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Environmental Efficiency Analysis of Shallot Farming: A *Stochastic Frontier Translog Regression Approach*

Budi Waryanto[1)], MA Chozin[2)], Dadang[2)], Eka Intan K Putri[2)]

1. Doctoral Student of Natural Resources and Environment Management Program, Bogor Agricultural University. Kampus IPB Darmaga, Bogor, Indonesia, 16680. West Java, Indonesia
2. Bogor Agricultural University, Kampus IPB Darmaga Bogor 16880, West Java, Indonesia

*e-mail of the corresponding author: b.waryanto@yahoo.co.id

Abstract

Shallot farming in Indonesia has been the predominant life support for farmers in the country side. However, when it is compared to that in other countries such as Thailand, shallot farming in Indonesia has yet to reach its optimal productivity. Numbers of determining factors have been identified, one of which is pest and plant diseases. The most common control measure devised by the local farmers to address the pest and plant diseases has been the use of chemical pesticide. Nonetheles, its use tend to be excessive so that it potentially endangered the environment. On the other side, shallot farming demanded environmentally friendly practices to create sustainable business for the future. Based on that a research has been done to assess the environmental efficiency through analysis of stochastic frontier translog regression approach. The objectives of the research are: 1) to assess the influence of some conventional production input, in particular the influence of excessive pesticide on the shallot production using *stochastic frontier translog (TL) regression,* 2) to analyse the technical efficiency and environmental efficiency, and 3) to analyse the technical inefficiency effect on shallot farming. The research held in Nganjuk Regency of East Java Province, Indonesia, from October to November 2013. The results of *stochastif frontier translog (TL)* regression analysis indicated that conventional production input variables such as seeds, organic fertilizer and labor, either individually or in quadratic forms, as well as in their interaction significantly affect the shallot production. The shallot farming has not reach the environmental efficiency level because the average of *EEnv* is only 0.5674. Similar result applied to the technical efficiency towards shallot farming, where the average TE is only 0.6107. The analysis of technical inefficiency aspect suggested that only access to farmer group provide a significant influence, where farmers with better access to the farmer group have higher technical efficency.

Keywords : *Stochastic frontier translog* regression, environmental efficiency/EEnv, technical efficiency/TE, effect of technical inefficiency and shallot farming

1. Introduction

The shallot farming had become the predominant life support of farmers in countryside, where in 2013 known there are 226.22 thousand of household that has shallot farming, although the number had decrease to 31.06% compare to 2003 (CBS, 2014). The result of productivity shallot by Indonesian farmer not yet optimal compare to the farmer from other country which produce shallot. Shallot productivity result in average by Indonesian farmer is only 9.69 tonnes per hectare, still lower than Thailand shallot farmer productivity that could reach 26.56 tonnes per hectare (FAO, 2013). According to Sasmito (2010), the un optimal of shallot productivity in Indonesia caused by several factors, some of them are cultivation technique used by farmer is inproper, uncontrollable environmental factor and the pest and plant diseases. Especially to pest and plant diseases on shallot crops, is one factor that farmers feared of because this is very dangerous and directly influence to crop damage then decreases the production. Dibiyantoro (1990) in his research reported that the decrease of shallot farmer production that caused by the beet armyworm (*Spodoptera exigua*) attack could be reach 45% up to 75%. Other research shown the attack influence *Thrips tabaci* in India could lower production 10% up to 15% (Dinakaran *et al*., 2013).

Udiarto *et al*., (2005) mentioned that the dominant pest and plant diseases that attack shallot crop consist of two categories, there are attack that caused by pest and by disease. Pest that attack crop are beet armywor (*Spodoptera exigua*), tropical armyworm (*Spodoptera litura*), onions thrips (*Thrips tabaci*), the stone leek leafminer (*Liriomyza chinensis*) and mole crickets (*Gryllotalpa spp.*), diseases that often attack was spotting purple blotch (*Alternaria porii*), anthracnose (*Colletotrichum gloeosporiodes*) and fusarium basal rot (*Fusarium oxysporum*).

Data on pest and plant diseases attack published by the technical implementation unit Technical Protection of Food Crops and Horticulture in East Java shown an incremental attack of pest and desease in the last few years.

In average the attack of pest on the last five years starts from 2006 up to 2010 in East Java for beet armywor increase 34.32 %, onions thrips 80.19 % and onion leaf blight *(Stemphylium vesicarium*) 28.93 %. Event the increment of attack from 2011 to 2012 high enough, for the beet armyworm increase 18.38 %, onions thrips 274.53 % and onion leaf blight 87.53 %. Especially for tropical armyworm, incremental of attack from 2011 to 2012 has reach 133.85 % (TIUPPFH East Java, 2013).

In order to control the pest and plant deseases, farmers generally use pesticides as the main option considered most practical. The use of pesticides in order to control the shallot pest attack tend not appropriate, whether it is the appropriate type, the appropriate way, appropriate dose, right on target and on time or called the five appropriate. The results of the study (Riyanti, 2011) showed that the use of pesticides to shallot crops in Brebes region do not follow the five proper rules, where farmers spray based on a period of every 3 to 4 days. The dose used in these studies are as follows, the dose of insecticide 6.27 liters per hectare, fungicide at 9.28 kg per hectare and the adhesive 3.28 liters per hectare. Dinakaran *et al.* (2013) also reported that farmer in India had a pesticide spray every 2 until 3 days in nursing their shallot crops without calculating the attack level of pest and plant diseases. Just as common farmers in general, the respondent of shallot in this research are also depend on pesticide in controlling the pest and plant diseases.

