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Technical Efficiency Analysis of Cassava Farmers on Suboptimal Dry Land

Analisis Efisiensi Teknis Petani Ubi Kayu pada Lahan Kering Suboptimal

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ABSTRAK

Pemerintah meluncurkan program diversifikasi pangan salah satunya ubi kayu agar penduduk tidak bergantung pada beras, serta mengantisipasi ketika produksi beras menurun akibat gagal panen. Tetapi, produksi ubi kayu jauh lebih rendah dibandingkan beras. Ada upaya untuk memanfaatkan lahan suboptimal untuk meningkatkan suplly ubi kayu untuk konsumsi penduduk. Oleh karena itu, penelitian ini bertujuan menilai tingkat efisiensi teknis usahatani ubi kayu pada lahan kering suboptimal. Sampel penelitian sebesar 60 petani ubi kayu di Desa Jaddih, Kabupaten Bangkalan diambil secara sensus untuk menjawab tujuan penelitian. Stochastic frontier analysis digunakan untuk mengetahui pengaruh input pertanian yang terdiri atas lahan, bibit, tenaga kerja, biaya, dan pupuk kandang terhadap produksi ubi kayu dimana. Kemudian untuk mengetahui pengaruh usia, pengalaman, pendidikan formal, pendidikan non-formal, dan tanggungan keluarga terhadap infeisiensi ubi kayu. Hasilnya menunjukan bahwa produksi ubi kayu akan meningkat seiring peningkatan luas lahan, tetapi akan menurun seiring peningkatan bibit. Rata-rata efisiensi teknis ubi kayu yaitu 87%, dimana nilai tersebut akan meningkat jika petani mengikuti pendidikan non-formal. Penelitian ini berkontribusi kepada pembuat kebijakan untuk mengoptimalkan penggunaan lahan suboptimal, dan kepada petani untuk memanfaatkan input produksi dan variabel sosial ekonomi yang berpengaruh terhadap peningkatan produksi dan efisiensi teknis.

Kata kunci: efisiensi teknis, lahan suboptimal, stochastic frontier analysis, ubi kayu

ABSTRACT

The government launched a food diversification program, one of which was cassava so that the population does not depend on rice, and anticipates when rice production decreases due to crop failure. However, cassava production was much lower than rice. There were efforts to utilize suboptimal land to increase cassava suplly for population consumption. Therefore, this research aims to assess the level of technical efficiency of cassava farming on suboptimal dry land. The research sample of 60 cassava farmers in Jaddih Village, Bangkalan Regency was taken by census to answer the research objectives. Stochastic frontier analysis was used to determine the effect of agricultural inputs consisting of land, seeds, labor, costs, and manure on the production of cassava. Then to determine the effect of age, experience, formal education, non-formal education, and family dependents on cassava insufficiency. The results show that cassava production will increase with the increase in land area, but will decrease with the increase in seedlings. The average technical efficiency of cassava was 87%, where this value will increase if farmers attend non-formal education. This research contributes to policy makers to optimize suboptimal land use, and to farmers to take advantage of production inputs and socio-economic variables that affect production increases and technical efficiency.

Keywords: cassava, suboptimal land, stochastic frontier analysis, technical efficiency

INTRODUCTION

Rice was the main food commodity for more than half of the world's population, where the largest producers and consumers of this commodity were Asian countries (Bandumula, 2017). In Indonesia, people depend on rice as their main food commodity. There was an assumption that Indonesians cannot eat and cannot sleep if they do not consume rice (Nugroho et al., 2022). Problems arise when there was a surplus demand caused by the conversion of paddy fields. Coupled with climate change which has the potential to reduce production, thus having an impact on decreasing food security and regional economies (Priyanto et al., 2021; Priyanto, 2021).

The projected decline in rice in the future encourages the government to urge the public to diversify their food (food diversification), which was regulated in Law Number 18 of 2012 (UU-RI, 2012). Food diversification was expected to overcome the problem of Indonesia's consumption dependence on rice and consuming alternative foods such as corn which have competitive and comparative advantages (Rum et al., 2020), and cassava.

Cassava was the most suitable commodity to be used as an alternative food (Dewi & Ginting, 2012). Cassava was used as a staple food source for millions of people in tropical and subtropical regions (Balagopalan et al., 2018). Cassava helps provide food security in areas with poor soils and low rainfall (Latif & Müller, 2015). In addition, cassava provides higher energy than other commodities such as corn, sweet potatoes, rice, sorghum and wheat (Byju & Suja, 2020).

