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Efficiency Analysis of Shallot Farmer in Brebes, Central Java

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ABSTRACT

Shallot is consumed daily by most Indonesian people and produced by small farmers. The important factor to maintain shallot production in Indonesia is technical efficiency. This paper aims to examine efficiency of shallot production by using Stochastic Frontier Analysis. The data comes from a structured survey of 380 shallot households in Brebes, Central Java. Results from this study will inform the factors affecting shallots production, Risk Productivity and technical inefficiency, measuring the level of technical efficiency and economic efficiency. This can be useful for government to formulate strategies in maintaining and even improving shallot production that will in turn reduce productivity risk of shallot in Indonesia. The results show Female Paid Labor input and adhesive have a negative effect on productivity while seeds have a positive effect on productivity. Male family labor input can reduce risk while adhesive increases the risk of shallot farming productivity. ZA fertilizer can reduce technical inefficiencies. The level of technical efficiency of shallots by 89.72 percent, the level of allocation efficiency by 74.38 percent and the level of economic efficiency by 66.75 percent. Social factors that influence the technical inefficiency of shallots are private extension dummy which has a negative effect

Keywords: *Stochastic Frontier Analysis Model Translog, Technical Efficiency, Economical Efficiency, Shallots.*

INTRODUCTION

Increasing population causes increasing need for agricultural products. Higher and better levels of productivity with available inputs are the challenges faced in farming. There are three ways to increase productivity through increasing efficiency, expanding the area (business scale) and adopting technology. The most possible way for the current conditions, namely through increased efficiency, because increasing productivity through expansion of the area (business scale) and technology adoption is relatively difficult to do in the short term. This is due to the small ownership of farming land and lack of capital. Efficiency can increase farmers' incomes with limited available resources (Nahraeni 2012).

Input allocation (allocation efficiency) and achieving technical efficiency are key determinants for accelerating the growth of the agricultural sector. Technical efficiency describes the potential production unit to achieve maximum output at a given level of input, while allocation efficiency is the production capacity at the level of optimum input usage at the minimum cost level. Economic efficiency is calculated by calculating the combination of technical efficiency and allocation efficiency.

Another problem faced by farmers is production risk. Just and Pope (1979) suggested that almost every production process, especially agricultural production, risk plays a very important role in the decision to allocate the use of inputs and output production. Kumbhakar (2002) argues that ignoring the existence of production risk can lead to bias in the estimation of production parameters and technical efficiency so that it can lead to misinterpretation of the phenomenon of decreased productivity.

Shallot is one of Indonesia's leading vegetable commodities that has many benefits and high economic value and it has been long sought by farmers intensively. The role of shallot is faced with farming that has a high risk, many challenges and obstacles faced in its cultivation, including the attack of Plant Pests (OPT) and climate change that can thwart the harvest.

Shallot productivity in the production center area in Central Java, in 2015 reached 11.05 tons per ha. This productivity is higher than the national productivity of 10.06 tons per ha (Ministry of Agriculture 2016), while it is still relatively lower compared to the productivity of other shallot producing countries such as Mainland China, Japan, Turkey, Iraq and Thailand which in 2013 have reached - respectively 38.43 tons / ha, 22.28 tons / ha, 17.87 tons / ha, 26.36 tons / ha and 12.46 tons / ha.

The low productivity compared to the potential production that occurred at the study site, allegedly due to inefficient use of production factors and cultivation technology applied by farmers. Shallot cultivation with the application of standard operating procedures (SOP) technology of good and right shallot cultivation combined with using quality seeds from superior varieties will increase the productivity of shallots reaching 17-20 tons / ha (Bappenas 2013). This is supported by research conducted by Baswarsiati et al. (2015) which states that some advanced farmers in East Java have been able to produce around 15 to 20 tons / ha in accordance with the yield of superior varieties released by the Government. This shows that shallot productivity still has the potential to be improved.

Based on the description above, this study aims to:

1. Analyzing the factors of production that affect productivity, risk and technical inefficiency of shallot farming
2. Analyzing the level of technical efficiency, allocation and economics of shallot farmers.
3. Analyzing social factors that influence technical inefficiency of shallot farming.

