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Technical Efficiency of Shallot Farming in Central Java Province: Stochastic Frontier Modelling

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Abstract - Shallot is an important high-value agricultural product (HVAP) produced by small farmers, that is consumed daily by most Indonesian people. In Indonesia, shallot experiences big price fluctuation and includes as the commodity that contributes to the inflation rate. In order to deal with the issue of big price fluctuation, farmers should supply shallot continuously for the whole year. From the production side, technical efficiency is an important factor to maintain shallot production in Indonesia. Previous literature paid little attention to the technical efficiency of shallot farming in Indonesia. This paper aims to examine and compare the technical efficiency of shallot production in different seasons by using Stochastic Frontier Analysis. The data comes from a structured survey of 380 shallot households in Brebes, Central Java in 2016. Results from this study will inform the technical efficiency of shallot farming in Indonesia in 2016. This can be useful for the government to formulate strategies in maintaining and even improving shallot production to reduce the big price fluctuation of shallot in Indonesia.

Keyword - Stochastic Frontier Analysis, Cobb Douglas, Production Function, Technical Efficiency, Shallot

I. Introduction

Shallot is one of the leading vegetables comodity in Indonesia which has many benefits and economic values. It has been cultivated by farmers intensively for a long time. Shallot is needed by almost all people and is commonly used as cooking spices or traditional medicines. This vegetable commodity belongs to an unsubstituted spice group which serves as a food seasoning and traditional medicinal ingredients. Therefore, shallot is determined as one of the commodities belong to the important agricultural product group which controls inflation in addition to chili and garlic in Ministry of Agriculture Strategic Plan, 2015-2016 [16].

The demand of fresh shallots for household consumption and raw materials in the domestic processing industry continues to increase every year in line with the development of the population and the growth of the food industry. Shallot production in Indonesia is still seasonal, along with the other crops in general. As seasonal crop, the peak of shallot production occurs in certain months, while consumption of shallots is almost used every day, especially when the demand tends to increase on religious holidays. The different patterns of production and demand led to the unfulfilled demands of shallots outside the harvest season. Therefore the production of quality shallots must be increased and produced throughout the year so that supplies are available. Monthly Shallot production throughout 2015 can be seen in Figure 1.

Inefficiencies in farming is a common problem faced by farmers and also shallot farmers. Research on shallot farmer conducted by [4] in Majalengka Regency shows that ET in Majalengka Regency is valued at 72 percent. Whereas [11] stated that ET in Bantul Regency is valued at 80.2 percent and in Nganjuk Regency is valued at 92.9 percent. Research conducted by [35] stated that ET of shallot farming in Nganjuk Regency is valued at 80.8 percent. The ET value of shallot farming in Donggala Regency, Central Sulawesi amounted to 89.7 percent [19]. Factors that can influence technical inefficiencies include age, experience, education, agriculture counseling, number of family dependents, membership of farmer groups, and so on. The results showed that for shallot farmer, formal education and variety use dummy had a positive effect while experience, agricultural counseling dummy, and land ownership dummy negatively affected the level of technical inefficiency [4]. Other study shows age has a negative effect on the level of technical inefficiency [11], meanwhile experience and education also has a negative effect. The number of family dependents has a positive effect on the level of technical inefficiency [19]. The frequency of attending counseling has a negative effect on the level of inefficiency [19] in contrast to the results obtained from the research conducted [35] which states that farmers with access to agriculture counseling have a lower level of technical efficiency than farmers who do not have access to agriculture counseling. Based on these studies, there are still opportunities to increase production by using the same technology through improvements by reducing the causes of technical inefficiencies.

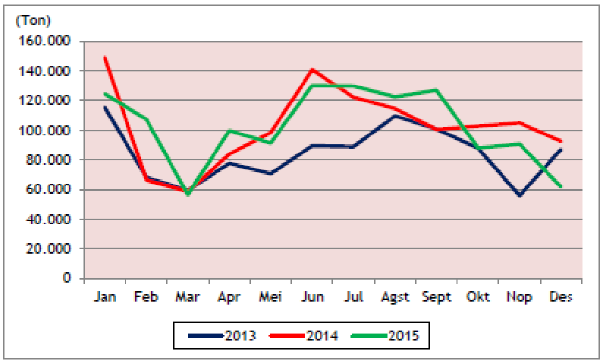

Figure 1 Shallot Monthly Production in 2013-2015
Source : Pusdatin, 2016

The objectives of this study are: (1) to analyze the effect of production inputs on production, (2) to analyze the level of technical efficiency and (3) to analyze the factors that influence the level of technical inefficiency of shallot farming in Brebes Regency in the dry season and rainy season.

