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EFFICIENCY ANALYSIS OF SHALLOT FARMING IN SERDANG BEDAGAI DISTRICT

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Abstract

Shallot is one of the essential ingredients for cooking in Indonesia. The price of shallot itself fluctuates. The fluctuates of the price randomly make the policy that enhances the farmer to exchange their plant for the shallot in some places. This study aims to determine the factors that influence economics, technics, and allocative efficiency. This research has been done in Serdang Bedagai District with the total sample was 60 farmers and used Stochastic Frontier Analysis with MLE with Log-Likelihood to analuze the efficiency. The result show that the shallots farming was efficient, it can be showed from the efficiency value more than 70 percent and the variable effected the inefficient was the participation in farmers group. In order to get more efficient in shallots farming the government have to push the farmers join the farmers group so they will get the newest information about the good agriculture practice and government aid such as fertilizer, machine and seeds.

Keywords: Shallots, Frontier, Efficiency

INTRODUCTION

Shallot is one of the vegetables that is used as an essential ingredients Indonesia. The challenge is how to fulfill the demand of consumers that want the shallot better in quality, environmentally friendly, and how the local farmers can compete the similar products due to free trade (Indonesian Ministry of Agriculture, 2020). FAO mentioned that the largest producer and consumer of shallot in the world is Indonesia. Several countries in Southeast Asia such as Malaysia, Thailand and the Philippines also consume shallots, but not as big as Indonesia so they tend to export the shallots they produce to Indonesia.

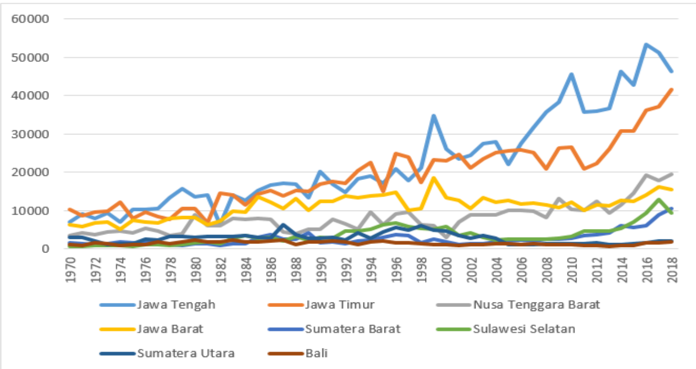

Figure 1: Shallot Harvested Area in 8 Provinces in Indonesia

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Figure 1. Indonesian Ministry of Agriculture (2020) showed that West Sumatra and North Sumatra are the provinces on the island of Sumatra with the highest harvested area nationally. In the same resource showed that West Sumatra's production continues to increase, while North Sumatra's production decreased. The data showed that the increase in harvested area is not in line with shallot production in North Sumatra.

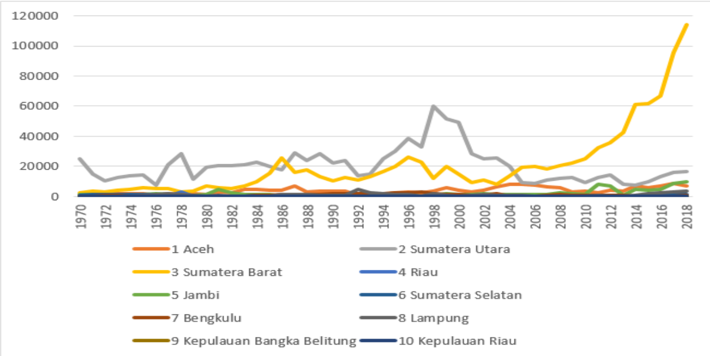

Figure 2: Shallot Production in Indonesia (tonnes)

Demand for shallots tends to increase every year while shallot production is seasonal. A gap is created between the demand and availability of shallots, resulting in price fluctuations over time. Prices will soar when demand is greater than supply or prices may fall when availability is greater than demand (Rachmat, 2013). Efforts to increase shallot production are still wide open apart from import substitution, shallot production has the opportunity to fill the export market. Export opportunities are still quite high where the need for shallots is estimated at 3 million Mt per year with a value of US$700 million and 30% of world production is supplied by tropical countries, one of which is Indonesia. For this reason, Indonesia needs to develop shallot production centers (Opara, 2003; Wahyudin et. al., 2015)

