International Business Management 11 (8-10): 1611-1619, 2017
ISSN: 1993-5250

Impact of Socio-Economics Condition of Farmer on Productivity Level of Soybean Farming in Indonesia

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Abstract: The study was aimed to analyze the level of productivity, technical efficiency, allocative efficiency and economic efficiency as well to identify factors affecting the productivity level of soybean farming in Indonesia. Random sampling by multi-stage method was performed to obtain cross-sectional data. Function model of stochastic production frontier and stochastic cost frontier through the MLE estimation method was adopted to analyze the research objectives. The results showed that there was over-use of fertilizer input thus the addition of fertilizer will only decrease the production and productivity of soybean farming. Moreover, an increase in production can be done through the increase in labor use, land price, labor price and production quantity which were significantly increased the production cost. Soybean farmers in research location have reached the level of actual productivity up to 90% of maximum productivity. However, socio-economic conditions of soybean farmers did not significantly affect the productivity achievement. This finding has an implicati on that increase in soybean production was no longer be achieved through the increase in land area and productivity but by improving the seed technology, since the comparison showed that soybean productivity per land area in research location was lower than that in Indonesia.

Key words: Soybean, productivity, stochastic frontier, efficiency, multi-stage, allocative

INTRODUCTION

Economic growth in Indonesia encourages people to consume more protein food. Changes in consumption patterns have led to an increased need for animal and plant protein foods. One of plant protein foods is soybean which is processed in the form of tempeh, tofu, tauco and soy sauce but largely consumed in the form of tofu and tempeh (Zakaria *et al*., 2016). Due to the increasing number of food and feed industry which requires soybean as raw material, soybean consumption in 2012 amounted to 241.8 million tons and it is estimated that the consumption in Indonesia will reach 2.6 million tons in 2020 and 3.35 million tons in 2025 (Harsono, 2008). A disparity between demand and supply of animal protein foods in Indonesia results in a high price of animal protein foods, thus tofu and tempeh as processed food made from soybean become a substitution for animal protein foods. Soybean supply in Indonesia is not simply an effort to meet the increasing demand of soybean due to the increasing economic growth. Yet, it is also an effort to provide quality food for the poor to improve their health as human capital on economic growth. Based on data from FAOSTAT, the gap between domestic demand and production of soybean in Indonesia started in 1976. However, despite the domestic soybean production which increased by 63% with an average annual of 2.5% in the period of 1976-2012, the increasing need in this period reached 294% with an average annual increase of 4.5%. Lower increase in soybean production in Indonesia was caused by fluctuation of soybean harvested area from 1990-2012 of which there was a decrease of 57% with an average annual reduction of 0.66%. This decline was due to competition between soybean farming and other commodity farming conducted in the surrounding area such as cassava, maize or upland rice which already have market share (Harsono, 2008). In addition, the decline of soybean harvested area was caused by decreased preference of farmers in planting soybean, since soybean farming did not provide greater benefit than that of other farming. Moreover, increase in harvested area was only caused by intensive policy program (Zakaria *et al*., 2016). Therefore, one effort to increase national soybean production is by improving the productivity of soybean

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farming, since its productivity growth declined by -0.11% in average from 1990-2012. For this reason, measurement and improvement of productivity are very important in soybean farming.

Problems concerning productivity in farming is closely related to managerial skills of farmers and the environment. In performing their farming activity, farmers will be faced with resource allocation problem in the form of input selection which should be in accordance with the farming technique to provide maximum output. Moreover, each farmer will face different natural conditions which will result in differences in productivity level between areas within the same farming. However, increase in productivity is not only related to technical problems in producing output but also related to the issue of socio-economic conditions that affect the ability of farmers in conducting farming. This socio-economic condition is expected to affect decisions made by farmers in allocating resources to farming and to non-farming business. Hence, socio-economic factors also influence the productivity achievement of soybean farmers indirectly.