II. Technical Efficiency Theory

The Stochastic Frontier Production Function, first introduced by [3], explains that there is a deviation consisting of two parts, namely: (1) symmetric error component that allows random diversity from the frontier between observations and capturing the effect of measurement errors or random surprises, (2) a one-sided error component of deviation that captures the effect of technical inefficiency. According to [3] along with Meeusen and Van den Broeck (1977) in [10], suggesting the stochastic frontier function is an extension of the deterministic original model for measuring stochastic frontier effects within the production limit. A random error is added to the production function, v_i into a non-negative random variable (non-negative random variable and u_i. The production function can be formulated as follows:

$$Yi = x_i\beta + (v_i - u_i)$$

Random error, v_i is useful for calculating error size and other random factors such as weather conditions etc. along with the effect of combinations of input variables which are undefined in the production function. Variable v_i is an independent random variable and is identically distributed normally (*independent-identically distributed* or i.i.d) with an average of zero and its range is constant σ_v^2 or N (0, σ_v^2). The variable u_i is assumed to be exponential i.i.d or half-normal variables. The variable u_i serves to capture the effect of inefficiency.

To find out the existence of systematic factors that are assumed to influence the business inefficiency, the business characteristic is included into the production model, noted by u_i and is formulated as follows: $u_i = z_i\ \delta + w_i$. This equation illustrates that the business' technical efficiency is assumed to be a linear function of the systematic component z_i and random component w_i.

The systematic component consists of the vector characteristics of the company z_i, which is related to technical efficiency through the parameter δ. The business technical efficiency index can be calculated using the formula:

$$TE = \exp(-u_i) = \exp(-z_i\delta - w_i)$$

This equation shows that the level of efficiency is determined by business characteristics (z_i) and random variables (w_i).

III. Research Method

3.1. Data Collection

The study was conducted in Brebes Regency. This location was purposively selected since this is as the center shallots production. Total of 380 plots of shallot farmer were sampled for this survey. Data collected in relation to this writing includes characteristics of farmer household, land ownership, planting's patterns, farmer business' input, and output

3.2. Technical Efficiency Analysis

The Cobb-Douglas function model is used to analyze the effect of production factors on shallot production. The analysis of the stochastic frontier production is used to measure the technical efficiency of shallot production in the dry season. The Cobb-Douglas Stochastic Frontier production function model for the farmer is formulated by the equation:

$$\ln Y_i = \beta_0 + \sum_{i=1}^{n=19} \beta_i \ln x_i + \beta_D D + \epsilon_i \quad (1)$$

Where:

y_i = The amount of shallot production (kg)
X_1 = Male Family Labour (Male Workdays)
X_2 = Male Paid Labour (Male Workdays)
X_3 = Female Family Labour (Female Workdays)
X_4 = Female Paid Labour (Female Workdays).
X_5 = seed (kg)
X_6 = urea fertilizer (kg)
X_7 = TSP fertilizer (kg)
X_8 = KCL fertilizer (kg)
X_9 = Phonska fertilizer (kg)
X_{10} = ZA fertilizer (kg)
X_{11} = Mutiara NPK fertilizer (kg)
X_{12} = Regular NPK fertilizer (kg)
X_{13} = Lime (kg)
X_{14} = organic fertilizer (kg)
X_{15} = pesticide powder (carbofuran) (kg)
X_{16} = Herbicide (lt)
X_{17} = Fungicide (lt)
X_{18} = Insecticide (lt)
X_{19} = Adhesive (lt)
D = Dummy season (1 = dry season (March - August); 0 = rainy season (September - February)). This variable is only for dummy model.
v_i = error term which indicates the uncertainty of production assumed to be i.i.d (0, σ_u^2),
u_i = technical inefficiency assuming i.i.d (0, σ_u^2), and u> 0, ui independent of vi.