The North Sumatra Bank of Indonesia and the North Sumatra Agricultural Service are developing shallot production in Simalungun District, Serdang Bedagai District and Medan City. Based on the Central Bureau of Statistics (2021), it is known that from 2019 to 2020 there a decrease in the production in Serdang Bedagai District from 2.200 quintals to 1.620 quintals. Medan City is an area that will be used as a shallot production base lowland. Meanwhile, Serdang Bedagai district It is known that the harvested area of North Sumatra Province is the second highest on the island of Sumatra but shallot production in North Sumatra does not increase or is quite low not in line with the increase in shallot harvested area, from these problems there has been no efficiency research using frontier stochastic methods for technical efficiency, prices and allocative in North Sumatra Province so it is necessary to conduct research that analyzes the efficiency of shallot farming in Serdang Bedagai District as one of the District that will develop the shallot which is also included in the plan of the North Sumatra Government and Bank Indonesia which projects North Sumatra to become one of the shallots producing centers in Indonesia. So later an action plan will be produced for the development of shallots that is oriented towards fulfilling domestic consumption of shallots and can increase farmers' income and research can be continued for other districts or cities in North Sumatra Province.

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Material and Method Study Area

This research was conducted in some sub-district in Serdang Bedagai District. According to the Central Bureau of Statistics (2021), some of the sub-district in Serdang Bedagai that have the farmers of shallot area are Pantai Cermin, Perbaungan, and Tanjung Beringin. But according to the research, we found the shallot farmers in Sei Bamban so we included Sei Bamban. There are no fixed data about shallot farmer, so this research uses simple random sampling. The sample in this research was 60 farmers of shallot.

Data analysis technique

To analyze the effiency (technical, cost and economic) in this research use Stocastic Frontier Analysis with MLE Log-Likelihood, mathematically defines below:

- Technical efficiency is the ratio between actual production to potential production. The stochastic frontier production function shown by the equation below.

LnPROD = ßo+ ß1lnLHN + ß2lnBNH + ß3lnPPK + ß4lnPES+ ß5lnTK + (vi-ui)....1

Keterangan:

PROD = Shallots Production (kg)

LHN = Land Area (ha)

BNH = Seeds (kg)

PPK = Fertilizer (kg)

PEST = Pesticide (liter)

TK = Labor (HKO)

vi = errors due to external factor that uncontrolled by farmers

ui = errors due to internal factors that controlled by farmers

- Economic effiency is the ratio between actual production csot to potential production cost. The stochastic frontier cost function is shown by the equation below

lnCOST= ßo+ ß1lnLHN+ß2lnPBNH+ ß3lnPPPK+ ß4lnPPES+ ß5lnPTK+ (vi-ui)....2

Keterangan:

COST = Total Cost (Rupiah)

LHN = Land Area (Ha)

PBNJ = Seed Price (Rupiah/Kg)

PPPK = Fertilizer Price (Rupiah/Kg)

PPES = Pesticide Price (Rupiah/Kg)

PTK = Labor Wages (Rupiah/HKO)

e = Random errors

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vi = Errors made due to random selection

ui = Errors due to internal factors that controlled by farmers

- Economy Efficiency = Technical Efficiency x Cost Efficiency

RESULT RESEARCH

Berdasarkan hasil uji dengan menggunakan metode Stochastic Frontier Analysis maka didapatkan hasil sebagai berikut:

Table 1: Estimation of Shallot Production Function in Serdang Bedagai Distict, North Sumatera MLE Frontier Method 4.1

Variables	Parameter	Coefficient	t-ratio	Sig
Constanta	β_0	0.2448	1.012	.ns
Land Area (X1)	β_1	2.4874	6.082	***
Seeds (X2)	β_2	0.9388	1.305	*
Urea Fertilizer (X3)	β_3	0.1837	4.532	***
KCL Fertilizer (X4)	β_4	-0.0630	-0.807	.ns
ZA Fertilizer (X5)	β_5	0.7413	0.688	.ns
NPK Fertilizer (X6)	β_6	0.2508	1.336	*
Pesticide (X7)	β_7	-0.1761	-0.666	.ns
Labor (X8)	β_8	0.7397	0.477	.ns
Sigma-squared (σ^2)		0.1804	1.841	**
Gamma (γ)		0.8600	8.660	***
Log-likelihood function OLS			59.05	
Log-likelihood function MLE			63.77	
LR test of the one-sided error			14.23	

Source: Primary Data Analysis, 2022

Description * : Significant Effect on the Level of α 10% (1.298)

** : Significant Effect on the Level of α 5% (1.677)

*** : Significant Effect on the Level of α 1% (2.403)

Based on table 1 it can be seen that the sigma-square value (σ2) is a symbol of the error term distribution in technical inefficiency. In the MLE method, the result of sigma-square value (σ2) is 0.1804. The meaning of this value is close to zero and is small, indicating that there is a normal distribution of technical inefficiency (ui) errors. Table 1 also shows that the gamma (ɣ) value is 0.86 which is significant at the 1% level. This value shows that the effect of inefficiency affects most of the production. The gamma value shown in table 1 also shows that the term error is caused by external factors and is difficult for farmers to control. The gamma value also shows that the term error is caused by a technical inefficiency factor seen in the equation in the model. The gamma value which is close to 1 shown in table 1 means that there is little noise and most of the error term results from inefficiency (ui).