Unlike rice, the focus on increasing cassava production was relatively slow. Most government programs on food commodities aim to increase rice productivity, namely PAJALE, BULOG, and SERASI. Meanwhile, as far as the author's knowledge, there was no program for cassava commodities. In addition, the harvested area for rice was larger than cassava, which was 15,994,512 ha and 792,952 ha respectively (2018 data). However, the productivity trend of cassava was relatively faster than rice, respectively 7.708 q/ha and 0.658 q/ha (2000-2015 data) (BPS, 2022). This shows that cassava was classified as a potential commodity to be developed, because it contributes to meeting household needs by increasing production and commodity stocks when the production of other food commodities decreases (Guira et al., 2017).

Sub-optimal land in Indonesia, which reaches 149 million ha, was abandoned by farmers in cultivation because sub-optimal land was unproductive compared to optimal land (Mulyani et al., 2016). Changes in land use amid increasing demand for food commodities was a further problem for food security. Therefore, increased productivity was not only targeted at ideal or optimal land (irrigated rice fields), but also rainfed, dry, and poor land (suboptimal land). Suboptimal land from marginal land with low natural fertility levels could be overcome by competent management, adjusting land characteristics, and applying appropriate science and technology (Lakitan & Gofar, 2013).

There have been many studies on the technical efficiency of cassava farmers, but not many have conducted research on suboptimal land. We were filling this gap due to increased land conversion to arable land for agricultural commodities. We assess the technical efficiency of farmers to find out whether the inputs issued by farmers produce optimal output. Therefore, this research aimed to examine the technical efficiency of cassava farmers on suboptimal dry land. This study was expected to be the basis for formulating policies related to the development of cassava commodities in suboptimal dry land.

MATERIALS AND METHODS

Locations and Samples

This research was conducted in Socah Subdistrict, Bangkalan Regency which was selected purposively, with the consideration that the majority of the villages used cassava as a companion plant in the intercropping system and carried out post-harvest processing of these commodities (Triyasari, 2020). Determination of the sample in this study was carried out by census, which took the entire sample from a population. The population of farmers who cultivate cassava is 60 people.

Data Analysis Method

Stochastic frontier production function analysis

The analytical method used to answer the first objective is to determine the factors that influence cassava farming production, namely the stochastic frontier production function. The equation model for estimating the frontier production function of cassava farming can be written as follows:

$$\text{Ln } Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + v_i - u_i$$

where Y: total cassava production (kg), β_0: constant, β_i: elasticity of production of cassava production factors i, X_1: land use (ha), X_2: use of seeds (kg), X_3: use of labor (HOK), X_4: use of costs (Rp), X_5: use of manure (kg), v_i: asymmetric, normally distributed random error or model random error, u_i: one-side error term ($u_i \geq 0$) or the effect of technical inefficiency.

Stochastic frontier parameters and technical efficiency are tested using Maximum Likelihood Estimation (MLE). MLE parameters, either finite or unbounded, are used to indicate the level of residuals achieved in the model and the efficiency and inefficiency of the OLS method. The general MLE equation is written as follows:

$$Y_i = \beta_0 + \beta_1 X_1 + u_1{}' + v_1$$

The residual showed the error value in terms of technical inefficiency. In the frontier model of the MLE approach, the output showed the value of gamma square which was the value of product variation resulting from production efficiency. This model also assumes that the residual achievement obtained showed the minimum possible value and states that this model will be more significant than the OLS (Amsler et al., 2016).

Analysis of technical efficiency of cassava farming

Quantitative analysis is used to determine the technical efficiency of cassava farming. Technical efficiency in cassava farming is categorized into several groups called technical efficiency indices which describe the different levels of technical efficiency achieved by different cassava farmers. The technical efficiency or inefficiency of cassava farming in Socah Village is estimated using the following mathematical equation:

$$TE_1 = \frac{Yi}{Yi*}$$

where TEi= Technical efficiency achieved by the i-th observation, Yi= Actual output of cassava farming (kg/ha), Yi*= Potential output of cassava farming (kg/ha).

TEi is the technical efficiency of the i-th farmer, namely 0 < TEi < 1. The value of technical efficiency is inversely related to the value of the effect of technical inefficiency and only used for functions that have a certain number of outputs and inputs (*cross section data*). The technical efficiency value is inversely related to the value of the technical inefficiency effect, and is only used for functions that have a certain number of outputs and inputs (*cross section data*).