The expected sign for each parameter is β_1 - β_9 > 0. The model estimation is done using the Maximum Likelihood Estimation (MLE) method.

Analysis of sources of technical inefficiency uses the effect model of technical inefficiencies developed by Battese and Coelli (1995) in [10]:

$$TI = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \delta_9 Z_9 + \delta_{10} Z_{10} + \delta_{11} Z_{11} + W_i \quad (2)$$

Where:
TI = value of technical inefficiency.
Z_1 = Age, measured in years.
Z_2 = Education, measured by the unit length of formal education of farmers (years).
Z_3 = Number of family members (person)
Z_4 = Amount Family Dependents (person)
Z_5 = Distance of land to home (meters)
Z_6 = Agricultural income outside shallot farming (Rp)
Z_7 = Off-farm income (Rp)
Z_8 = Dummy of agricultural extension (0 = farmer does not get extension, 1 = farmer who gets extension)
Z_9 = dummy of farmer's access to credit (0 = farmers who don't get credit; 1 = farmers who get credit)
Z_{10} = dummy of farmer membership in farmer groups (0 = not KT member, 1 = KT member)
Z_{11} = Dummy of land ownership (0 = rented land, 1 = own land)
δ = parameter that will be suspected
Wi = random error term is assumed to be independent and its distribution is cut off normally by N (0, σ_u^2).

The expected sign for each parameter has an effect on inefficiency, δ_4 and δ_5 is negative (δ_4 and δ_5 expected positive).

IV. Result and Discussion

4.1 Characteristics of Sample Farmer Households

The results about characteristic of farmers and their families as indicated in Table 1.

Table 1. Characteristics of Farmers and Family Members of Onion Farmers in Brebes 2016

Description	Average	
	Dry Season	Rainy Season
Head Family Age(Year)	50.41	52.69
Head Family Education (Year)	5.64	5.71
Age of wife (year)	42.36	47.05
Wife Education (year)	6.62	6.98
Family Members (person)	4.04	4.45
Family Dependents (person)	0.96	1.17

Source: Processed Primary Data

The study found that the average age of shallot farmer's family head is around 51-year-old. While the average age of shallot farmer's wife is 43 years. This age structure shows that in the research area, farmers and wives of farmers are still classified as productive age. The average number of family members is 4 people, and this is categorized as a small family with an average number of dependents of only 1 person.

Based on the results of interviews with 380 farmers, the majority of the households of shallot farmer households are mostly in the age group 51-60 year, about 34.47 percent of the total percentage. There are 17.89 percent of farmers who are in the age group under 40 years, this shows that shallot agriculture is still in demand for young people.

Level of education of the family head is mostly between 1 year to 6 years or the equivalent of elementary school (60.26 percent). 11.84 percent farmers didn't have any formal education and 1.84 percent farmer with higher education. The average education level of households in shallot farmer household is 5.65 years (didn't finish elementary school), meanwhile the average level of education of farmers' wives is 6.66 years (finished elementary school).

4.2 Analysis of Production Functions

The analysis of the production function uses the Cobb Douglas stochastic frontier production function model. The production function model in this study was built based on nineteen independent variables and one dependent variable (Equation (1)). Summary of the independent variables and dependent variables can be seen in Table 2.

Productivity in the rainy season is lower than the dry season because the shallot planting in the rainy season starts in October/December to March/April in a normal climate condition commonly referred as *off-season plants,* pests and diseases are increasing. So the use of these relatively high inputs cannot guarantee high productivity.

Tabel 2. Statistic Summary on Estimation of Shallot Production Function in Brebes Regency 2016

