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Determinant Factors of Technical Inefficiency of Soybean Farming in Pangandaran Regency

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Abstract

This study was conducted using the stochastic frontier production function which incorporates technical efficiency effect model. The research data was obtained from 40 soybean farmers by using structured questionnaire. The parameter values are estimated simultaneously using the technical efficiency effect model. The result showed that seed, labor, chemical fertilizer and organic fertilizer have significant effect to soybean production, while land and insecticide have no significant effect. The inefficiency model shows that age, experience and family size have significant effect to the level of technical inefficiency, whereas education has no significant effect.

Keywords: farming, soybean, technical efficiency, technical inefficiency

1. Introduction

Some of the agricultural productions could not meet growing demand for importing agricultural products. Therefore, for strategic agricultural commodities, the government tried to invoke self-sufficiency with the intention of meeting the consumption demand and increase of farmers' income at the same time (Asmara, et al, 2016). The only option to remedy agricultural production is through adoption of improved technology and efficient of available resources (Makesar and Kakde, 2016). The ability to produce food agriculture products is determined by a variety of factors, including biophysical, social, economic, and political (Kilmanun, 2016).

Soybeans is the third major food commodity after rice and corn considering its role as a source of vegetable protein for the community, industrial raw materials and raw materials of livestock (Karim, et al, 2014; Farikin, et al, 2016). Along with population growth rate, the need for soybean commodity keep increasing from year to year both as main foodstuff, animal feed and as raw material of food industry (Kuntariningsih and Mariyono, 2013) .This condition causes soybean become one of food crops fall into the category of strategic commodities (Muslim and Darwis, 2012).

However, so far Indonesia still relies on imported soybeans, especially when it is lack of shortages. It is partly also because the production of soybeans in soybean-producing areas is very fluctuating while soybean demand in the market tends to increase (Setiawan and Bowo, 2017). The inability of local soybean to meet domestic soybean needs causes domestic supply of soybean dependent on soybean imports. The greater dependence on imports of course is detrimental to soybean processing industry especially if world food prices become very expensive due to declining stock. This happens because the price applicable to imported soybean follows the prevailing price of international soybean prices (Rante, 2013).

The fulfillment of needs through import is indeed in the short term able to stimulate import quota of soybean to meet the needs of soybean needs in the country, but of course this is not good in terms of national food security (Widiatmaka, et al, 2013). Increased domestic production will reduce dependence on imports so that the effects of world soybean market turmoil can be minimized. On the other hand, reducing imports will save foreign exchange and improve trade transaction deficit (Nainggolan and Rachmat, 2014).

The low domestic production capability in soy supply when compared to demand requires efforts to correct the gap. These efforts can be pursued by intensification in production centers, extensification, and diversification based on resource potential (Tahir, et al, 2010). Another problem faced in increasing soybean productivity today is the lack of productive capacity of productive land (Efendi, 2010).

2. Theoretical Framework

Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977) in Coelli, et al (2005) independently proposed the stochastic frontier production function model of the form::

$$ln q_i = x_i'\beta + v_i - u_i \quad (1)$$

The model of equation (1) is called the stochastic frontier production function because the output value are bounded from above by the stochastic (i.e. random) variable exp(x'iβ + vi). The random error v_i can be positive or negative and so the stochastic frontier outputs vary about the deterministic part of the model, exp($x'_i\beta$).

Much of stochastic frontier analysis is directed towards the prediction of the inefficiency effects. The most common output-oriented measure of technical efficiency is the ratio of observed output to the corresponding stochastic frontier output:

$$TE_i = \frac{q_i}{\exp(x_i'\beta + v_i)} = \frac{\exp(x_i'\beta + v_i - u_i)}{\exp(x_i'\beta + v_i)} = \exp(-u_i) \quad (2)$$

This measure of technical efficiency takes a value between zero and one. It measures the output of the *i-th* firm relative to the output that could be produced by a fully-efficient firm using the same input vector. Clearly the first step in predicting the technical efficiency, TE_i, is to estimate the parameters of the stochastic production frontier model (1).

The model proposed by Battese and Coelli (1995) in Coelli, et al (1998) concerns the specific influence of technical inefficiency on the stochastic frontier model assumed to be free (but not identical) from non-negative random variables. For the i-th activity of the period t, the effect of technical inefficiency, u_{it}, is determined by the distribution of N(u_{it}, σ^2), where:

$$\mu_{it} = z_{it}\delta \quad (3)$$

Where z_{it} is a vector (1xM) of the observed explanatory variable, which has a constant value, and δ is a vector (Mx1) of unknown scalar parameters to be estimated.