RESULTS AND DISCUSSION

Factors Affecting Cassava Production

The Stochatic Frontier approach used in analyzing the factors that influence cassava production is the Maximum Likelihood Estimation (MLE) approach, Table 1 showed the estimation results.The results of the LR test value are compared with the critical value χ^2_R with the number of restrictions as much as 1, and the 5% error rate of 2.71. After comparison, the result showed that the LR test value was 89,691, which was greater than the critical value χ^2_R. This showed the coefficient of each variable in the inefficiency effect model is not equal to zero. Then each explanatory variable in the inefficiency effect model has an influence on the level of inefficiency in the production process of cassava farming. This proves that the frontier production function is able to properly explain existing data regarding the phenomenon of technical inefficiency in cassava farming.

The variables that influence cassava production are land and seeds. Among the two variables that influence cassava production, the land variable has a dominant influence on production. This means that if farmers want to increase production, they need to consider land use in terms of land preparation and processing. In addition, the negative effects of seedlings need to be considered because each increase will reduce cassava production.

Land area has a positive effect on production at a significance level of 1%. This result are in line with the findings of previous studies which stated that farmers' wider land areas would increase cassava production. Land area is an important assets in farming and a symbol of the ability of farmers to issue larger inputs. In order to increase production efficiency, farmers have to invest more money and technology as a result of expanding farm size (Sheng & Chancellor, 2019; Priyanto et al., 2022).

Table 1. Parameter estimation of the stochastic frontier production function

Variable	Coefficient	Standar error	t-ratio
Intersep	1.678	0.973	1.744
Land (X1)	3.249	0.691	4.722***
Seeds (X2)	-2.236	0.678	-3.358***
Labor (X3)	0.184	0.166	1.007
Costs (X4)	-0.443	0.423	-1.082
Manure (X5)	0.156	0.142	1.133
sigma-squared	7.591	5.632	1.345
log likelihood function	-75.576		
LR test of the one-sided error	89.691		

Note: *** = significant on α 1% (2.687), ** = significant on α 5% (2.021), *= significant on α 10% (1.688)

Seed quantity has a negative effect on production with a significance level of 1%. The addition of 1 kg of seed causes a decrease in production of 2.23 kg. This result is different from previous research which found that adding seeds would increase production. The reason is that they use seeds of poor quality. In fact, the use of quality seeds is important for the sustainability of farming because it is able to produce output with higher quantity and/or quality. Haryanto et al. (2016) found that the use of certified superior seeds obtained higher production and efficiency than other types of seeds. However, farmers are hampered in accessing it due to limited purchasing power, costs and geographical location. This problem needs to be resolved so that farmers use certified superior seeds to obtain higher production.

Technical Efficiency of Cassava Farming

The analysis of the level of technical efficiency in cassava farming aims to determine the highest level of efficiency and the lowest efficiency as well as the average efficiency achieved by farmers in trying to farm cassava. The following level of efficiency achieved by respondents in the research area can be seen in Table 2.

Table 2 showed that, the number of farmers who have the highest technical efficiency value is at a technical efficiency level of 0.85 - 0.89 of 45% or 27 cassava farmers from the total respondents of cassava farmers. Based on this data means that farmers still have a 11 - 15% chance of increasing cassava production. Farmers were categorized as efficient if they have an efficiency index value of more than 0.7 (Rahayu & Hanifah, 2021). This showed that the average cassava farmer in Socah Village has been quite efficient, because from the average value in table 2 the value is 0.87. Differences in efficiency levels between farmers indicate differences in the use of production factors by each farmer. Cassava farmers need to improve performance to be able to achieve potential production using existing inputs. Improving performance needs to pay attention to factors that affect production factors, namely land, and seedlings. Differences in efficiency levels can be caused by several factors, namely the age of farmers, farming experience, formal education, non-formal education and also the number of family members. Farmers in the study area were known to have an average level of technical efficiency has not reached 1. This showed that cassava farmers in the research area still have the opportunity to improve technical efficiency or actual production has not approached potential production.

Factors Affecting the Inefficiency of Cassava Farming

In this study, the factors included in the model are farmer age, farming experience, formal education, non-formal education of the number of family dependents. The results of the analysis of the impact of inefficiencies are presented in Table 3.