The use of pesticide as production input had been known very effective in controlling the pest and plant diseases on shallot crop, so it does not disrupt the crop growth and could give optimum result (Riyanti, 2011). However the use of pesticide had negative risk which is significant to human and other organism to the environment. On human, exposure to pesticides may increase the risk of adverse health in the long term, such as sensory disturbance, eye irritation, dermatologic reactions, liver damage, respiratory problems, increased cancer risk, the risk to the fetus, endocrine disorders, immunological effects, and many others (Calvert *et al.*, 2008). Other organisms also bear unintended consequences of the use of pesticides, the presence of natural enemies, organisme in soil and other usefull animals. Due to serious impact that has relation with the use of agriculture pesticide towards human health and environment, thus resulting movement toward decreased use of pesticides and integrate it with a non-toxic approach to pest control (Gretz *et al.,* 2011). Non toxic approach generally called as Integrated Pest Management (IPM), implementation in the long term is expected to provide improvements in environmental conditions or environmental conditions has the nature of sustainability.

To see how big the influence of pesticide use together with the other production input towards the shallot farming in environmental aspect, the research of environmental efficiency of shallot farming in Nganjuk Regency, East Java Province, Indonesia had been conducted. The approach of environmental efficiency analysis held thru quantitative methode using the *stochastic frontier translog regression (TL) (Coelli, 1996).*

Production inputs which considered detrimental to the environment to be used as indicators to do environmental efficiency analysis. On this research indicator used in environmental efficiency analysis is the surplus of pesticide, where the surplus appear because of dose use tend to be excessive, thus had environmental hazard potent (Harsanti, 2007; Hidayat *et al.,* 2010). Research to see the level of environmental efficiency in shallot farming has never been done, but it has been done on the dairy farm to see the level of environmental efficiency of the Nitrogen surplus (Reinhard *et al.,* 1998; Graham, 2004; Mkhabela, 2011) and the organic agriculture research in China (Guo & Marchand, 2012).

2. Research Objective

Research objective are as follows : 1) to assess the influence of some conventional production input and the chemical pesticide surplus on the shallot production using the stochastic frontier translog regression, 2) to analyse the technical and environmental efficiency, and 3) to analyse technical inefficiency effect to the shallot farming in Nganjuk Regency, East Java Province, Indonesia.

3. Theory Approach

Relation of production system in the *stochastic frontier regression* that put environmental factors as independent variables in general formulated as follow (Reinhard *et al*., 1998; Reinhard, 1999; Mkhabella, 2011).

$$Y_{it} = F(X_{it}, Z_{it}; \beta) * \exp\{V_{it} - U_i\}, \text{ i=1,2…,n, t=1,…,T} \quad (1)$$

where *i* as sample of farmer index and *t* as year index, description of other variables are:

Y_{it} = explained production level

X_{it} = conventional input vector

Z_{it} = production input that considered detrimental to environment/*detrimental input*

β = parameter estimation

v_i = random variables related to external factors, spreads $N(0, \sigma_v^2)$

u_i = non negative random variables, assumed to affect the level of technical inefficiency and related to internal factors, spreads $N^+(\mu, \sigma_u^2)$

Base on equation (1), then the technical efficiency can be calculated as follows (Reinhard, 1999):

$$TE_i = Y_{it} / [F(X_{it}, Z_{it}; \beta) * \exp\{V_{it}\}] = \exp\{-U_i\} \quad (2)$$

Where TE_i value is between 0 and 1 or $0 \leq TE_i \leq 1$ and could directly get it from *software Frontier 4.1* (Coelli 1996).

Next step after calculating the technical efficiency is to calculate environmental efficiency. Environmental efficiency referred to in this study is the ratio of the minimum viable use of production inputs that could potentially harm the environment/*environment detrimental input* which can be observed and depending on the desired level of output and the number of conventional input used (Reinhard *et al.,* 1998). Figure 1 shows the production frontier (Y) with conventional input (Xj) and input that could harm the environment (Z). Where Z^F is a minimum number of input that could potentially harm the environment which use from F function (●) and observed value X_R (namely in the form of conventional input use) and output Y_R.

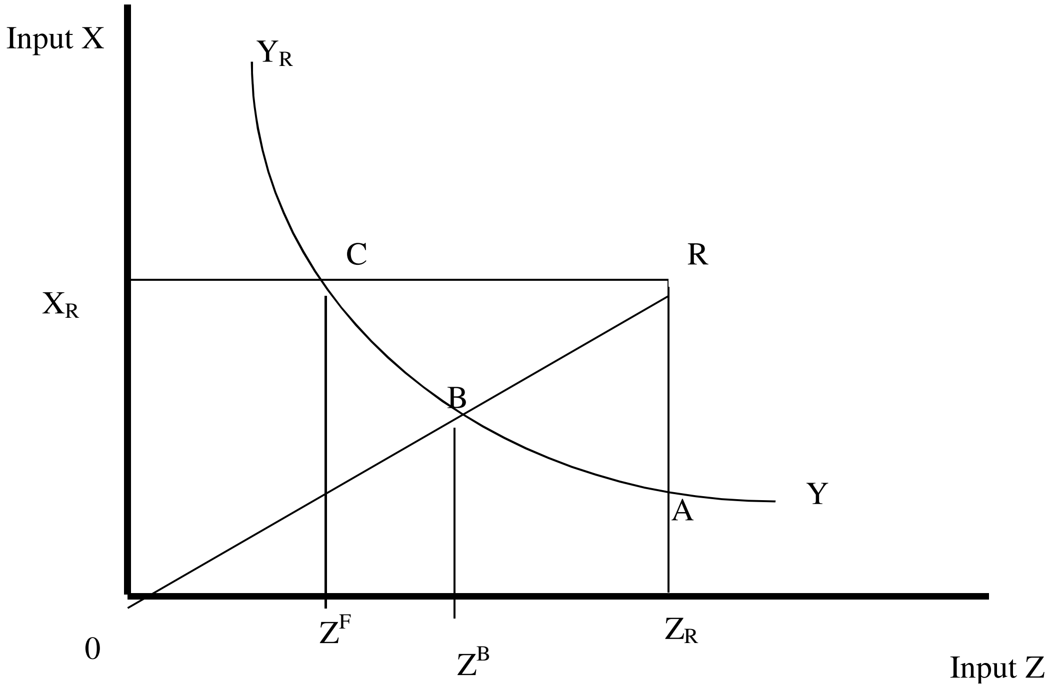

Figure 1. Frontier Production Curve for X and Environment Input Reduction Z (Source: Reinhard *et al.*, 1998)