Variable	Symbol	Max	Min	Average	Standard Deviation	Average Dry Season	Average Rainy Season
Productivity (kg/ha)	Y	71428.571	114.286	7815.187	5750.916	7912,60	7031,22
Male Family Labour (Male Workdays)	X1	190	0	63.637	28.000	63.556	64.286
Male Paid Labour (Male Workdays)	X2	840	0	41.745	59.630	39.583	59.143
Female Family Labour (Female Workdays)	X3	100	0	26.453	22.906	25.950	30.500
Female Paid Labour (Female Workdays)	X4	480	0	29.700	42.078	28.438	39.857
Seed (kg)	X5	8000	25	329.663	472.742	326.657	353.857
Urea (Kg)	X6	2400	0	42.258	140.977	39.920	61.071
TSP (Kg)	X7	2500	0	63.059	213.712	58.839	97.024
KCL (Kg)	X8	1000	0	27.796	74.694	27.300	31.786
Phonska (Kg)	X9	1500	0	34.253	111.523	31.497	56.429
ZA (kg)	X10	500	0	23.549	49.074	22.155	34.762
Carbofuran (Kg)	X11	120	0	5.545	11.604	5.674	4.512
NPK Mut (kg)	X12	1500	0	43.921	115.286	40.724	69.651
NPK Reg (kg)	X13	2250	0	14.211	136.589	12.234	30.119
Lime (kg)	X14	600	0	9.787	46.608	9.361	13.214
Organic fertilizer (Kg)	X15	600	0	3.502	32.240	2.010	15.512
Herbicide (liter)	X16	22.878	0	0.665	1.657	0.620	1.022
Fungicide (liter)	X17	34.790	0	1.381	2.307	1.339	1.717

Insecticide (liter)	X18	49.003	0	3.097	4.875	3.043	3.532
Adhesive (liter)	X19	36.358	0	1.278	2.277	1.230	1.666

Source: Processed Primary Data (2016)

The Maximum Likelihood Estimation (MLE) of stochastic frontier model of shallots farmers is presented in Table 3. The sigma-squared (σ2) significantly at the level of α = 1 percent in attests to the good fit and correctness of the models. Also, the gamma- (ɣ) estimate 0.95 shows the amount of variation in output resulting from the technical inefficiency of farmers. This means thar 95 percent of variation in the production function was due to technical inefficiency and 5 percent caused by random variables.

Table 3. Estimation of Cobb-Douglas Type Frontier Stochastic Production Function of Shallot Farming in Brebes Regency 2016

Independent Variable	**Dummy Joined Model**		**Dry Season**		**Rainy Season**		**Pooled Model**	
	Coeff	**t-ratio**	**Coeff**	**t-ratio**	**Coeff**	**t-ratio**	**Coeff**	**t-ratio**
Intercept	2.98E+00	8.84E+00***	3.08E+00	7.80E+00***	1.05E+00	1.10E+00	2.90E+00	8.83E+00***
Male Family Labor (Male Workdays)	8.56E-03	1.19E+00	4.40E-03	5.51E-01	2.69E-02	2.26E+00***	7.60E-03	1.06E+00
Male Paid Labor (Male Workdays)	6.08E-03	5.81E-01	1.29E-02	1.09E+00	-1.32E-02	-2.18E-01	4.36E-03	4.26E-01
Female Family Labor (Female Workdays)	1.73E-03	6.56E-01	-5.12E-04	-1.85E-01	1.69E-02	8.78E-01	1.44E-03	5.64E-01
Female Paid Labor (Female Workdays)	8.45E-03	5.28E-01	7.92E-03	4.54E-01	4.25E-02	2.93E-01	9.29E-03	5.86E-01
Seed (kg)	8.33E-01	1.81E+01***	8.04E-01	1.53E+01***	1.04E+00	7.18E+00***	8.30E-01	1.88E+01***
Urea (Kg)	-3.16E-03	-1.19E+00	-3.81E-03	-1.40E+00*	-6.65E-03	-6.83E-01	-3.58E-03	-1.37E+00*
TSP (Kg)	1.77E-03	4.74E-01	-7.30E-04	-1.80E-01	1.48E-02	1.59E+00*	2.08E-03	5.61E-01
KCL (Kg)	1.27E-03	4.80E-01	2.23E-03	7.95E-01	-5.27E-03	-9.68E-01	1.96E-03	7.48E-01
Phonska (Kg)	-2.73E-03	-1.15E+00	-2.81E-03	-1.17E+00	5.75E-03	6.86E-01	-2.80E-03	-1.19E+00
ZA (kg)	7.53E-04	3.39E-01	3.24E-03	1.40E+00	-1.90E-02	-3.14E+00***	6.84E-04	3.12E-01
Carbofuran (Kg)	-2.35E-04	-7.57E-02	7.60E-04	2.44E-01	-6.79E-03	-7.38E-01	4.82E-04	1.57E-01
NPK Mut Total (kg)	-1.40E-05	-5.25E-03	-4.77E-04	-1.73E-01	6.13E-03	5.01E-01	5.01E-04	1.91E-01
NPK Reg (kg)	5.83E-04	1.70E-01	2.18E-03	5.84E-01	-1.44E-02	-1.41E+00*	5.11E-04	1.56E-01