Disparity problem between demand and supply of soybean and processed foods in Indonesia also occurs in almost all regions in Indonesia. Processed food made of soybean is produced only to meet the demand of certain area, thus, the demand for soybean highly depends on the availability of soybean within the area. Based on BPS (2015), data soybean production in Indonesia is mostly produced in Java. Considering the fact that Indonesia is an archipelago where transportation for marketing purpose is costly, implication concerning the tempeh industry in regions outside Java rises: fulfilment of soybean needs should depend on its availability in each region because it would lead to a higher price if soybean is provided from other regions. An effort to produce food commodities in each area is essential because it encourages the achievement of food security in each area. Furthermore, the condition becomes an opportunity to conduct soybean farming business in the area. To achieve this goal, it is necessary to boost the productivity level of soybean farming in all regions in Indonesia. Increased productivity will result in an additional yield of soybean production and farmer’s income without adding the number of unit of any inputs. An increase in farmer’s income will lead farmer in putting the resource allocation towards soybean farming which further could increase the national soybean production.

In increasing soybean productivity, it is necessary to examine factors affecting the socio-economic conditions in order to achieve the productivity level. Increased productivity becomes greatly important, since soybean farmland is competing with maize farmland within the area. Thus, the best effort to increase the production can be done through an increase in farming productivity. Based on those reasons, this study tried to analyze the productivity level of soybean farming. Therefore, in particular, this study was aimed to analyze factors affecting the production and cost of soybean farming estimate the existing productivity level which has been achieved by soybean farmers today and analyze the impact of socio-economic conditions of soybean farmers on the achievement of productivity level.

MATERIALS AND METHODS

Methods of analysis: Study of soybean farming in Indonesia has been widely addressed by researchers (Harsono, 2008; Aldillah, 2014) with a certain perspective in examining factors affecting the productivity of soybean farming in Indonesia. Productivity level achievement determines the level of income. Failure of farmers in achieving the highest level of productivity is a loss of a certain amount of income which should be earned by farmers when they achieve the highest level of productivity. The remaining income received by farmers who cannot achieve the highest productivity will affect farmer’s decision in the selection concerning which farming to be conducted: soybean or other food crops, since farmers will choose to allocate resources to more profitable farming activity. Therefore, it is necessary to analyze the level of productivity and the factors affecting the productivity in soybean farming.

Measurement of productivity level which refers to the measure of efficiency consists of technical efficiency, allocative efficiency and economic efficiency. A method shows that Economic Efficiency (EE) is also termed as overall efficiency which means that producer has reached Technical Efficiency (TE) and Allocative Efficiency (AE). Technical Efficiency (TE) shows the ability of the producer to produce at the boundary (frontier) or isoquant while EA reflects the ability of the producer to produce a certain level of output through minimum input price ratio. Therefore, EE is defined as the ability of the producer to produce at output boundary or isoquant with minimum cost at a certain level of technology.

Another advantage of measuring the level of efficiency using probabilistic method is that it is able to observe the variation of efficiency level between farmers which indicates that there are certain factors affecting the level of efficiency between farmers. Until now, various studies always refer to the socio-economic conditions (Rahman and Umar, 2009; Kyei *et al*., 2011; Zhu *et al*., 2012; Bahari *et al*., 2012; Tahir *et al*., 2016). Socio-economic factors such as age, education level, farming experience, household size and others have always been the major factors affecting the level of efficiency, since socio-economic factors most likely to affect the managerial skill of farmers and decision taken by farmers in running their farming business.

Regarding the selection to use probabilistic methods to estimate the productivity frontier, model of stochastic production or cost frontier is applied to generate the value of technical efficiency, allocative efficiency and economic efficiency. Etwire *et al*. (2013) suggested that the model of stochastic production frontier is as follows:

$$Q_i = x_i`\beta+v_i-u_i \quad (1)$$

The model shows that there is a change in random disturbance which classified into u_i, that is a non-negative random disturbanceas it is always below the line of boundary/frontier estimation which is the technical inefficiency and v_i which is white noise random disturbance, Q_i output, x_i input vector and β parameter estimation. Model 1 is known as as stochastic production frontier because the output quantity is limited by the stochastic variable, that is $(x_i`\beta+v_i)$ exponent so that, estimation of boundary/frontier is obtained from the $(x_i`\beta)$ exponent. Efficiency level is the value of the ratio between the amount of actual value of output (output value which includes non-negative random disturbances as an effect of inefficiency and white noise random disturbances) or also called actual productivity and the amount of output value without non-negative random disturbances as an effect of inefficiency or also termed as maximum productivity. To assume that the model is based on Cobb-Douglass function, relationship between input and output will be non-linear and the form is depicted below if it is transformed into a linear form:

$$\ln Q_i = \beta_0+\beta_i X_i+v_i-u_i \quad (2)$$

$$Q_i = \text{exponent}(\beta_0+\beta_i \ln X_i)\times\text{exponent}(v_i)\times\text{exponent}(-u_i) \quad (3)$$

While the equation for estimation of efficiency level is formulated as follows:

$$TE_i = \frac{Q}{\text{exponent}(\beta_0+\beta_i \ln x_i+v_i)} = \frac{\text{Exponent}}{\text{Exponent}} \quad (4)$$

Duality in production function will cause the cost function is able to be derived from the production function which implicates in the determination of economic efficiency through differential calculus on the parameter estimation of production function (Mohapatra, 2013; Douglas, 2014; Ngombe and Kalinda, 2015) or through parameter estimation using stochastic cost frontier model (Coelli *et al*., 1998; Bahari *et al*., 2012; Bahari, 2014, 2012) as follows:

$$\ln C_i = \beta_0+\beta_1 \ln w_i+\beta_2 \ln Q_i+v_i+u_i \quad (5)$$

$$C_i = \text{exponent}(\beta_0+\beta_1 \ln w_i+\beta_2 \ln Q_i)\times \text{exponent}(v_i)\times\text{exponent}(u_i) \quad (6)$$

Where:

C_i = The production cost i
w_i = The price of production input i
Q_i = The production quantity i

Moreover, the non-negative random disturbance which is an effect of inefficiency effects is modeled to have positive value in Stochastic Cost Frontier Model, since the objective functions in production function model and cost function are different. The production function has objective function to always maximize output while the cost function is always aiming to achieve the lowest possible cost. The formula of the estimation of economic efficiency level derived from the cost function is as follows:

$$EE_i = \frac{Q}{\text{exponent}(\beta_0+\beta_1 \ln P_i+\beta_2 \ln Q_i+v_i)}$$
$$EE_i = \frac{\text{exponent}(\beta_0+\beta_1 \ln P_i+\beta_2 \ln Q_i+v_i+u_i)}{\text{exponent}(\beta_0+\beta_1 \ln P_i+\beta_2 \ln Q_i+v_i)} = \text{exponent}(u_i) \quad (7)$$

Results obtained from the Eq. 7 will result in economic efficiency value which is higher than 100% until infinite. Therefore, the equation below is required to be applied to obtain percentage between 0-100:

$$EE_i = \frac{1}{\text{exponent}(u_i)} = \text{exponent}(-u_i) \quad (8)$$

Difference element of random disturbances between u_i and v_i illustrates difference in production between farmers which is simply affected by different input use or also due to the inability of farmers in achieving maximum level of efficiency. The inability of farmer to reach technical efficiency can be observed from the significance of u_i value on production (for technical efficiency) or on cost (for economic efficiency). Furthermore, distribution of u_i and v_i is determined from the respective variance as follows:

$$\sigma^2 = \sigma_u^2+\sigma_v^2 \quad (9)$$

$$\gamma = \frac{\sigma_u^2}{\sigma^2} \qquad (10)$$

Where:

σ^2 = The total variance of random disturbances
σ_u^2 = The variance of u_i
σ_v^2 = The variance of v_i
γ = The percentage of variation of u_i on the total variation of random disturbances

In the estimation process using Maximum Likelihood Estimator (MLE), the significance of β_i, σ^2 and γ parameter will be measurable. The value of γ shows large inefficiency variationon the total variation of random disturbances in determining the output. In using distribution on those parameters, certain assumptions should be used. According to Backman *et al*. (2011), there are choices of u_i distribution assumption to be selected, those are half-normal distribution, exponential distribution, truncated normal distribution and gamma distribution. Furthermore, the half-normal distribution assumption is a moderate assumption which is not excessive or too small in performing estimation. Therefore, this study applied the half-normal distribution assumption in estimating the value of efficiency and parameters used.