Based on Figure 1 above, it can be made a general function of the value of environmental efficiency (EEnv), as follows.

$$EEnv_R = \min\{\theta : F(X_R, \theta Z_R) \geq Y_R\} = |OZ^F| / |OZ_R|, \quad (3)$$

Reinhard (1999) further stated that in order to obtain environmental efficiency measure, the first thing is to made a more specific equation from the equation (1) which is often called the *stochastic frontier Translog/TL* regression, as follows:

$$\ln Y_{it} = \beta_0 + \sum_j \beta_j \ln X_{itj} + \beta_z \ln Z_{it} + \frac{1}{2}\sum_j \sum_k \beta_{jk} \ln X_{itj} \ln X_{itk} + \sum_j \beta_{jz} \ln X_{itj} \ln Z_{it} + \frac{1}{2}\beta_{zz}(\ln Z_{it})^2 + V_{it} - U_i \quad (4)$$

where $\beta_{jk} = \beta_{kj}$, i= 1,2,3,…, n is sample of studied, t = 1,2,…, T is a time periode (month/year), j,k = 1,2,…., m is a conventional type of input applied, ln (Y_{it}) is the logarithm of output from farmers number-i, ln (X_{ijt}) is the conventional logarithm input number-j that applied by individual farmers number-i, ln (Z_{ijt}) is the logarithm of production inputs that have the potential to affect the environment-j are applied by individual farmers to-i, and β_j, β_z, β_{jk}, β_{jz}, dan β_{zz} is the estimate parameter. The environment efficiency logharithm from producer using X_{it} and Z^F_{it} to produce Y_{it}, by replacing Z_{it} with Z^F_{it} and with assumption U_i= 0 on the equation (4) so obtained:

$$\ln Y_{it} = \beta_0 + \sum_j \beta_j \ln X_{itj} + \beta_z \ln Z^F_{it} + \frac{1}{2}\sum_j \sum_k \beta_{jk} \ln X_{itj} X_{itk} + \sum_j \beta_{jz} \ln X_{itj} \ln Z^F_{it} + V_{it} \quad (5)$$

Stochastic environment efficiency logarithm (ln $EEnv_{it}$ = ln Z^F_{it} – ln Z_{it}) can be obtained by isolating the equation (4) and (5) become:

$$\frac{1}{2}\beta_{zz}[(\ln Z^F_{it})^2 - (\ln Z_{it})^2] + \sum_j \beta_{jz} \ln X_{itj}[\ln Z^F_{it} - \ln Z_{it}] + \beta_z[\ln Z^F_{it} - \ln Z_{it}] + U_i = 0 \quad (6)$$

and can be rewritten:

$$\frac{1}{2}\beta_{zz}[\ln Z^F_{it} - \ln Z_{it}]^2 + [\beta_z + \sum_j \beta_{jz} \ln X_{itj} + \beta_{zz} \ln Z_{it}] \times (\ln Z^F_{it} - \ln Z_{it}) + U_i = 0 \quad (7)$$

Equation (7) can be solved for ln $EEnv_i$ = ln Z^F_{it} – ln Z_{it} bring in:

$$\ln EEnv_i = \left[-\left(\beta_z + \sum_j \beta_{jz} \ln X_{itj} + \beta_{zz} \ln Z_{it}\right) \pm \left\{\left(\beta_z + \sum_j \beta_{jz} \ln X_{itj} + \beta_{zz} \ln Z_{it}\right)^2 - 2\beta_{zz} u_i\right\}^{0.5} \right] / \beta_{zz} \quad (8)$$

Environmental efficiency is calculated using the positive root $(+\sqrt{\ } formula)$ of the equation (8).

4. Material and Methods

4.1 Area of study

This research was conducted in Nganjuk Regency, East Java Province, Indonesia. Selection Nganjuk regency as research region based on that regency is one of the centers of shallot production in Indonesia, which contributed for 12.81 percent of the national production. The location of the sub districts were purposively selected (*Purposive*) involve Rejoso, Sukomoro, Bagor dan Wilangan region (Figure 2).

4.2 Responden

The selection of the sample for this study was conducted in two phases: phase one, four shallot farming centers were purposively selected. These include the sub districts of Rejoso, Sukomoro, Bagor and Wilangan and the second stage, respondents were randomly selected in order to obtain as many as 179 respondents.

4.3 Data Collection

Primary data were collected by means of interviews with respondents either using a structured questionnaire and discussion, as well as direct observation of activities at the study site to achieve its intended purpose. The questionnaires consisted of the characteristics of respondents and their farm, production data, cost of farm inputs and shallots farm income, and various problems faced by farmers. Data collection was conducted in October and November 2013.