Lime (kg)	6.96E-04	1.92E-01	-1.54E-03	-4.22E-01	1.16E-02	2.04E+00***	-2.91E-05	-8.34E-03
Organic Fertilizer (Kg)	-1.26E-03	-3.81E-01	-1.57E-03	-4.67E-01	2.46E-03	3.42E-01	-1.35E-03	-4.59E-01
Herbicide (liter)	1.27E-02	1.76E+00**	7.76E-03	9.68E-01	1.99E-02	9.69E-01	1.21E-02	1.71E+00**
Fungicide (liter)	-9.91E-04	-2.92E-01	-6.21E-05	-1.82E-02	1.96E-03	1.71E-01	6.24E-05	1.87E-02
Insecticide (liter)	3.20E-02	2.71E+00***	3.28E-02	2.90E+00***	3.96E-02	5.56E-01	3.11E-02	2.69E+00***
Adhesive (liter)	-4.44E-03	-6.49E-01	-6.65E-03	-9.91E-01	3.88E-02	7.00E-01	-6.17E-03	-9.24E-01
Dummy Season(D)	-6.94E-02	-1.10E+00						
Sigma-squared	7.45E-01	5.20E+00***	2.77E+00	3.86E+00***	1.31E-01	1.45E+00*	2.90E+00	3.08E+00***
Gamma	9.34E-01	4.81E+01***	9.80E-01	1.58E+02***	9.99E-01	2.87E+04***	9.81E-01	1.50E+02***
LR	1.15E+02	***	1.10E+02	***	5.78E+01	**	1.28E+02	***
N	380		338		42		380	

Source: Processed Primary Data (2016)

Factors that influence the production of shallot are also presented in Table 3. The estimated parameter coefficient β is its elasticity value. Seed is an important input in the production of shallot, this is indicated from the fact that only this variable has a significant and positive effect on both rainy season and dry season. In the dry season, the seed's elasticity value is the highest, amounting to 0.804. It means that every increase in usage of seed by 10 percent will increase the production by 8.04 percent. Whereas in the rainy season, the value of elasticity for seed amounts to 1.04, it means that every increase of seed usage by 10 percent will increase production by 10.4 percent. This is in line with previous research both on onion farming and other agricultural commodity farming [6], [19], [22], [23], [24], [28], [32], [33], [35]. Which needs to be considered is the number of seeds per planting hole and the selection of seed that will be used, it must be a well maintained seed and or have been purified through mass selection of the best population of plants so the quality and production will be guaranteed, because superior seed will be more responsive to fertilizer and has higher production potential.

Insecticide also has a positive and significant on the dry season. The use of insecticide can still be improved because its coefficient value shows a positive value of 0.032, it means if the farmers improve the use of insecticide by 100 percent, the production will increase by 3.2 percent in the dry season. Meanwhile, urea fertilizer has a negative and significant on the dry season. Urea coefficient value in the dry season equation is negative 0.00381 percent, which means when farmers increase the usage of urea by 100 percent, production will decrease by 0,381 percent. This shows that the usage of urea is already its limits and needs to be reduced.

The excessive use of urea fertilizer on shallot farming in the dry season shows that most of the farmers still believe with the presumption that more fertilizer used will improve the productivity of the shallot, besides, urea fertilizer is also a fertilizer easily carried by water. So, the inexact use of urea fertilizer will only worsen the excessive use of urea fertilizer. The use of insecticide that can still be improved shows that farmers still haven't use insecticide corresponding with its dose suggestion, this is probably because the farmers are limited in their capital. This is accordance with research [17] which stated that the elasticity value of agro-chemicals is positive while fertilizer is negative.