MATERIALS AND METHODS

Study underlying this research was conducted in the area of Konawe Selatan Regency which is one of the biggest soybean producing areas. Survey methods were constructed by analysis which used quantitative approach within the scope of production economy. This study used cross-sectional data from two villages in Konawe Regency, Southeast Sulawesi, Indonesia. The village were Amesiu Village and Belatu Village which are the major soybean farming area in Konawe Regency. The population of soybean farmers in both villages was 91 people. It is assumed that the population was homogeneous and as increase in precision at value of 15% upto 1% did not change the population variance, precision set was 15%. Based on the sampling technique, sample size of 34 people was used.

The determination of the level of technical efficiency, allocative efficiency and economic efficiency was done using stochastic production frontier function which was built to be estimated in this study, that is as follows:

$$\ln Y_i = \beta_o + \beta_1 \ln(X_{1i}) + \beta_2 \ln(X_{2i}) + \beta_3 \ln(X_{3i}) + \beta_4 \ln(X_{4i}) + v_i - u_i \qquad (11)$$

Where:

Y_i = Quantity of soybean production in one season (kg)
X_{1i} = Land area used to plant soybean in one season (ha/farmer/season)
X_{2i} = Quantity of fertilizer used in one season (kg/farmer/season)
X_{3i} = Quantity of pesticide used in one season (liter/farmer/season)
X_{4i} = Number of labor used in one season (man-day/farmer/season)
β_o = Constant
β_i = Parameter estimation of not-fixed input variable
v_i = White noise random disturbancethat iserror caused by natural factor or other uncontrolled factors
u_i = Non-negative random disturbancethat is parameter estimation of technical inefficiency of each unit of observation

Moreover, equation of stochastic cost frontier function which was built to be estimated in this study is as follows:

$$\ln Ci = \beta_o + \beta_1 \ln(P_{1i}) + \beta_2 \ln(P_{2i}) + \beta_3 \ln(P_{3i}) + \beta_4 \ln(P_{4i}) + \beta_5 \ln(Y_{5i}) + v_i - u_i \qquad (12)$$

Where:

C_i = Production cost of soybean farming in one season (IDR)
P_{1i} = Price of land area used to plant soybean in one season (IDR/ha/season)
P_{2i} = Price of fertilizer used in one season (IDR/kg/season)
P_{3i} = Price of pesticide used in one season (Rp/liter/season)
P_{4i} = Price of labor used in one season (Rp/man-day/season)
Y_i = Production quantity of soybean in one season (kg)
β_o = Constant
β_i = Parameter estimation of not-fixed input variable
v_i = White noise random disturbance that iserror caused by natural factor or other uncontrolled factors
u_i = Non-negative random disturbance that is parameter estimation of technical inefficiency of each unit of observation

Estimation of the parameter in stochastic production frontier function and stochastic cost frontier function will produce technical efficiency index and economic efficiency index. To determine the allocative efficiency, technical efficiency index and economic efficiency index, equation which is able to be used is written (Coelli *et al*., 1998; Bifarin *et al*., 2010).

