Agricultural Socio-Economics Journal
Volume XVI, Number 02 (2016): 45-51

P-ISSN: 1412-1425 | E-ISSN: 2252-6757

TECHNICAL EFFICIENCY ANALYSIS OF SUGAR CANE PRODUCTION IN SUTOJAYAN VILLAGE, PAKISAJI SUB-DISTRICT, MALANG, EAST-JAVA, INDONESIA

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ABSTRACT: Government has a sugar self-sufficiency program in 2020 up to 2025. However, based on data from the Directorate General of Plantation (2013), the amount of sugar production is lower than the national sugar demand. The research location is Sutojayan village, Pakisaji district, Malang Regency, East Java, Indonesia. The purposes of this research are: (1) analyzing the factors that affect sugar cane production, (2) analyzing the level of technical efficiency on the sugar cane production, and (3) identifying the characteristics of respondents related to the level of efficiency achieved in the sugar cane production activities. The methods used in this research are SFA (Stochastic Frontier Analysis) approach and descriptive statistical analysis. Based on the results, seed and labor affect the increase of sugar cane production significantly. Farmers at the research location also has 5 percent opportunity to increase the production of sugar cane. The farmer respondents have high technical efficiency which is 95%. The characteristics of respondents generally consist of the age between 51 – 60 years, the last level of education is primary school, sugar cane farmer is the main job, the household size is 3 – 4 people, the experience of sugar cane farmer ranged between 21 – 30 years, using the BL (Bululawang) variety, the farm size of sugar cane is 0.10 – 0.50 hectares, and the status of land is the owner.

Keywords: sugar cane, farmer, input production, Stochastic Frontier Analysis (SFA)

INTRODUCTION

The condition of sugar production realization is lower than the sugar needs; therefore, import of the sugar is needed and conducted by government. Government has an intention to increase production of sugar domestically and run strategic sugar cane development for strengthening self-sufficiency level. According to Marpaung et al (2011), the importance of self-sufficiency program is to fulfil the national sugar needs, use the resources optimally, increase the welfare of farmers and society, and increase work opportunities, so that, it can reduce the level of unemployment.

Sugar cane is the main raw material in the sugar processing and has influence in achieving sugar self-sufficiency. Central Statistics Agency (2013) published that the highest widespread of sugar cane land is in East Java province 1,243,390 hectares. The amount of sugar cane production in East Java is 1,255,825 tons. Based on data from the East Java Plantation Department (2010), the highest widespread of sugar cane land in East Java is in Malang District. The amount of the sugar cane production in Malang District is 191,428 tons coming from the total land 37,352 hectares in Malang. Malang Regency is considered the highest sugar cane production in East Java.

According to the farming system in Indonesia commonly and Malang Regency, East Java specifically, the number of farmers is so high and limited land occupied by farmer. In the other words, the farming is considered small-scale, which land used is less than 1 hectar generally, and from many previous researches were considered away from efficient level.

Sujarwo et al (2015) and Sujarwo et al (2016) found that all farmers in the study area East Java Indonesia faced relatively high production inefficient and resulting profit gap about 30% from the maximum profit could be obtained by farmers in efficient level. Moreover, the farmers got difficulty more in achieving price efficiency than technical efficiency.

The research location is in Sutojayan village that has a continuous production of sugar cane and potential sugar cane productivity. In the present of learning process in sugar cane crop production, it can be hypothesized that technical efficiency obtained by farmers there are hight.

Soekartawi (1994) said that the efficiency is an effort to use a minimal input to produce maximum output. Farrell (1957) in Coelli et al (1998) explained that the combination of input usage of farmers associated with technical efficiency. Therefore, the technical efficiency can reflect the ability of farmers to have maximum output from minimal input.

Some of other previous research have a various technical efficiency index. The research results of technical efficiency index by Khanna (2006) is 0.85; the status of ownership influence the leve of efficiency. The farmers that own their land have higher level of efficiency than the tenants have. It is because the irrigation system of the land is better than the land of the tenants have. Sulaiman et al (2015) found that the lowest technical efficiency is about 0.40 which is 0.3% of respondents, the highest group of farmers are greater than 0.90 which are about 71.50% of total respondents. The technology applied was the key of achieving the higher efficiency of the sugar cane farming at the research location.