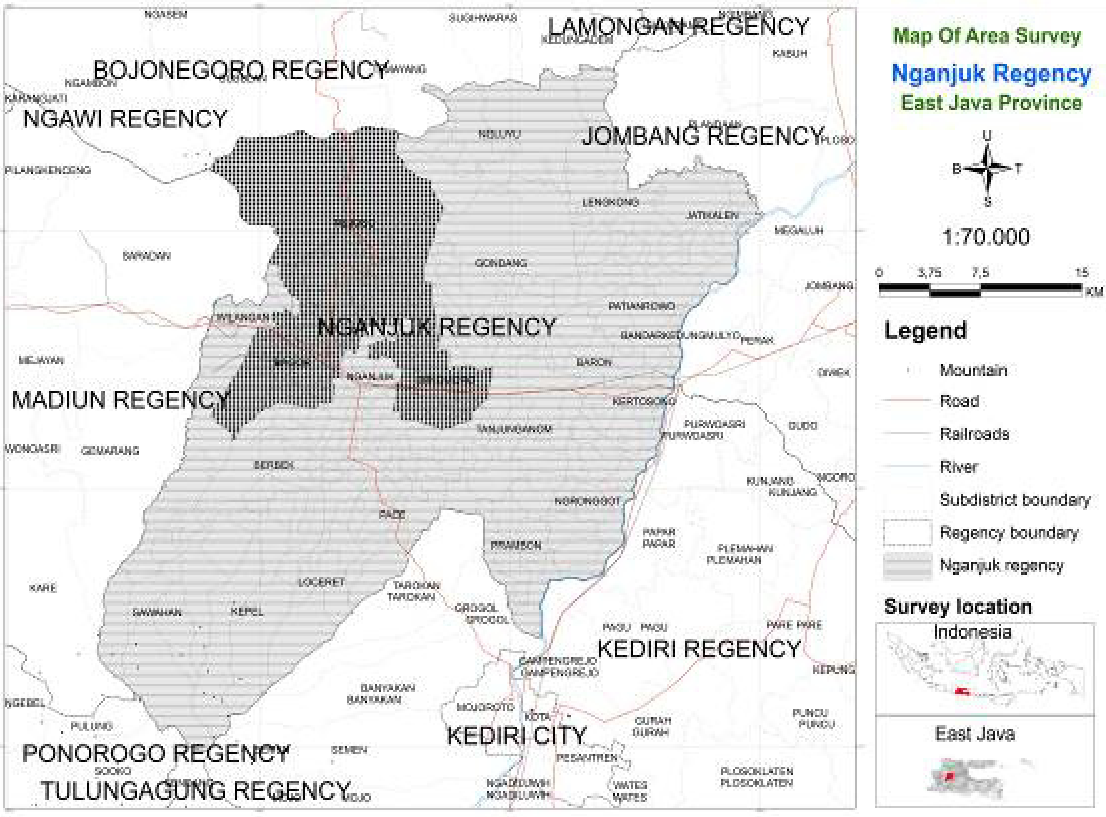

Figure 2. Area of Study in Nganjuk Regency

Description : = Choosen region

4.4 Data Analysis

Analysis of the data to see the effect of inputs on shallot production is done through the stochastic frontier regression translog, where the potentially harmful input to the environment (Z) is the surplus pesticides. Surplus pesticides is calculated from the difference between the recommended doses of pesticides contained in accordance to the commercial packaging with the real dose of farmers per hectare. By using the translog functional approach in equation (4) then can be obtain the operational equation, as follows:

$$\ln Y = \beta_0 + \sum_{j=1}^{5} \beta_j \ln X_j + \beta_6 \ln Z + \beta_7 0.5*(\ln X_1)^2 + \beta_8 0.5*(\ln X_2)^2 + \beta_9 0.5*(\ln X_3)^2 +$$
$$\beta_{10} 0.5*(\ln X_4)^2 + \beta_{11} 0.5*(\ln X_5)^2 + \beta_{12} 0.5*(\ln X_1 \ln X_2) + \beta_{13} 0.5*(\ln X_1 \ln X_3) +$$
$$\beta_{14} 0.5*(\ln X_1 \ln X_4) + \beta_{15} 0.5*(\ln X_1 \ln X_5) + \beta_{16} 0.5*(\ln X_2 \ln X_3) +$$
$$\beta_{17} 0.5*(\ln X_2 \ln X_4) + \beta_{18} 0.5*(\ln X_2 \ln X_5) + \beta_{19} 0.5*(\ln X_3 \ln X_4) +$$
$$\beta_{20} 0.5*(\ln X_3 \ln X_5) + \beta_{21} 0.5*(\ln X_4 \ln X_5) + \beta_{22} \ln X_1 \ln Z + \beta_{23} \ln X_2 \ln Z +$$
$$\beta_{24} \ln X_3 \ln Z + \beta_{25} \ln X_4 \ln Z + \beta_{26} \ln X_5 \ln Z + \beta_{27} 0.5*(\ln Z)^2 + v_i - u_i \quad (9)$$

Description :

Y = shallot production (kg)

X_1 = total planted area (m^2)

X_2 = seeds (kg)

X_3 = fertilizers (kg)

X_4 = organic fertilizer (kg)

X_5 = number of labour use

Z = Total surplus pesticides (ml)

β_0 = intercept / constant

β_j = coefficient parameter estimators number-j, where j = 1,2,3,…, 6

V_i-U_i = V_i is error and U_i technical inefficiency effects in the model

Completion of equation (9) is done with the help of software Frontier 4.1 (Coelli, 1996) in order to obtain the coefficient of allegations of equations (9) and concurrently from the output of frontier software 4.1 also obtained the value of TE (Equation 2). From the results obtained values Frontier 4.1 also alleged technical inefficiency effects according the following equation:

$$u_i = \delta_0 + \delta_1 I_1 + \delta_2 I_2 + \delta_3 I_3 + w_{it} \qquad (10)$$

where:

u_i = technical inefficiency effect

I_1 = membership of farmer group (I_1=1 if 'yes' and I_1=0 if 'no')