METHODOLOGY

Location and Research Data

The location selection was done intentionally (purposive), in Brebes Regency, Central Java Province as a center of shallot production. This research is a series of collaborative studies conducted by IPB, the Center for Horticulture, and the University of Adelaide. Research data are primary data obtained by interviewing farmers who planted shallots in 2016 as many as 380 farmers. Data collection was carried out in November - December 2016. Data collected was input output data from of shallots farming; each plot was 1 per farmer, which is the last and largest farm.

Data analysis method

Analysis of production factors that affect productivity, risk and technical inefficiency of shallot farming and the level of efficiency using the stochastic frontier translog model had been developed by Kumbhakar (2002), with the following equation:

$$\text{Ln}\, y_i = \alpha_0 \sum_{j=1}^{19} x_{ji}^{\alpha_j} + \beta_0 \sum_{j=1}^{19} x_{ji}^{\beta_j} e^{\varepsilon_i} - \gamma_0 \sum_{j=1}^{19} x_{ji}^{\gamma_j} e^{u_i} \ldots (1)$$

where:

y : productivity

x_{ji} : vector of variable input

$\alpha_0 \sum_{j=1}^{19} x_{ji}^{\alpha_j}$: function of production

$\beta_0 \sum_{j=1}^{19} x_{ji}^{\beta_j} e^{v_i}$: production risk function

$\gamma_0 \sum_{j=1}^{19} x_{ji}^{\gamma_j} e^{u_i}$: function of technical inefficiency

ε_i : error term indicates production uncertainty

u_i : error term indicates uncertainty of technical inefficiency

Analysis of the level of technical efficiency using the equation:

$$TE = 1 - TI \ldots (2)$$

TE is technical efficiency, defined as the ratio of expected output values in conditions of inefficiency to the expected output values in conditions where inefficiency does not occur (fully efficiency). Technical inefficiency (IT) is the ratio between the loss of potential output to the maximum output that can be achieved.

The parameters generated in equation (1) are used to find the value of allocation inefficiency by using equation:

$$\eta_j = f'_j(x_i) - w_j + \theta g'_j(x_i) - \lambda q'_j(x_i) \quad \ldots\ldots\ldots (3)$$

where:
ηj : inefficient allocation
f´ j (xi) : the first derivative of the production function with respect to the input i
wj : ratio of input price to j and output price
θ and λ : the amount of risk behaviors productivity
g j (xi) : the first derivative of the function of the risks to the input to i
q ´ j (xi): first derivative of the inefficiency function with input to i

The value of the efficiency allocation per unit of input used by each farmer can be found using the equation:

$$EA\ \square\square 1\square\square|\square_j| \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where $\square_j$ is the inefficient value of the allocation of input units in shallot farming activities. Furthermore, economic efficiency can be calculated using the equation:

$$EE = TE.EA \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Analysis of social factors that influence technical inefficiency using the equation:

$$TI_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \delta_9 Z_9 + \delta_{10} Z_{10} + \delta_{11} Z_{11} + W_i \quad \ldots (6)$$

Estimation model is done by using the Maximum Likelihood Estimation (MLE) method.

RESULTS AND DISCUSSION

Characteristics of Farmers and Shallots Farming

Households that are sampled are farm households that do shallot farming. The average age of a shallot farmer's family head is 51 years. Whereas the average age of a farmer's wife is 45 years. This age structure shows that in the research area, farmers and farmer's wives are still at productive age. The average number of family members is 4, and this is categorized as a small family with an average number of dependents of only 1 person (Table 1).