Susilowati and Netti (2012) found that the average technical efficiency level of farmers is 0.67. This was due to sugar cane farming in the study are used the cane buds from the previous cane cut that is left on the ground for more than three times. The local term of this is called “kepras”. The second cause is because the seeds used were local seeds.

Carambas (2011) using 104 farmer as the samples found that the technical efficiency on average was 0.82 and also concluded that education of farmers is the important factor influencing the technical efficiency level. The relatively the same result also was showed by Debela (2013). The average efficiency level was 0.84. However, the range of technical efficiency was quite high. The lowest technical efficiency obtained was 0.49 and the highest level of the efficiency was 0.98.

Paramitha et al (2014) found that the technical efficiency of farmer joining with Padjarakan Sugar Cane factory was 0.95. However, the farmers who did not join to the Padjarakan Factory had only 0.84. Muflikah (2014) analyzed the farming performance of PTPN X Kebun Ajong Gayasan Jember, East Java, Indonesia found that technical efficiency obtained by sugar cane farmers was 0.93.

Based on the several researches have been conducted in Indonesia indicate that the farmers obtain different level of technical efficiency and the connection of farmers to the farmers’ group and sugar cane factory tend to influence the level of technical efficiency. Moreover, the characteristics of farmers can also affect the technical efficiency index achieved as on the statement Pitt et al (1981) in Coelli et al (1998). Furthermore, this research will prove empirically factors that influence the technical efficiency of sugar cane farmers.

RESEARCH METHODS

Research Location and Respondents

The location of research was in the Sutojayan Village, Pakisaji, Malang Regency, East-Java Province, Indonesia. The determination of the research location is purposively considered that the village has potential productivity and continuously in sugar cane production.

All sugarcane farmers in this research joined in farmer groups and have a partnership with the sugar cane factory. The determination of sampling method is census of all the sugarcane farmers in the Sutojayan village that become partners of the sugar factory. The total farmers there are 36 farmers.

The type of data in this research are the primary data and secondary data. The primary data obtained from the results of interview from respondents with questionarefor the purpose of the research. The secondary data used in this research are from the previous research, published survey results, archives of the company or local government office.

Data analysis methods used in the first and second purpose of research is the inferential statistics. The first purpose is about the relationship between several variables on research and the second purpose is to test the hypothesis. The approach that used in the first and second purpose is SFA (*Stochastic Frontier Analysis*) using STATA 14 software. The third purpose is got through descriptive statistics related to the exposure of the data from the research results.

Analysis the Factors Influencing Sugar Cane Production

The function of the stochastic production frontier in this research is:

$$\text{Ln Yi} = \text{Ln } \beta 0i + \beta 1i \text{ Ln X1i} + \beta 2i \text{ Ln X2i} + \beta 3i \text{ Ln X3i} + \beta 4i \text{ Ln X4i} + \beta 5i \text{ Ln X5i} + B6i \text{ Ln X6i} + (vi - ui)$$

Where:
Y = the amount of sugarcane production (quintals)
β_0 = constant or intercept
β_i = estimated parameters
X_1 = farm size (hectares)
X_2 = seeds (quintals)
X_3 = ZA fertilizer (quintals)
X_4 = phonska fertilizer (quintals)
X_5 = herbicides (liter)
X_6 = labour (man days)
i = farmer-i, i = 1, 2, …, n
g = error term from farmer-i, g = vi – ui
vi = stochastic error term
ui = technical inefficiency effects

The parameters of each independent variable are estimated using stochastic frontier production function. The value of the coefficients show how the independent variables (farm size, seeds, ZA fertilizer, Phonska fertilizer, herbicides, and labour) affect dependent variables (sugar cane production). The value of the coefficient was determined from the results of the input usage combination by respondents. The result of the parameters are tested the level of the significance. The selection of probability level related to the percentage of the risk of tolerated error. Level of significant that used in this research is 5% or 95% of confidence interval level.

Analysis the Technical Efficiency Level

The mathematical equation in technical efficiency according to Coelli *et al* (1998) is:

$$TE_i = \frac{Yi}{\exp(Xi\beta)} = \frac{\exp(Xi\beta - ui)}{\exp(Xi\beta)} = \exp(-ui)$$

Where:
TEi = technical efficiency
Yi = the amount of sugarcane production by farmer-i
Xi = the amount of input usage by farmer-i
β_i = estimated parameters
ui = random variable associated with the technical inefficiency
i = farmer-i, i = 1, 2, …, n

Based on the equation above, it is known that the value of technical efficiency is derived based on the value of ui. Then, technical inefficiency can be caused by the characteristics of the respondents such as firm size, age, level of education, and others. Therefore, the high value of ui related to the high technical inefficiency. The value of technical efficiency index is between 0 to 1. If the value close to 1, it means the farming activities more efficient technically.