In the rainy season, Male family Labor, TSP and Lime positively affected the production of shallot. While ZA fertilizer and NPK regular has a significant negative effect. The coefficient value of Male Family Labour is 2.26 percent, it means that every increase of Male Family Labour in the family by 10 percent will improve production by 22.6 percent. These results are in accordance with previous studies, namely [1], [5], [6], [9], [11], [13],

[14], [19], [22], [23], [24], [26], [27], [28], [29], [32], [33], [35]. Horticulture plants require higher labor than other plants. Shallot needs intensive care during the growth process, thus, farmers always use the maximum level of labour.

The use of TSP and Lime can still be improved in the rainy season, with a coefficient value of 1.59 percent and 2.04 percent respectively. It means, whenever there is an increase of TSP fertilizer or Lime by 10 percent, the production will also increase by 15.9 percent or 20.4 percent respectively. The addition of lime also have another role to increase the soil PH, so it can improve the nutrients absorbtion effectiveness which ultimately could improve the production of shallots.

Meanwhile, ZA fertilizer and regular NPK is already excessive. The Nitrogen contained in this fertilizer is expected to increase productivity due to the farmers was use more fertilizer. Based on coefficient value means that every increase of ZA fertilizer or regular NPK usage by 10 percent will bring down production of shallot to 31.4 percent or 14.1 percent respectively.

The dummy season variable in the equation above shows insignificant value. This means productivity in the dry season and rainy season are not significantly different.

4.3 Technical Efficiency Analysis

Frontier production model allows inferring inefficiencies in a production process without ignoring *error terms* of the model. In addition, it can also find out the level of efficiency achieved by each individual farming units (Coelli *et al,* 1998), as shown in Table 4.

Based on Table 4, it is found that farmer with ET values lower than 0.6 is higher in the rainy season than the dry season, which amounted to 19.05 percent and 18.05 percent. The average value of technical efficiency in the dry season is 72.52 percent, with the lowest value of 4.94 percent and the highest value of technical efficiency at 95.24 percent. The average value of technical efficiency in the rainy season is 75.61 percent, with the lowest value of 11.61 percent and the highest value of technical efficiency at 99.98 percent. Based on the average value in the equation models, shallot farmer still has the probability to increase their production in order to get higher results until they reach the desired production.

The Technical Efficiency Level of the rainy season is higher than the dry season, which is respectively 75.61 percent and 72.52 percent. This shows that in the rainy season; which is an off-season for shallot farming caused the farmers to use a higher input and become more careful on their farming in the rainy season to keep their harvest stable. Based on ET values, for the shortterm farmers still have the opportunity to increase their production level to reach the highest ET in its dry season at 22.72 percent and in the rainy season at 24.37 percent.

These opportunities can be obtained by increasing the skills of farmers in adopting the most efficient cultivation technology, one of which can be done through seed use technology. This is in line with the results of the regression analysis as shown in Table 2, which shows that the estimated parameters from seed input to production by assuming other independent variables are constant, have a significant effect on all equation models. Opportunities for increased production through seed technology innovation are also in line with research [30], who suggested replacing seed bulbs that had always been used by farmers from previous harvests with botanical seeds or thrue shallot seeds. This is most likely because the seed bulbs have decreased in quality.

Table 4. Technical Efficiency Distribution Value of Shallot in Brebes Regency 2016

ET Level %	Dry Season		Rainy Season		Dummy Season		Pooled	
	farmer	percentage	farmer	percentage	farmer	percentage	farmer	percentage
0 - 20	8	2.37	1	2.38	10	2.63	10	2.63
20,1 - 40	13	3.85	1	2.38	18	4.74	14	3.68
40,1 - 60	40	11.83	6	14.29	75	19.74	58	15.26
60,1 - 80	128	37.87	15	35.71	143	37.63	134	35.26
80,1 - 100	149	44.08	19	45.24	134	35.26	164	43.16
Total	338		42		380		380	
Average	72.52		75.61		69.21		72.00	

Min	4.94	11.61	5.43	4.92
Max	95.24	99.98	95.17	95.13

Source: Processed Primary Data (2016)

4.4 Effect of Technical Inefficiency

When producers/farmers use their resources at the level where production is still possible to be improved, technical efficiency is not achieved. This is due to the presence of inhibiting factors. Factors that influence the level of technical efficiency of farmers are analyzed simultaneously with the model of the effect of technical inefficiencies in equation (2). In the technical inefficiency model, a positive sign on the regression coefficient indicates that the variable increases technical inefficiency, and vice versa.