I_2 = access to Agriculture Officer (I_2= 1 if 'yes' and I_2 = 0 if 'no')

I_3 = received training in Integrated Pest Management/IPM (I_3= 1 if 'yes' and I_3 = 0 if 'no')

As for EEnv calculation were done manually using equation (11), as follows (Reinhard *et al.*, 1998; Reinhard, 1999; Mkhabella, 2011) :

$$LnEEnv_i = \left[\begin{matrix} -(\beta_6 + \beta_{22}\ln X_1 + \beta_{23}\ln X_2 + \beta_{24}\ln X_3 + \beta_{25}\ln X_4 + \beta_{26}\ln X_5 + \beta_{27}\ln Z) \pm \\ \left\{ (\beta_6 + \beta_{22}\ln X_1 + \beta_{23}\ln X_2 + \beta_{24}\ln X_3 + \beta_{25}\ln X_4 + \beta_{26}\ln X_5 + \beta_{27}\ln Z)^2 - \right. \\ \left. 2\beta_{27} U_i \right\}^{0.5} \end{matrix} \right] / \beta_{27} \qquad (11)$$

Environmental Efficiency denote a calculation of positive root (√+) from equation (11).

4.5 Environment Efficiency Analysis Coverage

Environmental efficiency that were examined in this study is defined as the ratio of the minimum viable use of production inputs that could potentially disserve the environment which can be observe and depending on the desired level of output and the amount of conventional inputs used (Reinhard *et al.,* 1998). Production inputs which considered detrimental to the environment hereinafter used as an indicator for the analysis of environmental efficiency. In this study the indicators used in the analysis of the environmental efficient is a surplus use of pesticides. Surplus pesticides that may occur due to shallot farmers tend to exceed the recommended dose in spraying in order to control pests and diseases of shallot plants, thus leaving pesticide residues (Harsanti, 2007; Hidayat *et al*., 2010).

The use of pesticides surplus indicators in environmental efficiency analysis calculation have not been studied by other researchers, but studies using other indicators have been widely studied. Kamande (2010) for example, uses an indicator of fossil fuel use in researching aspects of environmental efficiency of plant operations in Kenya. Another indicator is the surplus use of fertilizer N used by Reinhard (1999) in studies of dairy cows in the Netherlands, Mkhabela (2011) using the same indicators for dairy research in South Africa, as well as Guo and Marchand (2012) uses the indicator N surplus in agricultural research organic in China.

The approach used in calculating the pesticides surplus is through the calculation of the difference between the amount of pesticides doses used by shallot farmers (ml / land area) with the recommended dosage (ml / land area) listed on the packaging label. Table 1 shows an example of calculation of surplus pesticide use by farmers. Calculation of surplus pesticides on the table is an example taken from one respondent (sample code = 10911) which has a land area of 0.25 hectares. The frequency of spraying pesticides in the cultivation period are 16 times, using a combination of two or three types of pesticides for one time spraying. Pesticides used include Ludo, Demolish, Score, Manzate, Antracol and Rizotin. Surplus pesticides occurs in the type of Ludo, Demolish and Score, the total surplus reached 760 ml for land area 0.25 hectar. The same calculation method, is also used to calculate the surplus pesticides on the remaining 178 respondents.

Tabel 1. Example of Calculation of Surplus Use of Pesticides

Type of Pesticide	Status	Frequency of use	Surplus Amount (ml/land area)
Ludo	Surplus	11	220
Demolish	Surplus	10	480
Score	Surplus	2	60
Daconil	No Surplus	3	
Manzate	No Surplus	3	
Antracol	No Surplus	2	
Rizotin	No Surplus	2	
Total			760

] tained a
] s of the environmental efficiency analysis with stochastic frontier translog regression approach, then just use data of 121 respondents who have a surplus pesticides, hereinafter to give the symbol Z as an identifier and incorporated into the translog model together with other input variables (X_i).

5. Result and Discussion

The result of environmental efficiency analysis is presented in three parts: 1) analysis of stochastic frontier translog regression refers to equation (9), 2) analysis of technical efficiency and environmental efficiency, and 3) analysis of the effects of technical inefficiency with the independent variable is membership of farmer groups (I_1), access to agricultural extension (I_2) and IPM training (I_3).

5.1 Description of Data

Before the results of stochastic frontier translog regression analysis are discussed in more detail, first it has to be seen from the descriptive analysis of the data used, as shown in Table 2. The results of descriptive analysis showed that the average land area of shallot farming is 3528 m^2, where the smallest land area is 300 m^2 and the largest land area is 1.7 hectares. Average use of seeds is 394 kg, the average use of fertilizer is 226 kg, organic fertilizer 210 kg and 36 person-days of labor. As for the use of pesticides there are total 1804 ml surplus, with a minimum value of surplus pesticides by 12 ml and a maximum of 14980 ml. As for the output variable shows the average production of shallot production produced by the farmers included in this study were 4.45 tons of 0.35 hectares planting area. Lowest production are 600 kg and the highest production are 18 tons.

Tabel 2. Summary of *Stochastic Frontier* Translog (TL) Regression Variable

Variable	Code	Average	Minimum	Maximum	Deviation
Land (m^2)	X_1	3528	300	17000	2918
Seed (Kg)	X_2	394	60	1500	265
Fertilizer (Kg)	X_3	226	27	1326	194
Organic Fertilizer (Kg)	X_4	210	15	600	158
Labor	X_5	36	3	159	30
Pesticide Surplus (ml)	Z	1804	12	14980	2439
Production (Kg)	Y	4452	600	18000	3252

From Table 2 can also be explained variation in the distribution of the data seen from the deviation of each variable. For variable fields, surplus pesticides and shallot production has sizable deviation, ie 2918, 2439 and 3252, meaning that the amount of land area farmers and pesticide use varies which impacted on the production variations generated. The standard deviation value of other production inputs variables such as seeds, fertilizer, organic fertilizer and labor is relatively small, meaning that the variations use of such production inputs do not have a large variation. Variations in the labor input is the smallest with a standard deviation of 30.