The technical inefficiency of sugar cane farming activities is tested based on the value of σ^2 and γ parameters. Hypothesis test on this research is as follows:

a. The σ^2 parameters
   H_0: $\sigma^2 = 0$, which means that there is no technical inefficiency effects in the model
   H_1: $\sigma^2 > 0$, which means that there is a technical inefficiency effects
b. The γ parameters
   H_0: $\gamma = 0$, which means that there is no technical inefficiency effects
   H_1: $\gamma > 0$, which means that there is a technical inefficiency effects

Characteristics of Sugar Cane Farmers towards the Level of Technical Efficiency

The third research goal is to describe the respondent characteristics regarding the technical efficiency achieved by the farmers. Therefore, the characteristics of respondents in this research will be explained through graph or table summarizing the data available. In addition to this analysis, the variation coefficient to know the spread of the data of farmer characteristics towards the technical efficiency index is also performed. Then the value of the variation coefficient will be compared on each category. The purpose is to know the condition of data distribution of farmers in the field that is homogeneous or not.

RESULTS AND DISCUSSION

Analysis the Factors Influencing Sugar Cane Production

The results of the stochastic frontier production function estimation on sugarcane farmering groups in the Sutojayan village, Pakisaji, Malang Regency, East Java is represented in Tabel 1.

The results of the technical efficiency estimation analysis of sugarcane farming have a parameters coefficient from each of the independent variables assumed that other factors are constant (catteries paribus). The explanation of each independent variables towards the dependent variable are follows:

Table 1. The results of the estimation of Stochastic Production Frontier on the sugar cane farming

Production (Quintals)	Para-meters	Coef.	P>|Z|
Intercept	β_0	-1.763	0.168
Farm Size (ha)	β_1	0.005	0.678
Seeds (Quintals)	β_2	1.158	0.000
ZA fertilizer (Quintals)	β_3	0.025	0.795
Phonska Fertilizer (Quintals)	β_4	-0.006	0.933
Herbicides (Liters)	β_5	0.045	0.062
Labour (Man Days)	β_6	0.611	0.014

Source: Primary Data, 2016

a. Farm size (X_1)
The coefficient of farm size is 0.005 which means that the farm size improvement of 1% and drives increasing the amount of sugar cane production of 0.5%. The value of probability is 0.678 where the value is more than 5% from the error tolerated and it conclude that farm size in the research location is not significant. The value of farm size coefficient is not significant due to the fact that the level of farm size is relatively the same which is in small-scale level and the variety used is BL (Bululawang) varieties. Based on the farmers' statement, BL varieties is a superior variety which can produce sugarcane higher than other varieties have ever tried.

b. Seeds (X_2)
Seed has a coefficient value of 1.158 so when the usage of seeds increased by 1% increase the amount of sugarcane production of 1.158%. The value of the probability is 0.000 and less than 5%. Therefore, seed has significant coefficient. This supports the previous statement that BL has high productivity and influences significantly increasing of sugar cane production.

c. ZA fertilizer (X_3)
The coefficient value of ZA fertilizer variable is 0.025 with the probability value is 0.743. Every increase the usage of 1% ZA fertilizer it will increase the amount of sugarcane production at 2.5%. Hoever, the value is not significant statistically. This result also support the argument that fertilizer of nitrogen tend to reduce the land fertility due to overused and generate the acid reaction in the soil.

d. Phonska Fertilizer (X_4)
Phonska fertilizer has a coefficient value -0.006 with the value of the probability is 0.933. This means, the coefficient is not significant because the probability value is much higher than 5%.

e. Herbicides (X_5)
The coefficient value of the herbicides is 0.045 with the probability value is 0.062. Considering 5% significant level, herbicide has no significant influence to the sugar cane production. Herbicides have function in reducing competition among the plants for consuming nutrients. No significant of herbicide influence means that there are differences effect among the farmers regarding the application and the effect of it in sugar cane production.

f. Labour (X_6)
The coefficient of labor is 0.611 and the probability value is 0.014 which is significant statistically. The effect among farmers relatively changing in the same direction with the changing of sugar cane production. Every adding 1% of labor usage tends to increase 0.611 % the amount of sugarcane production.