Table 1: Characteristics of Farmers and Family Members of Shallots Farmers in Brebes 2016

Characteristics	Min	Maks	Average	Standar Deviasi
Head Age (years)	28	80	50.67	9.93
Head Education (years)	0	18	5.65	3.72
Wife age (years)	24	72	45.48	9.64
Wife Education (years)	0	18	7.05	4.01
Household Size	1	12	4.11	1.66
Number of family dependents (people)	0	4	0.98	0.89

Based on the area of land tenure, in the study area, the area of land cultivated for shallot plants ranged from 0.01 hectare to 5.6 ha per research plot. In the study area, the average area of land cultivated was 0.23 hectares. Most shallot farmers (94.21 percent) cultivate less or equal to 0.5 hectares of land. This is because the land owned by farmers is divided into plots, while the research sample is the last plot planted and the broadest area.

The average production of shallots in Brebes is 1.6 tons with an area of planting area of 0.23 ha. The average shallot productivity in Brebes is 7.8 tons / ha with the price received by farmers is Rp 20,000 / kg.

Factors Affecting Productivity, Risk and Technical Inefficiency

Based on the estimation results of production factors that significantly influence (90-99 percent confidence level) on productivity are female paid labor, seeds, and adhesives, with elasticity values of -0.0352, 0.0740 and -0.2242, respectively. This means that increasing the use of female paid labor by 1 percent, ceteris paribus, will reduce productivity by 0.0352 percent. Increasing the use of seeds and adhesives by 1 percent respectively, ceteris paribus, can increase the productivity of shallots by 0.0740 percent and 0.2242 percent, respectively. The R2 value is 0.8281; meaning that 82.81 percent of the variation of shallot productivity can be explained by the variation of the independent variables in the model, and the rest is influenced by other things not examined.

Estimation results on the productivity risk function show that male family labor production factors and adhesives have a significant effect (90-99% degree of confidence) on the productivity risk of shallot farming with elasticity values of -0.0585 and 0.2341. This means that when the use of male family labor is increased by 1 percent, it will reduce the risk by 0.0585 percent and when the use of adhesive is increased by 1 percent, the risk will increase by 0.2341 percent. R2 value is obtained at 0.5282, meaning that 52.82 percent of the variation of the risk of shallot can be explained by variations in the independent variables in the model, and the rest is influenced by other things that are not examined.

There are 14 interaction variables between factors of production that significantly affect the risk of shallot productivity. Interactions that negatively and significantly affect, namely the interaction of male family labor with male family labor, male paid labor with female family labor, female paid labor with urea, urea with urea, TSP with fungicide, KCL with pearl NPK, and phonska with phonska. The interaction of these factors can reduce the risk of productivity of shallot farming. While interactions that can increase productivity risk are interactions between male family labor and seeds, male family labor with insecticide, female paid labor with female paid labor, TSP with TSP, phonska with adhesive, NPK pearl with adhesive and herbicide with adhesive.

The estimation results of production factors that affect technical inefficiencies that significantly influence (90 percent confidence level) are ZA fertilizer, with an elasticity value of -4.49E-05. This means that when ZA fertilizer is increased by 1 percent, it will reduce technical inefficiency by -4.49E-05 percent. R2 value of 0.3586, it means that only 35.86 percent of the variation of the technical inefficiency of shallots can be explained by the variation of the independent variables in the model, and the rest is influenced by other things not examined.

There are 7 interaction variables between factors of production that significantly affect the technical inefficiency of shallots. Interactions that negatively and significantly affect, namely: interactions between male family labor and male family labor, female paid labor with urea and lime with herbicides, while interactions that can significantly increase inefficiency, namely interaction of seeds with NPK pearls, TSP with carbofuran and herbicides with adhesives.

The use of female paid labor can reduce productivity. This shows that the addition of labor input will actually result in additional production costs so that reducing the use of female labor in the family will reduce costs and increase production. While the use of male family labor, although not significantly increase productivity, it contributes significantly to reducing risk. This workforce includes various jobs such as land management, planting, weeding, spraying, fertilizing and harvesting. These results are consistent with research conducted by Abbeam et al. (2017), Astuti et al (2020), Kurniati (2012), and Saptana et al. (2011) which states that labor can reduce risk and family labor can increase productivity. The result shows that farmers can utilize the workforce in their families to be able to reduce the risk of productivity, because the sense of ownership and responsibility of the workforce is greater for their own farming.