Several studies have shown that factors affecting production are: farm size, planting materials, family labor, hired labor, fertilizer (Amaza and Ogundari, 2008), land area, manure, solid pesticides and liquid pesticides (Rahayu and Riptanti, 2010), land, farmer participation in training activities (Isyanto, 2012), farm size and other inputs (Etwire, et al, 2013), male labor, female labor, seeds, land area (Mahabirama, et al, 2013), soybean plot size, intermediate inputs (Mugabo, et al, 2014), land area, seed, urea fertilizer, and ponska/NPK fertilizers (Ambarita, et al, 2014), improved seeds, plant density, fertilizers, fallow, sex of farmers (Zoundji, et al, 2015), land area, seeds, labor (Ningsih, et al, 2015), human labor, manure, irrigation (Datarkar, et al, 2015), constraints of marketing, production, linkages hampered (Agada, 2015), seed, phonska fertilizer, manure (Asmara, et al, 2016), land size, seed (Putri, et al, 2015).

Several studies have shown that factors affecting technical inefficiency are: age, gender, market accessibility, animal traction (Amaza and Ogundari, 2008), land size, age, educational, experience (Tahir, et al, 2010), land, use of modern equipment (Isyanto, 2011), working hours farmers outside agriculture, livestock yields, farmland, garden fields, garden yields, use of modern equipment (Ajao, et al, 2012), education, experience, number of cattle ownership, credit (Isyanto, et al, 2013), age, experience, distance of land to drilling well irrigation, land tenure status Ningsih, et al, 2015), education, land ownership, counseling frequency, demonstration plot (Asmara, et al, 2016), age, education, number of livestock ownership, family size and credit (Maemunah and Isyanto, 2017).

3. Research Methodology

The research was conducted in Pangandaran Regency, West Java Province, Indonesia. The research data consist of primary and secondary data. Primary data were obtained from 40 farmers who were randomly selected as research samples. Data analysis was performed by using stochastic frontier production function with the following model:

$$ln\ Y = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + v_i - u_i \quad (4)$$

where: Y = soybean production (kg), X_1 = land (ha), X_2 = seed (kg), X_3 = labour (man-day), X_4 = chemical fertilizer (kg), X_5 = organic fertilizer (kg), X_6 = insecticide fertilizer (kg), β = coefficient of regression, v_i = random error, and u_i = technical inefficiency effects in the model.

Inefficiency model was defined to estimate the influence of some farmer's socio-economic variables on the technical efficiency of the farmers. The model is defined by:

$$\mu_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 D_1 \quad (5)$$

where: μ_i = technical inefficiency, Z_1 = age (years), Z_2 = education (years), Z_3 = experience (years), Z_4 = family size (persons), δ = regression coefficient.

4. Results and Discussion

The level of technical efficiency achieved by soybean farmers in Pangandaran Regency is shown in Figure 1. The level of technical efficiency ranges from 0.75-1.00 with an average of 0.95. The average value of the technical efficiency level of 0.95 indicates that the average soybean farmer in Pangandaran Regency produces 95% of the frontier output potential, given the present level of technology and input use. Hence, 5% of the potential frontier output is not realized.

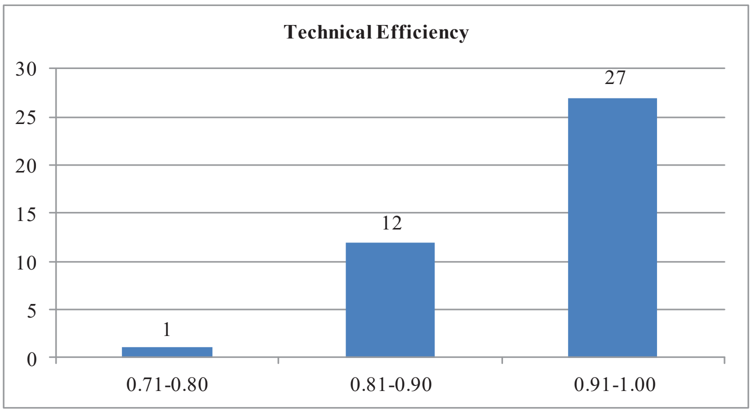

Figure 1. Technical Efficiency

The estimation of production function and inefficiency functions parameters is carried out using the maximum likelihood method. The parameter estimation is performed using Frontier 4.1 software as presented in Table 1.

The sigma square value of 0.0011 is statistically significant at the 1% level indicating the goodness of fit of the model used and the correctness of the specified distribution assumption of the composite error term. The value (γ) of 0.9999 is statistically different from zero at the 1% level. These results indicate unexplained systematic effects by using the production function in the form of a dominant resource of stochastic random error. Approximately 99.99% of the variation in output levels of soybean farming is attributable to technical inefficienciy in resource use. The generalized likelihood ratio test (89.2678) is statistically significant at the 1% level indicating the presence of a one-sided error component. The results of the diagnostic analysis further confirm the relevance of the stochastic parametric production function and maximum likelihood estimation.