$$EE_i = TE_i \times AE_i \tag{13}$$

After technical efficiency index and economic efficiency index are obtained, allocative efficiency can be determined as follows:

$$AE_i = \frac{EE_i}{TE_i} \tag{14}$$

The variance of those efficiency indicesis allegedly influenced by socio-economic factors. Influence of these factors indicates that soybean farming productivity can be improved without increasing the use of inputs. Considering that this study applied the assumption of half-normal distribution, two stages were required in estimating factors that affect the technical efficiency index and economic efficiency index (Kebede, 2001; Asogwa *et al*., 2011; Bahari *et al*., 2012; Etwire *et al*., 2013; Bahari, 2014; 2012), i.e., after the technical efficiency index and economic efficiency index were obtained by estimating the parameters on function used estimation of socio-economic factors on the index of technical efficiency, allocative efficiency and economic efficiency was performed. The economic model which was built to estimate the factors affecting efficiency is known as the equation of determinant function of efficiency. Moreover, socio-economic factors included in the determinant function of efficiency in this study are depicted as:

$$\text{Efficiency index}_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \varepsilon_i \tag{15}$$

$$\text{Index of efficiency}_i = TE_i,\ AE_i \text{ and } EE_i$$

Where:

Z_{1i} = Age of soybean farmer (years old)
Z_{2i} = Level of education of farmer (years)
Z_{3i} = Soybean farming experience (years)
Z_{4i} = Household size of farmer (person)
δ_0 = Constant
δ_i = Parameter of estimated not-fixed input variable
ε_i = White noise random disturbances

To test whether a regression model which was estimated using maximum likelihood estimation method meets the requirementset concerning the estimated regression model parameter, Likelihood Ratio test (LR test) was performed. LR test was calculated using the following Eq. 16:

$$LR = -2\,(L_0 - L_1) \sim \chi^2_m \tag{16}$$

Where:

L_0 = Value of log likelihood function in regression model without restriction
L_1 = Value of likelihood function in regression model with restriction
m = Number of restriction

In test, we compare the χ^2-value obtained from the equation with the critical χ^2-value at a certain confidence level. If the χ^2_m value is greater than the χ^2 value obtained from the critical value table, then the value of whole parameter is equal to zero (H_0: $\beta_1 = \beta_2 = \ldots\ \beta_i = 0$) and can be rejected (Bahari *et al*., 2012). Result of LR test on the model showed that H_1 is accepted if the LR test $>\chi^2$ at certain confidence level which means that the independent variables simultaneously have significant effect on the dependent variable. H_0 is accepted if LR test $<\chi^2$ at certain confidence level which means that independent variables simultaneously have no significant effect on the dependent variable (Zajc, 2006; Gallego *et al*., 2012).

$$H_0 : \beta_1 = \beta_2 = \ldots \beta_i = 0 \quad H_1 : \beta_1 \neq \beta_2 \neq \ldots \beta_i \neq 0$$

Furthermore, for partial test for each variable in stochastic frontier production function, stochastic cost frontier function and determinant function of efficiency, t-student test was performed with equation follows:

$$t = \frac{\hat{b}_i - b_i^*}{\sqrt{\hat{\sigma}^2_{\hat{b}_i}}} \tag{17}$$

Where:

$\hat{b}_i$ = Parameter estimation obtained after estimating process using methods of Ordinary Least Square Estimator (OLSE) and Maximum Likelihood Estimator (MLE)
b_i^* = Value of parameter estimationwhich is obtained from estimation of parameter performed through hypothesis using certain estimation method, the hypothesis in this study is $b_i^* = 0$
$\hat{\sigma}^2_{\hat{b}i}$ = Variance of $\hat{b}_i$

Econometrically, partial significance test in this study can be written in equation:

$$H_0 : b_i = b_i^* \quad H_1 = b_i \neq b_i^* \quad i = 1,2,3,4...$$

RESULTS AND DISCUSSION

Tabulation of research result and discussion in this study will be discussed in three parts. First, discussion of estimation result of stochastic production frontier function and stochastic cost frontier function. Second, discussion of the level of achievement of technical efficiency, allocative efficiency and economic efficiency. Third, discussion concerning the impact of socio-economic conditions on technical efficiency, allocative efficiency and economic efficiency.