Adding the use of seed inputs will significantly increase the production of shallots. The results of this study are the same as those of Astuti et al (2020, 2019a, 2019b), Nurhapsa (2013), Tahir et al. (2011) and Fauziyah (2010). Factually, the average farmer uses 1.7 tons / ha of seed, which is still lower than the recommendation from the Department of Agriculture and Horticultural Crops, Brebes Regency in 2011, with a spacing of 15x20 cm2 or 20x20 cm2 requiring 1.8 tons of seeds or 2.4 tons tons. Therefore, increasing the number of quality seeds to increase productivity is needed, because superior seeds are more responsive to fertilizers and have high potential production.

The use of adhesive inputs has an effect on reducing productivity, and can increase risk. These result of this study is the same as those of Astuti et al (2020) and differ from studies conducted by Villano et al. (2005), where adhesives are used to treat pests, in other words, control decision making tends to be more directed at anticipating the risk of pests and at the same time to overcome pests, but their use is excessive, so adding the use of adhesives will only reduce productivity and increase risk.

Table 2: Elasticity of Production, Risk and Technical Inefficiency of Shallots Farmers in Brebes 2016

No	Jenis Input (per ha)	Production Elasticity	Risk Elasticity	Technical Ineff Elasticity
1	Male Family Labor (Male Workdays)	0.5633	-0.0585	-6.98013E-05
2	Male Paid Labor (Male Workdays)	0.4302	0.1497	-0.000192491
3	Female Family Labor (Female Workdays)	-0.1881	0.0563	-0.000264024
4	Female Paid Labor (Female Workdays)	-0.0352	-0.0745	0.000549084
5	Seed (kg)	0.0740	0.0091	-0.000166969
6	Urea (Kg)	0.8232	0.8280	0.000206626
7	TSP (Kg)	0.1479	-0.2932	0.00012298
8	KCL (Kg)	-1.1571	0.1983	-0.000141735
9	Phonska (Kg)	0.2552	1.3689	-0.000142679
10	ZA (kg)	-1.5661	-0.4810	-4.49949E-05
11	Carbofuran (Kg)	-0.7892	0.3059	0.001693833
12	NPK Mut Total (kg)	-0.3788	-0.3474	-0.000700791
13	NPK Reg (kg)	1.2504	-0.1335	-8.93751E-06
14	Lime (kg)	1.1492	-1.5694	-8.66647E-05
15	Organic Fertilizer (Kg)	0.8051	0.6255	-0.00025135
16	Herbicide (liter)	0.6328	0.3295	-0.002171279
17	Fungicide (liter)	-0.9123	-0.3120	-0.00060591
18	Insecticide (liter)	0.3681	-0.0598	-0.00733085
19	Adhesive (liter)	-0.2242	0.2341	0.004935724

Analysis of Technical, Allocation and Economic Efficiency Levels

The production of shallots produced depends on internal and external factors. The average TE level in shallot farming was 89.72 percent, the average AE value was 74.38 percent and the average EE value was 66.75 percent (Table 3). The average TE level achieved in the available technological conditions is already very high. This shows the opportunity for increasing productivity through increasing technical efficiency in available technology that is very limited, only around 10.28 percent.

AE is the ability of shallot farmers to produce a number of outputs in the condition of minimizing the input cost ratio. Based on the results of the analysis obtained the average allocation efficiency is in a condition that shows room to increase the productivity of shallots through increased efficiency of the allocation is still quite open, amounting to 25.62 percent.

The phenomenon of the AE value which is still relatively low compared to the TE value can be used as a reason for the need to optimize the use of production inputs with the most appropriate price level of these inputs. Waryanto et al. (2014), states that it is necessary to increase farmers' knowledge about price and marketing information through increasing the role of agricultural institutions (agricultural extension institutions, farmer groups and even government agencies). Furthermore Saptana et al. (2011) state that shallot farmers who are responsive to price changes, input and output price policies (soft credit, fertilizer subsidies, and output price stabilization) can increase the allocation of the use of production inputs.