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Table 1 also shows that the value of the MLE Log-likelihood function is 63.77. This value is greater than the value of the OLS Log-likelihood function. The OLS Log-likelihood function value is 59.05. The meaning of these two values shows that the conditions are in accordance with the existing field reality. If you look at the LR-test value in the MLE of 14.23 as shown in table 1 it indicates that this value is already better when compared to the restriction X2 value in Table Kodde and Palm (1986) 13.40 at the 5% level. In this way the results correctly show that there is a technical inefficiency effect shown in the equation model.

Table 1 shows that there are four variables that have a significant effect on shallot production cultivated by farmers in Serdang Berdagai District. The four variables in question are Land Area, Seeds, Urea Fertilizer and NPK Fertilizer variables. The variables Land Area and Urea Fertilizer affect shallot production with a significant level of 1% while Seeds and NPK Fertilizer affect production with a significant level of 10%. Table 1 also shows that there are still variables that do not affect production, such as KCL Fertilizer, ZA Fertilizer, Pesticide and Labor.

The influence of the Land Area variable on shallot production is shown in table 1 with a coefficient value of 2.487. The meaning of these figures shows that the increase in land for shallot cultivation by 1 percent assuming that other inputs are considered constant, shallot production can be increased by 2.487%. This is in line with research by Mutiasari et al (2019) who also stated that the Land Area affects shallot production in Majalengka Regency. The addition of Land Area is still rational if done by farmers in order to increase production value even though the resulting increase in production is relatively small. Therefore it also needs to be balanced with the suitability of the use of inputs according to recommendations that farmers can do to increase shallot production. This was also expressed by Waryanto et al (2015) who stated that land areas do affect shallot production but also need to be balanced with the implementation of good management. The influence of the variable use of Seeds also affects shallot production as shown by the regression results of the MLE method in table 1. The variable use of Seeds has a coefficient value of 0.938, meaning that an increase in the number of Seeds by 1 percent will increase shallot production by 0.938 percent assuming that the input others are considered fixed, ceteris paribus. An indication of this is that the use of Seeds used by farmers can still be added with the aim that the shallot production produced is getting better. This is in line with Rosdianti's research (2013) which states that to support production, good seeds and the use of appropriate spacing are needed. It is also necessary to select good quality shallot seeds to support good production as well.

Table 1 also shows that the Urea Fertilizer variable influences shallot production in Serdang Berdagai District. The coefficient value of the Urea Fertilizer variable is 0.187, meaning that the addition of 1 percent Urea Fertilizer will increase shallot production by 0.187 percent. Recommendations for using Urea fertilizers for shallots are 180-300 kg/ha (Suwandi et al, 2017). In reality, in the field, farmers use only an average of 100 kg/ha of Urea Fertilizer. The NPK Fertilizer variable also has an influence on shallot production. The coefficient of this variable is 0.258 so that an increase in the use of the NPK Fertilizer variable by 1 percent will increase shallot production by 0.258 percent. This is in line with the research of Minarsih and Waluyati (2019) who conducted research in Madiun Regency. The recommendation for using

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NPK Fertilizer is 250 kg/ha (Cybex Agriculture, 2019). The reality in the field is that farmers use NPK of 200 kg/ha so that this amount can still be adjusted to obtain optimal shallot production.

Efficiency is actually an indicator that is used as a benchmark to determine whether a farming business is said to be successful or not. Technical efficiency has the basis that there are two sides that are underlined. The input side is one of which is used as a measure that can be changed to increase the output in optimal conditions. The output side is the second side that is discussed in technical efficiency to see the changes that occur in the output achieved by using a certain amount of input. This study uses the production input side in its analysis so that the indicators of a farming business, especially shallots, are at a technically efficient level if the inputs used are minimal but are able to provide maximum output. The stochastic frontier production function is used to estimate technical efficiency in this study. Farming is said to be technically efficient if the index reaches 0.7 or even more. In fact, farming is said to be efficient if it has reached 0.7, but it would be better if the technical efficiency value could reach 0.8 (Nainggolan et al., 2017). The distribution of values or the technical efficiency index of each farmer in Serdang Berdagai District can be seen in table 2 below.