The result of parameter estimation on stochastic production frontier function modeled as in Eq. 12 is presented in Table 1. The estimation results indicate that fertilizer inputwas over-use as seen from the negative elasticity of which the marginality was also negative thus the addition of fertilizer input would only lower the production. Moreover, labor input still showed positive elasticity so that, the allocation of resources should be directed to increase the labor input in order to increase production. The LR test resulted in value of 9.467 which was greater than the critical χ^2 value for the standard error of 1% which was equal to 5.412. Thus, it shows that these inputs collectively significantly determined the output quantity of soybean production which also shows that the economic model built in Eq. 12 has been very good in explaining soybean farming in the study area. Furthermore, estimation of the economic model of stochastic frontier production function shows that the γ value was statistically significant and γ was 100% which means that the difference between the output quantity of soybean between farmers was caused by the difference in the achievement of technical efficiency between farmers. This result then implicated on the improvement of technical efficiency achievement which will increase the productivity and further will increase the soybean production without increasing inputs.

The result of parameter estimation in stochastic cost frontier function modeled in Eq. 13 is presented in Table 2. Estimation result using the MLE method shows that increases in land price, pesticide price and production quantity can significantly increase the production cost. The condition shows that the allocation of the amount of land and labor input used determined the ratio of the combination of input prices which resulted in the minimal cost. Production quantity will determine the production cost used because the increased use of inputs that have positive marginality on output will lead to increase in production cost and the amount of production as well. However, it would be different if the increased use of inputs has negative marginality of which will lead to higher production cost but lower output

Table 1: Result of parameter estimation in stochastic production frontier function of soybean farming, 2016

	OLSE		MLE	
Variables	Coefficient	t-ratio	Coefficient	t-ratio
Constant	-0.4761	-2.2559	-0.3010	-2.6137
Land	0.0157tn	0.4927	0.0328tn	1.7785
Fertilizer	-0.1462***	-15.2494	-0.1233***	-10.9840
Pesticide	0.0005tn	0.0887	-0.0075tn	-1.3201
Labor	1.1435***	35.0929	1.1092***	51.2107
σ^2			0.0023tn	4.8688
γ			1.0000***	166.1283
LR test			9.4666***	

Table 2: Result of parameter estimation in stochastic cost frontier function of soybean farming, 2016

	OLS		MLE	
Variables	Coefficient	t-ratio	Coefficient	t-ratio
Constant	2.5183	0.00000044	2.3013	2.3071
Price of land	0.8720tn	1.5578	0.8707***	19.4044
Price of fertilizer	0.0975tn	0.0000	0.1888tn	1.6471
Price of pesticide	-0.0665tn	-0.0876	-0.0632tn	-0.9739
Price of labor	0.1922tn	0.5140	0.1885***	5.6648
Total production	0.3076tn	0.2375	0.3144***	2.7998
σ^2			0.0235tn	1.1733
γ			0.5616tn	0.7180
LR test			156.9678***	

Processed data (2016) based on FRONTIER 4.1. ***Significantly different at the 99% confidence level; tn = not significantly different

quantity. Based on that reason, the production cost is found to be highly dependent on the interaction of two things: the selection of increased use of inputs which have positive marginality to encourage increased production and the selection of input that is based on the price of these inputs to obtain minimal cost ratio. If farmers can achieve those two interacted things, then farmers will achieve both technical efficiency and allocative efficiency. The result of parameter estimation indicates that farmers in this study have not managed to achieve both, yet farming was still inefficient. However, the result of parameter estimation has not shown the amount of technical inefficiency, allocative inefficiency and economic inefficiency from farmers thus setting the achievement levels of efficiency in soybean farming is required.