Based on the distribution of the level of technical efficiency, allocation and economy, the largest percentage of farmers for TE and AE is at an efficiency level of 80-100 percent, while in EE the largest distribution is at an efficiency level of 60-80 percent. The distribution of the level of technical efficiency, allocation and economics of shallot farming is presented in Table 3. The analysis also reflects that the biggest contribution from economic inefficiency comes from allocation inefficiency and the rest is from technical inefficiency.

Tablee 3: Distribution of Technical. Allocation and Economic Efficiency Level of Shallots Farmers in Brebes 2016

Efficiency Level	TE		AE		EE	
	Farmer	Percentage	Farmer	Percentage	Farmer	Percentage
0 - 20	0	0.00	0	0.00	1	0.27
20,1 - 40	24	6.43	0	0.00	42	11.26
40,1 - 60	76	20.38	0	0.00	89	23.86
60,1 - 80	105	28.15	20	5.36	128	34.32
80,1 - 100	168	45.04	353	94.64	113	30.29
Average	**0.8972**		**0.7438**		**0.6675**	

Social Factors Affecting Technical Inefficiency

The results of the analysis of social factors that influence technical inefficiency have a significant effect on the level of confidence of 10 percent, namely the private counseling dummy that has a negative effect on technical inefficiency. This means that farmers who receive extension from the private sector have a lower level of technical inefficiency than those who do not receive counseling (Table 4).

Farmers who participate in counseling are more technically efficient compared to farmers who do not get counseling, this shows that by participating in agricultural counseling, will affect the improvement of farmers' skills in applying farming technology, which has an impact on increasing the technical efficiency of shallot farming in Brebes Regency. This is consistent with research conducted by Astuti et al (2019a), Kolawole (2017), Lwelamira (2015) and Samarpitha et al. (2016).

Table 4: Inefficiency parameters of Shallots Farmers in Brebes 2016

Variables	Coefficient	T value	P value
Intersep	0.311	3.95	0
Umur (Z1)	0.000	-0.32	0.75
Pendidikan (Z2)	-0.004	-1.15	0.25
Jumlah anggota keluarga (Z3)	0.011	1.18	0.24
Jumlah Tanggungan (Z4)	-0.001	-0.09	0.92
Jarak lahan dari rumah (Z5)	-0.001	-1.30	0.19
Pendapatan Pert di luar bawang merah (Z6)	0.000	-0.16	0.87
Pendapatan di luar pertanian (Z7)	0.000	-0.78	0.43
Dummy penyuluhan Pemerintah (Z8)	-0.012	-0.52	0.6
Dummy penyuluhan Swasta (Z9)	-0.038	-1.66	0.1*
Dummy akses kredit (Z10)	0.000	0.02	0.99
Dummy anggota Kelompok Tani (Z11)	0.013	0.55	0.58
Dummy kepemilikan lahan (Z12)	-0.020	-0.89	0.37

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

1. Female Paid Labor input and adhesive have a negative effect on productivity while seeds have a positive effect on productivity. Male family labor input

can reduce risk while adhesive increases the risk of shallot farming productivity. ZA fertilizer can reduce technical inefficiencies.
2. The level of technical efficiency of shallots by 89.72 percent, the level of allocation efficiency by 74.38 percent and the level of economic efficiency by 66.75 percent
3. Social factors that influence the technical inefficiency of shallots are private counseling dummy which has a negative effect

Policy Implications

1. To increase the productivity of shallots, farmers can increase the use of high quality seeds.
2. Farmers can take advantage of family labor and improve the skills of family members in farming.
3. Counseling and assistance to farmers in shallot farming continues to be carried out on an ongoing basis.
4. To be effective, counseling is focused on target groups with low TE values so it can increase the value of TE and contribute to increase the shallot production in Brebes and even nationally.
5. It needs an increase of farmers' knowledge about price and marketing information through increasing the role of agricultural institutions (agricultural extension institutions, farmer groups and even government agencies). To be able to increase the allocation of the use of production inputs, it is necessary to have input and output price policies such as soft loans, fertilizer subsidies, fuel subsidies, and output price stabilization.

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