mechanization

Rational farmers aim to make the most money possible in the production process. If the combination of the usage of the production components reaches the optimum level of economic efficiency, profits will be maximized. Farmers are expected to allocate their resources wisely and effectively to achieve significant earnings. It is said to be effective if farmers or producers can manage their resources as efficiently as possible. Something is considered efficient if there are no unnecessary products or if they are used as effectively as possible. Land area, capital, and total production all had a favourable and marginally significant impact on income. 44.2% of income comprised the variable land area, capital, and production. [14–17]. Cost minimization is a critical idea in economic efficiency. If no other process can provide a similar output at a lower cost, a manufacturing process will be economically efficient at that output level. The farming enterprise's products will have reached their most significant profit when produced with the highest economic efficiency. The strategy that maximizes profit can be used to determine the highest economic efficiency. If the value of the marginal product of the factors of production is equal to the price of the factor or if the ratio between the value of the marginal product (NPMxi) and the price of the factors of production (Pxi) is equal to 1, the highest level of economic efficiency can be [18–22].

Table 2. Analysis of the efficiency of rice farming production factors through mechanization

Variable	NPMXi	Pxi	$\frac{NPMxi}{Pxi}$	Note
Land area(X1)	29972156.7	31.667	946.48	needs to be increased
Labor(X2)	-379132.19	70.000	-5.42	needs to be reduced
Seeds(X3)	-40696,58591	10.233	-3.98	needs to be reduced
Organic Fertilizer(X4)	2057,504301	1.000	2.06	needs to be increased
Urea fertilizer(X5)	848,6156282	3.800	0.22	needs to be reduced
Sp36(X6) Fertilizer	1957,101344	4.000	0.49	needs to be reduced
Spontaneous Pesticide(X7)	-592280.67	35.733	-16.58	needs to be reduced
Furadan Pesticide (X8)	-218718.0252	35.000	-6.25	needs to be reduced

Source: Primary Data Analysis, 2021

The land area variable has a value of 946.48, meaning the value is more than one, meaning that the use of land area production factors is inefficient, so it is necessary to increase the land area to increase maximum production results. The labor variable has a value of -5.42, meaning its value is less than one, meaning that the use of labor production factors is inefficient, resulting in costs incurred greater than the revenue earned. The seed variable has a value of -3.98, which means its value is less than one, meaning that the use of seed production factors is necessary to reduce its use because it results in additional costs that are greater than the additional revenue obtained. The organic fertilizer variable has a value of 2.06 which means the value is more than one, meaning that the use of organic fertilizer production factors is not efficient, so it is necessary to add organic fertilizer to increase maximum production results. The urea fertilizer variable has a value of 0.22, meaning the value is less than one, meaning that using urea fertilizer production factors is necessary to reduce urea fertilizer to increase maximum production yields. The sp36 fertilizer variable has a value of 0.49 which means the value is less than one, meaning that the use of the sp36 fertilizer production factor is inefficient, so it needs to be reduced because it results in additional costs that are greater than the additional revenue obtained. The spontan pesticide variable has a value of -16.58, meaning its value is less than one, so reducing its use in production is necessary. The furadan pesticide variable has a value of -6.25, meaning the value is less than one, meaning that the use of furadan pesticide production factors is inefficient. So it needs to be reduced because it results in additional costs greater than the additional revenue obtained.

4. Conclusion

The application of production variables in lowland rice farming through mechanization has not been effective, according to research on the subject conducted in Tawangsari District, Sukoharjo Regency. The production elements of land area (X1) and organic fertilizer need to be raised (X4). The target recipients' corporate farming system needs to be expanded and recalculated To increase automated machinery's production efficiency. Forty hectares as a demonstration area is not a sufficient area for mechanization and modernization. The use of modern tools and machines in Indonesia needs to be reviewed because most farmers have a narrow land area. Appropriate technology applications for narrow land may provide better options for farmers. In comparison, the labor (X2), seeds (X3), urea fertilizer (X5), and sp36 fertilizer (X6), spontaneous pesticides (X7), furadan pesticides (X8) so that their use does not need to be added. Lowland rice farming needs to manage production elements effectively and appropriately, technically and economically, to increase productivity, revenue, and income. Due to ineffective lowland rice production, careful consideration must be given to the various components employed.

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