Based on Table 3, it is known that around 97% of total soybean farmers observed have already achieved the level of technical efficiency above 0.90 (90%). Furthermore, soybean farmers who have reachedthe levelof allocative efficiency above 0.90 (90%) were about 88%of total soybean farmers observed. However, there was only 74% of farmers who were able to achieve the level of economic efficiency above 0.90 (90%). The average value of technical efficiency level which reached 0.96469 (96.5 %) indicated that the average productivity of soybean farmers in research area has reached 96.5% of boundary/frontier, that was maximum productivity which can be achieved using the best farming techniques. Likewise, the level of allocative efficiency only left gap

Table 3: Tabulation result of distributionof technical efficiency, allocative efficiency and economic efficiency level of soybean farming, 2016

	Efficiency level		
Strata of efficiency level	TE	EE	AE
0.825-0.849	0	4	0
0.850-0.874	1	1	0
0.875-0.899	0	4	4
0.900-0.924	7	11	4
0.925-0.949	0	11	8
0.950-0.974	13	2	12
0.975-1.00	13	1	6
Total No. of farmer	34	34	34
Average	0.96469	0.91162	0.94521
Min.	0.86721	0.82885	0.87593
Max.	0.99994	0.96359	1.00000

between actual productivity and maximum productivity by 5.48%. Meanwhile, the level of economic efficiency achieved by soybean farmers also created a gap between the actual productivity and maximum productivity by 8.84%.

Based on the achievement level of technical efficiency, allocative efficiency and the economic efficiency, it can be concluded that the achievement was considerably high, thus the gap between the actual and maximum productivity was also very small. Increase in technical efficiency to achieve maximum productivity will only increase the soybean production by 34 kg whereas the increase in economic efficiency to achieve maximum productivity will only lower the cost of soybean production by IDR 224/kg. Achievement of technical efficiency of soybean farming in Brantas watershed was lower than the achievement of technical efficiency of soybean farming in Konawe which was already very high. The average technical efficiency of soybean farming in Brantas watershed reached 83% (Siregar and Sumaryanto, 2016) while the average technical efficiency of soybean farming in research area reached 96%. Moreover, the achievement of technical efficiency in Nganjuk that was 72% (Ningsih *et al*., 2015) was also much lower than the achievement of technical efficiency in the research area. Yet, no comparison result was found concerning the level of allocative efficiency and economic efficiency of soybean farming.

The result of parameter estimation of the determinant function of technical efficiency, allocative efficiency and economic efficiency indicates that socio-economic conditions both in cumulative and partially showed no significant effect on the various levels of efficiency is presented in Table 4-6. Variables of socio-economic conditions used in the model of determinants of efficiency were not the major variables affecting the level of efficiency in soybean farming in research area as seen from the low R^2 value. This finding was not in line with the result of research conducted by Zakaria *et al*. (2016)

Table 4: Result of estimation of determinant of technical efficiency level of soybean farming, 2016

Variables	Coefficient	SE	t-ratio
Constant	0.993863	0.039378	25.238920
Age	-0.000435^{tn}	0.000713	-0.006104
Education	-0.000893^{tn}	0.001729	-0.005164
Farming experience	0.000081^{tn}	0.000870	0.000934
Household size	-0.001690^{tn}	0.004672	-0.003618
R^2 = 0.022			
F_{hit} = 0.956438			

Table 5: Result of estimation of determinant of allocative efficiency level of soybean farming, 2016

Variables	Coefficient	SE	t-ratio
(Constant)	0.947325	0.040487	23.398100
Age	0.000568^{tn}	0.000733	0.007753
Education	0.001454^{tn}	0.001777	0.008182
Farming experience	-0.00136^{tn}	0.000895	-0.015150
Household size	-0.00372^{tn}	0.004804	-0.007740
R^2 = 0.156			
F_{hit} = 1.334			

Table 6: Result of estimation of determinant ofeconomic efficiency level of soybean farming, 2016

Variables	Coefficient	SE	t-ratio
Constant	0.941828	0.047094	19.998800
Age	0.000125^{tn}	0.000853	0.001465
Education	0.000502^{tn}	0.002067	0.002427
Farming experience	-0.00121^{tn}	0.001041	-0.011620
Household size	-0.005190^{tn}	0.005588	-0.009290
R^2 = 0.111			
F_{hit} = 0.905			

Data (2016) were processed using SPSS 16.0; tn not significantly different

which showed that technical aspect and socio-economic aspect were the important aspects in the development of soybean because the development of these aspects put farmers as key players in the development of soybean production.