5.2 Stochastic Frontier Translog Regression Analysis

Stochastic frontier translog production function analysis in this study was calculated using equation (9). The result of the regression analysis is detailed in Table 3.

Table 3. Summary of Stochastic Frontier Translog (TL) Regression Analysis

Type of Variable	Code	Coeffisien Value		Standard error	t-ratio
	beta 0	5.1897		1.0454	4.9642
ln land (X_1)	beta 1	0.5937		0.5722	1.0375
ln seed (X_2)	beta 2	-1.6712	*)	0.7504	-2.2272
ln NPK (X_3)	beta 3	-0.2626		0.7853	-0.3345
ln organic fertilizer (X_4	beta 4	-0.2266	*)	0.1063	-2.1306
ln labor (X_5)	beta 5	2.1171	*)	0.6604	3.2056
ln pesticide surplus (Z)	beta 6	0.0473		0.2221	0.2130
$\ln X_1 \ln X_1$	beta 7	-0.0078		0.0695	-0.1122
$\ln X_2 \ln X_2$	beta 8	0.5035	*)	0.2199	2.2900
$\ln X_3 \ln X_3$	beta 9	-0.0218		0.1435	-0.1518
$\ln X_4 \ln X_4$	beta10	0.0041		0.0310	0.1310
$\ln X_5 \ln X_5$	beta11	0.3886	*)	0.1357	2.8639
$\ln X_1 \ln X_2$	beta12	0.0171		0.2242	0.0762
$\ln X_1 \ln X_3$	beta13	0.0199		0.1866	0.1068
$\ln X_1 \ln X_4$	beta14	0.2326	*)	0.0615	3.7809
$\ln X_1 \ln X_5$	beta15	-0.3055		0.2487	-1.2284
$\ln X_2 \ln X_3$	beta16	0.0459		0.1540	0.2984
$\ln X_2 \ln X_4$	beta17	-0.3175	*)	0.0687	-4.6191
$\ln X_2 \ln X_5$	beta18	-0.5935	*)	0.2330	-2.5469
$\ln X_3 \ln X_4$	beta19	0.0661		0.0598	1.1055
$\ln X_3 \ln X_5$	beta20	0.0334		0.3281	0.1018
$\ln X_4 \ln X_5$	beta21	0.1134	*)	0.0400	2.8370
$\ln X_1 \ln Z$	beta22	-0.0096		0.0353	-0.2715
$\ln X_2 \ln Z$	beta23	0.0216		0.0425	0.5080
$\ln X_3 \ln Z$	beta24	0.0337		0.0432	0.7794
$\ln X_4 \ln Z$	beta25	-0.0189		0.0134	-1.4070
$\ln X_5 \ln Z$	beta26	-0.0710	*)	0.0286	-2.4823
$\ln Z \ln Z$	beta27	0.0177		0.0123	1.4394
	delta 0	-0.0580		0.3548	-0.1634
I_1	delta 1	-1.0101	*)	0.2907	-3.4754
I_2	delta 2	0.4837		0.2953	1.6383
I_3	delta 3	-0.0358		0.2796	-0.1282
σ^2	sigma-squared	0.9770	*)	0.1934	5.0505
γ	gamma	0.9999	*)	0.0000	26041009.00

Description: *) value t-tabel α 5% = 1.65376 and α 10% = 1.28649

Table 3 explained that from the 27 value of the coefficient β, 10 coefficients were found to affect the shallot production significantly. Variables that significantly affect in shallot production is seed (X_2), organic fertilizer (X_4) and labor (X_5). Especially for seed and labor variable, in addition to having a partial effect on the production, the quadratic form of the logarithm of seed and labor is also had significant affect with results of t-test α 5 % each variable is 2.2900 and 2.8639. The value of β coefficient generated was 0.5035 for quadratic forms seeds and 0.3886 for quadratic forms of labor. Besides partially effect and its square shape, the interaction between the seedlings variables with organic fertilizer and seeds with labor variables significantly affect the production, as well as the interaction between organic fertilizer and labor had significant effect. Only the interaction of pesticides surplus had significant effect on the production, in this case is the interaction between the labor and excessive pesticides.

The results of the regression analysis in Table 3 above shows that the seed variable (X_2) has a significant effect on the production both partially or in the form of quadratic and interaction. The consistency of the strong influence of the seed production through a translog stochastic frontier regression analysis in line with the study of Shah *et al.* (2011), in which the research results indicate that seed is the most important production input to the production of shallot in Pakistan. The results of Shah *et al*. (2011) analysis shows the input seed has the highest score of 103 and on the first rank, followed by efforts to control pests and diseases in the second and third, while the fourth and fifth order is the availability of water and labor. Attention to the importance of seeds as well proposed by Triharyanto *et al.* (2012) that suggest the needs for the application of new technologies using botanical seeds in shallot farming for the future. Other variable that is very important and need to get attention is the use of organic fertilizer and labor. The analysis of translog function had shown that both of them had significant influence as well as seed variable.

Based on translog function analysis for other variable such as Land (X_1), fertilizer (X_3) and pesticide surplus (Z) there are no significant effect indicated to the production (Y). Unsignificant effect of land variable, fertilizer variable and pesticide variable could be caused by various factors. For example, the use of fertilizer, the unsignificant effect allegedly caused by the dose had exceed the recomendation, so it does not have any effect to the production anymore.