Table 2: Frequency Distribution of Technical Efficiency

Index Spread	Number of Farmers	Percentage
≤ 0,70	45	75
0,71 – 0,80	12	20
0,81 – 0,90	3	5
0,91 – 1,00	0	0
Total	60	100
Average		0.519
Maximum Value		0.845
Minimum Value		0.128

Source : Primary Data Analysis, 2022

Based on table 2 regarding the distribution of technical efficiency, it can be said that most of the farmers in Serdang Berdagai District have a technical efficiency index below 0.7. The percentage of 75% of farmers who have not achieved technical efficiency is due to several reasons, including not maximizing the use of inputs properly and according to recommendations. Meanwhile there are 12 farmers who are at the technical efficiency level with an index value in the range of 0.71-0.8 or with a percentage of 20%. There are also farmers who are more efficient because they have an index of more than 0.8, namely 3 people or 5%. Farmers with good index values should be role models for other farmers so that the way of cultivation and the use of inputs must be an example for other farmers, especially for farmers who have not achieved technical efficiency. Table 2 also shows that the average value of technical efficiency is 0.519 which can be concluded that this value is still below the standard value limit for efficient farming. This value indicates that farmers need to change their input use according to what has been recommended by both the regional and central agricultural services. The use of inputs that are not yet efficient must be encouraged so that production can have maximum value, especially when coupled with the use of appropriate

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technology. Table 2 also shows that there are still farmers who have a very low technical efficiency index, which is around 0.128, in contrast to the highest efficiency value, which is 0.845. Farmers need to share with each other, especially in knowledge sharing regarding shallot cultivation so that optimal production can be achieved together. Other factors besides the inputs shown in table 1 are also possible for a model of technical inefficiency effects that are outside table 1. Errors originating from internal factors can be identified by the production of the stochastic frontier. The estimation can be seen in the following table.

Table 3: Estimation of Factors Affectiong Technical Inefficiency

Variables	Coefficient	t-ratio	Sig
Constanta	-1,019	-1,106	ns
Participation of Farmer Groups (Z1)	2,826	5,330	*
Education (Z2)	0,587	0,587	ns
Experience (Z3)	-2,759	-1,260	ns

Source : Primary Data Analysis, 2022

Description * : Significant Effect on the Level of α 10% (1,298)

** : Significant Effect on the Level of α 5% (1,677)

*** : Significant Effect on the Level of α 1% (2,403)

Based on table 3, it can be seen what factors affect technical inefficiency. Table 3 also shows that there is one influential variable, namely participation in farmer groups. The effect of these variables is positive while the remaining two variables, namely education and experience, have no significant effect on technical inefficiency. The existence of farmer groups can actually be used as a forum for discussion between farmers and sharing knowledge within them, especially in terms of shallot cultivation. The existence of this farmer group can also improve the skills and use of technology for farmers. Farmers who join farmer groups are expected to be able to minimize the level of efficiency. Table 3 shows a real influence and a positive correlation at the 1% level. This is due to the fact that the farmers who participate in farmer groups and in group activities are still not maximally discussed in detail regarding the handling and managerial abilities of farmers in cultivating shallots. Economic efficiency is obtained by estimating the cost function used by farmers in Serdang Berdagai District. The MLE (Maximum Likelihood Estimation) method on the stochastic frontier is used to see how much it costs farmers. The results of the estimation of the cost function are shown in the following table.

Table 4: Estimation of Stochastic Frontier Cost Function of Shallot Farming in Serdang Berdagai District, North Sumatra

Variables	Parameter	Coefficient	t-ratio	Sig
Constanta	β_0	0.5486	1.010	.ns
Total Production	β_1	0.8776	1.421	*
Price of Seeds	β_2	0.4796	4.428	***
Price of Urea Fertilizer	β_3	0.2654	0.604	.ns
Price of KCL Fertilizer	β_4	0.3197	0.320	.ns

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Price of ZA Fertilizer	β_5	0.1624	0.286	.ns
Price of NPK Fertilizer	β_6	1.9189	1.001	.ns
Price of Pesticide	β_7	0.9502	-0.666	.ns
Price of Labor	β_8	0.4539	7.498	***
Constanta	δ_0	0.1245	1.245	.ns
Participation of Farmer Groups (Z1)	δ_1	0.1265	1.651	*
Education (Z2)	δ_2	0.1844	0.151	.ns
Experience (Z3)	δ_3	-0.3351	-0.351	.ns
Sigma-squared (σ^2)		0.2793	1.438	*
Gamma (γ)		0.7695	7.101	***
Mean Eficiency		0.528		