Table 1. Maximum Likelihood Estimates and Inefficiency Functions

Variable	Parameter	Coefficient	Standard Error	t-ratio
Production function				
Constant	β_0	10.0672	1.1246	8.9520*
Land	β_1	-0.0299	0.0811	-0.3686
Seed	β_2	3.0026	0.1695	17.7172*
Labour	β_3	1.1875	0.1941	6.1184*
Chemical fertilizer	β_4	-0.5338	0.0836	-6.3845*
Organic fertilizer	β_5	-2.0683	0.1599	-12.9376*
Insecticide	β_6	0.0017	0.0668	0.0250
Inefficiency function				
Constant	δ_0	3.9281	1.4511	2.7070**
Age	δ_1	-1.6038	0.4203	-3.8155*
Education	δ_2	0.1750	0.1231	1.4208
Experience	δ_3	1.1253	0.1677	6.7094*
Family size	δ_4	-0.5192	0.1320	-3.9335*
Sigma square	σ^2	0.0011	0.0003	3.4071*
Gamma	γ	0.9999	0.0072	139.6894*
Log likelihood function	= 104.2781*			
LR Test	= 89.2678*			

*, ** significant at 1%, 5%

Table 1 showed that seed and labor have positive and significant effect on soybean production, while chemical fertilizer and organic fertilizer have negative and significant effect on soybean production. Land and insecticide have no significant effect on soybean production.

The model used is linear regression equation so that the regression coefficient shows the production elasticity of each input. For example, a 1% increase in seed use will increase soybean production by 3.0026%. The sum of production elasticity of 1.5998 indicates that soybean farmers operate in the area of increasing returns to scale.

The result of inefficiency parameter estimation shows that age and family size have negative and significant effect to the level of technical inefficiency reached by soybean farmer, while experience has positive and significant effect. Education does not significantly influence the level of technical inefficiency achieved by soybean farmers.

Age has a negative and significant effect on the level of technical inefficiency. The results of this study indicate that increasing age of farmers will improve technical efficiency level. In other words, older farmers are more technically efficient than younger farmers. This result is consistent with the findings by Etwire, et al (2013), Hasan, et al (2015), Anang, et al (2016), Rasyid, et al (2016), Ali and Jan (2017), Sudrajat and Yusuf (2017). Age play important role in decision making and has contribution towards general learning and correct judgment. If age increases then technical inefficiency will decrease, this may be due to the managerial ability of farmers (Ali and Jan, 2017), resulting in increased technical efficiency. Age was correlated with farm experience and increased experience and knowledge led to increased technical efficiency (Rasyid, et al, 2016).

Education has no significant effect on the level of technical inefficiency. Regression coefficients that have a positive sign indicate that the increase in formal education will decrease the level of technical inefficiency. This result is consistent with the findings by Adzawla, et al (2013), Betonio, et al (2016), Junaedi, et al (2016). The results of Ali and Jan's (2017) study indicate that the increase in formal education will increase technical inefficiency or decrease in technical efficiency. It may be that farmers are using traditional methods that require no formal education or people get educated finds off-farm income opportunities and give less attention to farming.

Experience has a positive and significant effect on the level of technical inefficiency. The results of this study indicate that increasing farmer’s experience will decrease the level of technical efficiency. This result is consistent with the findings by Adzawla, et al (2013), Hikmasari, et al (2013), Erhabor and Ahmadu (2013), Sudrajat and Yusuf (2017). The longer the farmers have experience in implementing soybean farming then they are more comfortable with the farming system that has been implemented. They tend to be difficult to accept innovations in soybean farming so that the level of technical efficiency achieved is low.

Family size has a negative and significant effect on the level of technical inefficiency. The results of this study indicate that more family size will improve the level of technical efficiency. This result is consistent with the findings by Bathon and Maurice (2015), Rasyid, et al (2016), Ali and Jan (2017). The more family size the more labor in the family is available in implementing soybean farming. In addition, the more family size, the more family needs that must be met so that farmers will intensively implement soybean farming. This results in a high level of technical efficiency achieved.

5. Conclusion

Production model shows that seed, labor, chemical fertilizer and organic fertilizer have significant effect to soybean production, while land and insecticide have no significant effect. The inefficiency model shows that age, experience and family size have significant effect to the level of technical inefficiency, whereas education has no significant effect.

6. Recommendation

The use of quality seeds and labor needs to be added, while the use of chemical fertilizers and organic fertilizers need to be reduced. This will lead to increased production of soybeans. Consideration should be given to the implementation of extension and technical guidance to improve the knowledge and technical skills of farmers so as to increase the production and income of soybean farmers.

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