Table 2. Distribution of farmers based on technical efficiency of cassava farming

No	Technical Efficiency	Number of Farmers (people)	Percentage (%)
1	0.80-0.84	13	21.6
2	0.85-0.89	27	45
3	0.90-0.94	9	15
4	0.95-0.99	11	18.4
	Total	60	100
Minimum	0.80		
Maximum	0.99		
Mean	0.87		

Table 3. Result of estimation of factors affecting inefficiency of cassava farming

Variable	MLE (Maximum Likelihood Estimation)		
	Coefficient	Standar error	t-ratio
Intersep	7.69	1.15	6.68
Age (X1)	-0.19	0.44	-0.44
Experience (X2)	0.12	0.21	0.58
Formal edu (X3)	-0.27	0.24	-1.09
Non-formal edu (X4)	-0.44	0.17	-2.53**
Family members (X5)	0.02	0.1	0.22

Notes: ** = significant on α 5% (2.021)

The coefficient value for the farmer age factor is negative with a value of -0.19 and the t-value is 0.44. The t-value is smaller than the t-table of 0.44 < 0.68, thus the age factor of the farmer has a negative but not significantly affect on the technical effect of inefficiency in trying to farm cassava with an error rate of 25%.

Then the experience was known to be positive but has no significant effect on technical inefficiency with an error rate of 25%. The coefficient of the experience variable is 0.12 with a t-value smaller than the t-table value of 0.58 < 0.68. The coefficient value on the farmer's formal education factor has a negative sign and the magnitude is -0.27 and the t-value of 1.09 greater than the t-table of 1.09 < 0.68, so that the respondent's formal education factor although negatively marked but has a noticeable effect on the effect of technical inefficiency in trying to farm cassava with an error rate of 25%.

Formal education is measured based on the level of education taken by cassava farmers in formal education. Then, the factor of the number of members of the farmer's family has a positive sign with a value of 0.02 and a t-count value of 0.22. The t-count value is smaller than the t-table of 0.02 < 0.68, so the factor of the number of respondents' family members has a positive but not real effect on the effect of technical inefficiency in trying to farm cassava with an error rate of 25%. This suggests that the increasing number of family members has no effect on the degree of inefficiency effect. Even though there are many family members of farmers, if they do not know how to manage cassava farming, it will not help farmers in cultivating cassava.

The coefficient value in the non-formal education factor of farmers has a positive sign of 0.44 and the t-value is greater than the t-table of 2.53 < 2.02 (t-table 5%). So that the non-formal education factor has a positive sign and has a real effect on the effect of technical inefficiency in carrying out cassava farming with an error rate of 5%. Non-formal education was measured by the frequency with which farmers attend training and extension services in agriculture. This was in line with the initial expectations of the study, namely that it would have a negative impact. Our findings show that farmers who attend training and extension services in agriculture have lower technical inefficiencies than farmers who do not participate. This also means that farmers who attend counseling and training have higher technical efficiency.

Farmers in the research area attended non-formal education 2 times. Non-formal education has a real effect on the effects of inefficiency because in non-formal education farmers were given information, guidance, training, and assistance about farm management instead of general knowledge as in formal education. Our findings were in line with the study of (Tenaye, 2020) which states that farmers who receive counseling have a lower level of inefficiency as they acquire knowledge and practices related to agronomic instructions and practices, crop protection, utilization of inputs (such as the use of seeds and fertilizers), soil conservation, feasibility and other services all provided by agricultural extension workers. This knowledge was expected to increase technological efficiency so that farming activities were more optimal. (Dube et al., 2018) states that farmers who interact and communicate with extension workers, were likely to adopt new technologies so that agricultural productivity increases.

CONCLUSION

By using stochastic frontier analysis on 60 farmers' data taken by census, three results were obtained, namely the factors that significantly affect cassava production are land area and seeds at a significant level of 1 percent. Meanwhile, labor, cost and fertilizer factors have no significant effect. Second, the technical efficiency of cassava farming in the research area was the lowest at 0.80, while the highest efficiency of cassava farming was 0.99. The average respondent farmer has a technical efficiency level of 0.87, which means that on average the farmer has only produced 87 percent of the potential cassava production and there is still 13 percent for the average farmer to increase his production. Lastly, we find that the factor that influences technical inefficiency is non-formal education with a negative sign.

This means that if the respondent farmers more often participate in training and counseling in the field of agriculture, it will be useful to reduce technical inefficiency or increase the technical efficiency of cassava farming. This is because the knowledge gained in training and counseling is more directed at the application of farming in the agricultural sector.

Based on the conclusions from the results of this study, it is necessary to suggest a number of things as follows. Farmers can increase cassava production by increasing the use of superior seeds, as well as skilled labor and balanced use of fertilizers, namely techniques, dosages, and types of fertilizers according to needs.

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