Age is expected to be a factor affecting the level of efficiency due to different effect between young and old farmers in term of physical ability, working skill and thinking ability. Later, age also affects the ability of farmers to accept, understand and apply the technology particularly regarding the farming production (Bahari *et al*., 2012). However, such difference will also occur in the different stratum of age, that is between productive time and non-productive time. The age difference of soybean farmers in research area was between 28-63 years which was still included in productive age. Thus, physical ability, working skill and thinking ability between farmers were not too different. Those conditions caused the age variable did not significantly affect various levels of efficiency.

Kebede (2001) said that the level of education was considered as a proxy of managerial skill of farmers thus farmers with a higher level of education will result in better managerial skill. Later, better managerial skill will improve efficiency, since it will help in boosting the technical ability to transform and implement the farming technique to achieve maximum productivity. Moreover, result found in research area showed large variations in the level of education, from never attending school to graduating from high school, yet those variations of education level did not affect the level of efficiency. This finding was due to the reason that knowledge of soybean farming received by farmers was obtained from friends or family which were also farmers who already have soybean farming experience. Adoption of technical and managerial of soybean farming will be easier and more successful if it is done by family and friends who play a role as a source of knowledge. As a result, technical and managerial skills of soybean farming will have not much different between farmers. These conditions will result in farmers to be able to transform and implement the technical and managerial of farming that will lead to maximum productivity achievement, both for farmers who never went to school or farmers who have graduated high school.

The longer a person performing farming, the better the improvement effort of business management (best practiced) carried out that aims to create essential improvement in each farming period as one effort to achieve maximum income. In addition, better experience in farming will result in better farming skill thus will help in farming adaptation concerning the extreme environmental conditions (Bahari *et al*., 2012). However, this situation did not occur in soybean farming in the research area where the variation of soybean farming experience ranged from 1-30 years. This was because of difference in soybean farming skill which means that there was not much difference in farming experience between farmers, since the source of knowledge obtained by soybean farmers which were derived from farmer friends or family caused farmers with less farming experience were able to gain knowledge from farmers with more farming experience. This implicated in similar skill in performing soybean farming both in technique and managerial which impact on well equal soybean farming efficiency achievement.

Household size will have implicationon total working hours provided by household to do the farming. Large household size can improve the allocation of labor on farming which will increase the production. Finding in this study indicates that household size did not significantly affect the different levels of efficiency, since the household member mostly involved in farming was only the head of household, thus household size did not change the allocation of labor which later also did not affect the efficiency.

CONCLUSION

Factors affecting the production of soybean farming was determined by estimating the parameter in stochastic production frontier function by using the method of maximum likelihood estimator. The estimation result indicates that there was over-use of fertilizer input thus the addition of fertilizer will only decrease the production and productivity of soybean farming. Moreover, increased production can be done through the increased use of labor, since the significant increase in labor use was able to increase production. Factors affecting the cost of soybean farming which were determined by estimating the parameters in stochastic cost frontier function showed that increases in land price, the price of labor and production quantity significantly will increase the cost of production.

The productivity of soybean farmers in research area can be seen through the achievement of the level of technical efficiency, allocative efficiency and economic efficiency which was currently very high, since the average gap between the level of actual productivity and maximum productivity was <10%. Achievement of soybean farming productivity in research area was the highest achievement of productivity achievement if compared to productivity achievements of farming in some other areas which were measured using the same method. Later, socio-economic factors namely farmer's age, farmer's level of education, farming experience and household size did not result in the significant effect.

IMPLICATION

These findings implicated on the selection of resource allocation by the government in order to increase the soybean production. Based on the results of parameter estimation and level of efficiency obtained, the significant increase in soybean production was no longer be done by increasing the land area and productivity but through the improvement of seed technology. This was due to the fact that the average soybean farming productivity per land area in research area was lower than the average soybean farming productivity per land area in Indonesia despite soybean farming in research area has been carried out efficiently. The productivity of soybean farming in research area was 0.97 tons per ha while it was 1.5 tons per ha in Indonesia.

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