Based on Table 5, age has a positive and significant effect on the dry season. This means that when the age of the farmer increases, the level of technical inefficiency also increases, or in other words, the level of technical efficiency decreases. This is because older farmers tend to be slower in adopting technological innovations, they also have less desire to adopt more modern practices of cultivation and use of inputs [32]. This is in line with research conducted by [5], [31]. This shows that young farmers can be targeted for improvement of the technical efficiency of shallot farming.

Another factor that positively and significantly influences the level of technical inefficiency in the dry season is education. The better the farmer's education level, the higher the level of technical inefficiency. The result is not as expected. But this can happen because usually, farmers with a good education have other alternative sources of income, where they are not fully dependent on agriculture for their living needs [8]. Therefore there will be differences of attention from farmers who are highly educated on shallot farming compared to farmers with a relatively lower level of education who depend their lives mainly from shallot farming. The research that supports the results of this study is [12], [31].

The number of family members and the number of family dependents has a positive and significant effect on technical inefficiencies. This means that the higher the number of family members, the higher the value of technical inefficiency. This shows that a large number of family members are not utilized in shallot farming as a laborer and the higher the number of family dependents will increase the technical inefficiency. This is supported by the phenomenon that occurs a lot. Many children of farmers are reluctant to get involved or to continue the family business, and even there are parents who do not support their children to become a farmer because the agricultural sector is considered to not provide attractive incentives to the business actors, so they are reluctant to continue [19]. The results of this study is in line with the research conducted by [24], [27].

Another factor that has a positive and significant effect on the level of technical inefficiency is the dummy membership of farmer groups. This means that farmers who are members of a farmer group are found out to have a lower level of technical efficiency than those who do not belong to the farmer group. This could be because farmers who are members of farmer groups spend more time planning and requesting input assistance from the government or the private sector, seeking information about higher prices, and has variety of market access than increasing knowledge in the field of agronomy, so transfer of knowledge and technology from farmer groups is not focused on cultivation commodity of shallot and farmers who are members of that group cannot improve the technical efficiency of shallot farming [17]. This result is supported by research [2].

The distance of farming area from home has a negative and significant effect on the level of technical inefficiency. This means that the further away the land from the farmer's residence will increase the technical efficiency of shallot farming. The result is not expected but can occur if the land is far from the farmer’s residence, but is close to the market or road access so it can have better access of transportation so that farmers will have an increase in their production. Income from non-shallot farming and off-farm income negatively affects the level of technical inefficiency. This means that the higher off-farm income will reduce the level of technical inefficiency in shallot farming. This other source of income is used by farmers as additional capital in farming to buy inputs, to adopt more modern technologies and to enlarge their farming so that it can improve the technical efficiency of shallots.

Dummy access to credit has a negative and significant effect on technical inefficiencies. This means that farmers who have access to credit will be more technically efficient than farmers who do not have access to credit. This is the same as the off-farm income used as capital, where farmers are faced with capital constraints to buy production inputs. With the availability of credit as business capital, the allocation of fertilizer inputs, superior planting materials, and out-of-family labor will be better to improve technical efficiency (Addai 2014). Other research also stated the same [14], [18], [26].

Another factor is the dummy ownership of land which has a negative and significant effect on the level of technical inefficiency. This means that farmers who own their own land will be more efficient than farmers who rent. This is supported by research [13]. Income from non-shallot farming and from off-farm activity will increase the technical efficiency. This also shows that farmers need capital to run their business well and using inputs as suggested. This in line with research carried out by [21].

Dummy agriculture extension and access credit also have a negative and significant effect in the dry season. That Means farmers who participate in extension are more technically efficient compared to farmers who have no access to agriculture extension. This is also in line with research carried out by [1], [17], [18], [20] and [26]. Farmers who has access to credit are more technically efficient compared to farmers who have no access to credit, this is also supported by the research done by [14], [15] and [17].