Specially for the pesticide surplus variable (Z) as identifier variable assumed to give negatif effect against environment, the analysis showed predicted values of 0.0473 had no significant effect to the production. Althought there is one interaction variable between pesticide and labor showed a significant effect, still its not enough to explain the pesticide surplus variable role. The same thing happened to Guo *and* Marchand study (2012) that insert the surplus N as an indicator variable that suspected to negatively affect the environment in organic rice farming in China, turns out the estimated value β obtained of 0.216 had no effect. Translog function analysis results in Table 3 is not only issued alleged β value, but also released the results of the analysis in the form of parameter γ. γ used to see the variation of output difference caused by the influence of inefficiencies effect or by the influence of noise (Ojo et al., 2009). Based on the analysis results obtained γ value of 0.99, which means that 99% of the model variation is caused by the influence of the technical inefficiency in the production process, while 1% can be attributed to the error.

5.2 Technical Efficiency Analysis (ET) and Environmental Efficiency (*EEnv*)

The results of technical efficiency and environmental efficiency analysis are presented in Table 4, the technical efficiency is calculated using the approach of equation (2), while the environmental efficiency is approached through equation (3).

Table 4. Technical Efficiency (TE) and Environment Efficiency (EEnv)

Efficiency Interval	Efficiency			
	TE	%	EEnv	%
0.00 - 0.10	1	0.83	0	0.00
0.11 - 0.20	4	3.31	0	0.00
0.21 - 0.30	12	9.92	5	4.13
0.31 - 0.40	11	9.09	53	43.80
0.41 - 0.50	15	12.40	11	9.09
0.51 - 0.60	19	15.70	2	1.65
0.61 - 0.70	13	10.74	0	0.00
0.71 - 0.80	14	11.57	15	12.40
0.81 - 0.90	15	12.40	21	17.36
0.91 - 1.00	17	14.05	14	11.57
	121		121	
Average	0.6107		0.5674	
Min	0.0834		0.2612	
Max	0.9998		0.9933	

Based on Table 4 the average values obtained for technical efficiency is 0.6107 while the average value of the environmental efficiency is 0.5674. The minimum value is 0.0834 for technical efficiency and environmental efficiency of 0.2612, while the maximum value is 0.9998 for the technical efficiency and 0.9933 for environmental efficiency. From the average value of technical efficiency and environmental efficiency derived of a *stochastic frontier translog* production function as shown in Table 4 above, in general the shallot farmers included in this study can be categorized have not been efficiently. Kurniawan (2008) states that a farm effort could be called efficient if the value of technical efficiency and environmental efficiency above 0.8.

From Table 4 can also be seen that the distribution of technical efficiency analysis results did not show a stands out pattern. There is only 26.45% of farmers which have reached technical efficiency level, most of the rest have not yet reached technical efficiency level. Different with the environment efficiency distribution pattern, while the percentage of farmer that had reach the environment efficiency level is much more than the farmer that had reach the technical efficiency level. From 121 sample, found that 29.93% of farmer that had reach the environment efficiency level, while the rest of 70.07% is not yet reach the environment efficiency level. Even for the environment efficiency distribution between 0.31 until 0.40 the percentage is high enough, its about 43.40%.

The high percentage of farmers which have not yet reached the level of environmental efficiency allegedly linked to several factors, including the extent of land farming and pesticide surplus use. It can be seen from some of correlation analysis the results, including: first, analysis of the correlation between shallots planting area with a pesticide surplus that is equal to 0.117 and the statistically test results significant at α> 20 percent. It can be inferred that the bigger the shallot farm size, the higher the pesticides surplus will be, and consequently the lower environmental efficiency level. Second, analysis of the correlation between land farming with environmental efficiency is at -0.228 and significant with p-value 0.12. Meaning that farmer with bigger land farming will have lower environmental efficiency level. On the other side, the farmer with small land farming have higher environmental efficiency level (Table 5). From the correlation analysis result could be concluded that the bigger land farming could not guaranteed the efficient use of pesticide. However when we see the technical aspect it shown a good result. Where from correlation value between land farming with production resulted 0.339 and the correlation between production and tecnical efficiency is 0.455, both correlation significant on α = 1 percent. So technically there is correlation on farmer that had biger land farming become technically efficient, but not on environmental efficient side.

Table 5. Value of Correlation Input, Production and Efficiency Variabel

Type of Correlation	Correlation value	*p-value*
Farm Land – pesticide surplus	0.117	0.202
Farm Land – Environmental Efficiency	-0.228	0.012
Pesticide surplus - Environmental Efficiency	0.023	0.805
Farm Land- production	0.339	0.000
Production – Technical Efficiency	0.455	0.000

The use of quite high pesticides by farmers included in this study reflected by the frequency of spraying which done during the shallot planting season as shown in Table 6. From the above table could be seen that the frequency used of pesticide is quite high minimum 6 times and maximum 18 times. In general, a fairly high percentage for the frequency of spraying is done 10 times, 11 times and 12 times. The control using pesticides is intended to overcome the major pests and diseases such as caterpillar shallots (*Spodotera exigua*), anthracnose (*Colletotricum sp*.) and dieback (*Phythopthora porii*).

The problem of surplus pesticides have been analyzed in terms of environmental efficiency and show results that farmers have not yet reached the level of environmental efficiency, so it will be difficult to achieve environmentally friendly shallot farming because of the potential negative effect of pesticides is still high both on humans and the environment. The results of research related to environmental efficiency by Kamande (2010) in Kenya related to energy surplus at the end of the study concluded that there were advantages in terms of efficiency in the company when environmental issues are incorporated in the business goals. Graham (2004) also reported the results of the efficiency research environment seen from the N surplus on dairy farms to reduce the use of N because it is considered excessive and potentially negative effect on the environment. Action on the Reduction use of N are by improving the management such as conduct the N requirements test, calculate the nutrient requirements and recommendations usage reduction incentive N.