Sumber: Analisis Data Primer, 2022

Keterangan * : Significant Effect on the Level of α 10% (1,298)
** : Significant Effect on the Level of α 5% (1,677)
*** : Significant Effect on the Level of α 1% (2,403)

Based on table 4 it can be seen that there are three variables that influence the costs incurred by farmers to produce shallots in Medium Berdagai District. The three variables in question are the amount of production, Seeds prices and Labor wages. The influence given by these three variables is also positive on shallot production costs. In addition to the results that have been stated there are indications that the participation of farmers in the group also has a significant effect on cost inefficiency with an α level of 10%. This indicates that farmers who are members of the group will be more efficient in the use of shallot production costs. This is because usually farmers who are members of the group can access some of the inputs used in cultivation at subsidized prices so as to save costs incurred. The distribution of farmers' economic efficiency levels can be seen in the following table.

Table 5: Distribution of Economic Efficiency Levels of Shallot Farmers in Serdang Berdagai Districts, North Sumatra

Index Spread	Number of Farmers	Percentage
≤ 0.70	44	73.33
0.71 – 0.80	13	21.67
0.81 – 0.90	3	5
0.91 – 1.00	0	0
Total	60	100
Average		0.528
Maximum Value		0.828
Minimum Value		0.165

Source : Primary Data Analysis, 2022

The economic efficiency of shallot farmers in Serdang Berdagai District shows that there is an economic efficiency value in the range of 0.165 to 0.828. If seen from the percentage, the highest economic efficiency value is still below 0.7. This indicates that shallot farmers are still not efficient in terms of the economy or costs used. The implication of the value of efficiency that is not yet efficient forces farmers to increase their technical efficiency in the hope that later or later their economic efficiency will also improve. Based on table 5 it can also be seen

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that there are 21.67% of farmers who have an economic efficiency value of 0.71 - 0.80 while there are also farmers who have an economic efficiency value of 0.81 - 0.90 with a percentage of 5%. If you look at the average value of the farmers' economic efficiency of 0.528, it can also be concluded that economically the shallot farmers in Serdang Berdagai District are not yet efficient. Based on table 5, the highest value of farmer's economic efficiency is 0.828, which means that shallot farmers can realize efficient cost savings of 17.2%, meanwhile, seeing the farmer's lowest value is 0.165, the farmer should be able to save 83.5% but this is not done. The efficiency values listed in table 5 indicate that actually shallot farmers can still optimize the level of economic efficiency of their farming business. This is in line with the research by Rosdiantini (2019) and Fauzan (2016) which states that shallot farming in Bantul Regency is not efficient. There are several efforts to improve the achievement of the level of economic efficiency by improving farming management. Support for the use of input allocation according to recommendations is also important to do, especially regarding the price of the inputs used. Shallot farmers must be more observant about which inputs should be reduced or increased so that the costs incurred can be reduced. After obtaining technical and economic efficiency, it is continued by looking for predictions of allocative efficiency values. This efficiency value is obtained by dividing between two aspects, namely economic efficiency and technical efficiency.

Allocative efficiency is said to be efficient if it has a value of 1 (EA=1) but in fact, the value obtained by farmers is not the same as 1. Farming is said to need to increase its production factors if it has an allocative efficiency value of more than 1 whereas if it is less than 1 then it is necessary to reduce the factors of production used. Such conditions are intended to achieve optimal conditions (Darwanto, 2010). The allocative efficiency value obtained is 1.02. The meaning of these figures is that the average allocative efficiency level of shallot farming in Medium Berdagai District is not yet efficient (EA > 1), so to achieve allocative efficiency, shallot farmers need to increase the number of production factors as recommended.

CONCLUSION

Shallotas farming in Seradang Bedagai Regency was efficient, both technically, costly and economically. This efficiency value is indicated by the percentage of the farmers were efficient more than 70 percent. Those variable that effected technical efficiency were land area, number of seeds, urea and NPK fertilizer, meanwhile variable effected cost efficieny were total production and seed price. Variable that effected inefficiency in shallots farming was ada participation in farmers groups, therefore it is hope farmers can join the farmers groups so that they will get information about good agriculture practice and get government aids such as production input to increase a production and efficiency.

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