Tabel 5. Technical Inefficiency Estimation of Shallot Farming in Brebes Regency 2016

Independent Variable	Dummy Joined Model		Dry Season		Rainy Season		Pooled Model	
	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio
Intercept	-1.12E+00	-1.12E+00	-1.08E+01	-2.9E+00***	-7.22E-01	-3.39E-01	-9.00E+00	-2.49E+00***
Age (Z1)	5.33E-03	3.96E-01	4.12E-02	1.74E+00**	1.67E-02	1.21E+00	3.09E-02	1.80E+00**
Education (Z2)	3.22E-02	9.53E-01	2.35E-01	3.03E+00***	3.13E-02	3.94E-01	1.60E-01	2.22E+00***
Family Members (Z3)	1.38E-01	1.92E+00**	5.27E-01	4.08E+00***	3.57E-01	6.16E-01	5.95E-01	4.30E+00***
Family Dependents (Z4)	9.67E-02	7.59E-01	7.64E-01	3.13E+00***	2.13E-02	6.27E-02	4.57E-01	2.44E+00***
Farm-Home Distance (Z5)	-5.46E-06	-7.92E-01	-2.84E-05	-1.90E+00**	-5.86E-05	-4.33E-01	-3.57E-05	-1.87E+00**
Non-Shallot Income (Z6)	-1.38E-08	-1.63E+00*	-2.50E-08	-3.6E+00***	-2.93E-08	-5.97E-01	-2.85E-08	-1.23E+01***
Off-farm Income (Z7)	-1.15E-08	-1.84E+00**	-1.62E-08	-1.9E+01***	-1.89E-08	-1.35E+00*	-1.45E-08	-2.45E+01***
Dummy Counselling (Z8)	-1.39E-01	-5.64E-01	-5.97E-01	-1.69E+00**	-6.11E-01	-1.46E+00*	-9.49E-01	-2.27E+00***
Dummy Credit (Z9)	-2.50E-01	-1.07E+00	-1.04E+00	-3.5E+00***	5.07E-02	5.22E-02	-1.06E+00	-3.17E+00***
Dummy KT member (Z10)	2.67E-01	1.18E+00	1.62E+00	3.67E+00***	-2.28E-02	-2.59E-02	1.13E+00	3.07E+00***
Dummy land ownership (Z11)	-3.20E-01	-1.39E+00*	-3.56E-01	-8.48E-01	-9.78E-01	-8.42E-01	-1.40E+00	-3.19E+00***

Source: Processed Primary Data (2016)

V. CONCLUSION

Based on the results of the study it can be concluded that:

1. Production factors that have a positive and real effect on shallot production in all seasons are seeds, while other inputs that are real in the dry season are the use of urea

which has a negative effect and insecticide which has a positive effect. The use of Men Labor in Family, TSP, and lime have a positive and significant effect in the rainy season, whereas the use of ZA, regular NPK has a negative and real effect.

2. The average value of technical efficiency the rainy season is higher than the dry season.

3. Factors affecting the value of technical inefficiency in the rainy season are non-shallot farming income and off-farm income that are negatively affecting the technical inefficiency value. While in the dry season, technical inefficiency is significantly positively affected by age, education, number of family member, number of family dependents and the dummy members of farmer groups. The factors of the distance of farm land from home, non-shallot farming income, off-farm income, dummy education, dummy access to credit and dummy ownership of land have a significant negative effect on technical inefficiencies.

The implications based on the results of the study are:

1. Based on the value of TE which is still below one, indicates that farmers still have the probability to increase production. These probabilities can be obtained by increasing the skills of farmers in adopting the most efficient cultivation technology, one of which can be done through the use of seed technology. In addition, in the dry season, farmers can reduce the amount of urea usage and increasing the insecticide on their farm. While in the rainy season, farmers can increase their male Family Labour, the usage of TSP and lime, reduce the amount of ZA fertilizer and regular NPK.

2. To increase the value of technical efficiency can be focused on young farmers. Improving the skills of young farmers in the field of cultivation through the adoption of technological innovations will increase the technical efficiency of shallots.

3. Provision of skills enhancements can also be focused on farmers who are still lowly educated and land owners who have shallots as the main source of family income.

4. For farmer group meeting to be more utilized for the development of farmers' skills to improve technical efficiency of shallots.

5. Giving credit as a source of capital assistance can be increased

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