Table 6. Pesticide Spraying Frequency on Shallot

Pesticide Spraying Frequency	Amount	Percentage
6 times	7	3.50
7 times	12	6.00
8 times	4	2.00
9 times	17	8.50
10 times	21	10.50
11 times	29	14.50
12 times	41	20.50
13 times	18	9.00
14 times	19	9.50
15 times	7	3.50
16 times	11	5.50
17 times	11	5.50
18 times	3	1.50
	200	

In this environmental efficiency case study of shallot farming and related pesticides surplus, action to improve the environmental efficiency is by reducing pesticide use and increase the role of biological control use. The move done very relevant, because the research results Dinakaran *et al.* (2013) in India showed that the use of biological control techniques through the approach of Integrated Pest Management (IPM) has alerted farmers so they understand that shallot production costs could be reduced by 2.60 % and increase 20.28 % production

Associated with the opportunity to reduce pesticide use and improve the control of the IPM method in shallot. The results of this study obtained from 200 sample farmers facts which have known IPM techniques, including the use of *Trichoderma viridae*, pheromones trape, yellow trap and so on (Table 7). The results of the study found that farmers essentially already know the benefits of various IPM techniques such as those presented in the table, but its implementation is still lacking, farmers commonly control pests and diseases using pesticides.

Table 7. The Level of Awareness of Farmers on IPM Methods

Awarenesss of IPM technique	Frequency	%
Trichoderma viridae	35	8.50
Pheromone trape	53	12.74
Yellow trap	58	14.08
Lamp trap	86	20.75
Plant rotation	61	14.68
Manual control	85	20.63
Utilization of host plants	21	5.10
Use of Bokasi organic fertilizer	9	2.18
Use of Biological EM 4	3	0.73
Do not know	3	0.61

5.3 Analysis of Technical inefficiency effect

Variables associated with the inefficiency effect are farmer group membership (I_1) , access to agricultural officer (I_2) and IPM training (I_3). The results of the analysis as shown in Table 3. Table 3 shows that of the three technical inefficiency effects variables, only variables (I_1) significantly effect at t-α with 5 % of the estimated value of δ -1.01. It can be interpreted that the farmers who are members of farmer groups have positive influence on the achievement of technical efficiency of shallot farming. The role of the group in realizing the technical efficiency becomes very important, because through this role the transfer of knowledge become better. Through farmer group a result of the researchers study disseminated to farmers, farmer groups become a success barometer of the performance distribution of the technological innovation from research institutes to farmers (Nuryanti & Swastika, 2011).

If the farmer group membership variable (I_1) had significant effect and give positive effect on the improvement of technical efficiency effects, on the other side it does not occur in the access to agricultural extension variable (I_2). Estimators δ value for the variable I_2 obtained by 0.4837, although not statistically significant, but the positive sign of the value of δ implies farmers with access to agricultural officer was even more technically inefficient. The trend is happening in this case indicates that the performance of agricultural officer is not as good as the performance farmer groups. Some of the current agriculture extension so that the performance of agricultural officer has decreased due to several reasons, including: 1) decentralization of agricultural extension management to local governments, so that the pattern of supervision and guidance counselor neglected which causes performance to decline sharply extension, 2) the changing role of officer as professionals workers in the field of agriculture to the field of public administration, and 3) implementation constraints extension in the field due to limited funding, infrastructure and extension materials (Riyaningtyas, 2010).

The inefficiency effects analysis also adds IPM training variables (I_3), namely the question against the respondents whether they had attended training in IPM or not for pests control and diseases on shallot plant. This variable is particularly relevant to the purpose of this study is to see the environmental efficiency with a focus on the effects of pesticides on production surplus. By entering variables IPM training, is expected to see its effect on the technical efficiency of farming shallots, and can provide information on the sustainability of the environment. The analysis showed that the predicted values for the variable parameters δ I3 is -0.04. The negative sign indicates which farmers have been trained in IPM have a positive impact in improving technical efficiency. Although when viewed from the α percent t-test showed no significant effect on shallot production, but there is hope in the future that the application of IPM can improve technical efficiency and ultimately will improve environmental efficiency. It should be encouraged to re-use in the IPM treatment plants from pest attack.

6 Conclusions and Recommendations

Based on the above results, the following conclusions are formulated:

a. The use of stochastic translog frontier regression identified several production inputs variables which affect on shallot production, there are seeds variable, the use of organic fertilizer and labor, either individually or in quadratic forms and their interactions. Specificaly for pesticides surplus variable only the interaction variables that affect the shallot production.
b. The Environmental Efficiency as the primary goal that would like to be seen on this study resulted the average EEnv 0.5674. Based on these values, it can be said that EEnv shallot farming in this study have not yet reached the level of environmental efficiency, one reason is the high surplus of pesticides.
c. Besides the EEnv which has not been achieved, the technical efficiency of the farm shallot also has not achieved because TE values obtained by an average of 0.6107.
d. Analysis of the technical inefficiency effects showed that only the access to the group of farmers have significant effect, where farmers with better access to farmer group are technically more efficient. But not for variable access to agricultural officer and IPM training, although there is a positive tendency to technical efficiency for IPM training.
e. Especially for access to agricultural officer that have different tendencies, because farmers with access to the officer have a tendency to be more inefficient on technical side.

Based on the conclusion, and in order to establish sustainable farming of shallot in the future, it is necessary to improve technical efficiency by increasing the use of quality seeds and other inputs such as increased use of organic fertilizer and increase the use of a professional workforce. In addition, there is a need to improve environmental efficiency by reducing the use of pesticides and improve the methods of integrated pest management (IPM) through increased training to farmers in the farmer groups, as well as enhance the strategic role of agricultural extension.

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