Analysis the Technical Efficiency Level of the Input Usage Combination

The parameters estimation results of the the hypothesis test and technical efficiency index by the farmers:

a. Hypothesis test results
Hypothesis test used to prove the claims that the sugar cane farming activities in the Sutojayan village was not technically efficient. The coefficients related to the efficiency measure are the σ^2 and γ parameters. The result of the estimation of each parameter is as presented in Table 2.

Based on the analysis results, the following is a hypothesis test on the analysis of technical efficiency:
1) The σ^2 parameter
The sigma-square (σ^2) value of the results is 0.005 where the value is more than zero. So the hypothesis that received was an alternative hypothesis (H_1) because $\sigma^2 > 0$. Based on the results of the hypothesis test it can be concluded that the sugarcane farming activities by farmers was not achieved 100% of the technical efficiency level.

Table 2. The result of the estimation of parameters on technical efficiency

Parameters	Coef.	Std. Err.	P>|Z|
Ln σ2v	-6.948	1.043	0.000
Ln σ2u	-5.454	0.827	0.000
σ2v	0.001		
σ2u	0.004		
σv	0.031	0.016	
σu	0.065	0.032	
σ2s	0.006		
σ2	0.005	0.027	
γ	0.845		

Source: Primary Data, 2016

2) The γ parameter

Based on the analysis, it can be known that the value of γ is more than zero; then, there are the influence of technical inefficiency on the model. Therefore, the hypothesis accepted is an alternative hypothesis (H_1) where $\gamma > 0$. The results indicate that the sugar cane farming activities has technically efficient. The value of γ is 0.845 that shows the variation of the value of error term in the model 84.5% is caused by technical inefficiency.

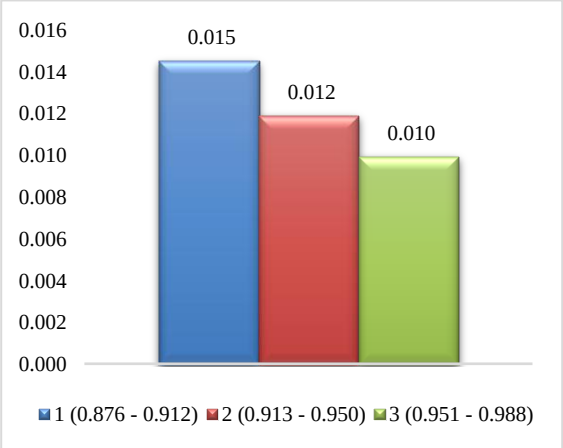
b. Technical efficiency index

The average of technical efficiency index accomplished by farmers in this research is 0.95. Farmers have 5% the opportunity to increase the sugar cane production of 100% efficient technically. The minimum level of technical efficiency is 0.870 and the highest one is 0.989. The high index of technical efficiency achieved in this research is because the respondents are part of partnership program with Kebon Agung Sugar Factory. The advantages of being a partner of Kebon Agung Sugar Factory are getting improved production technology dissemination and capital aid from PG. Kebon Agung.

Characteristics of Sugar Cane Farmers towards the Level of Technical Efficiency

Technical efficiency index is also associated with the farmers' characteristics. Based on the value of technical efficiency index farmers, the farmers are divided into three categories namely category 1, 2, and 3 from the lowest to the highest technical efficiency index. Technical efficiency index of category 1 is 0.876 – 0.912; category 2 is 0.913 – 0.950; and the index on category 3 is 0.951 – 0.988. The amount of farmers in category 1, 2 and 3 are 5 farmers, 8 farmers, and 23 farmers, respectively.

The coefficient variation of those three group of technical efficiency level are described in Figure – 1. The graph shows that the higher level of technical efficiency tends to get lower its coefficient variation.



Source: Primary Data, 2016

Figure 1. Coefficient variation of technical efficiency index

Technical efficiency index categories and the characteristics of the farmers are different among the groups. As mentioned before, category 3 has the most homogenous data compared to the other categories. Farmers in the group have similarities of the age, farming experience, and farm size.

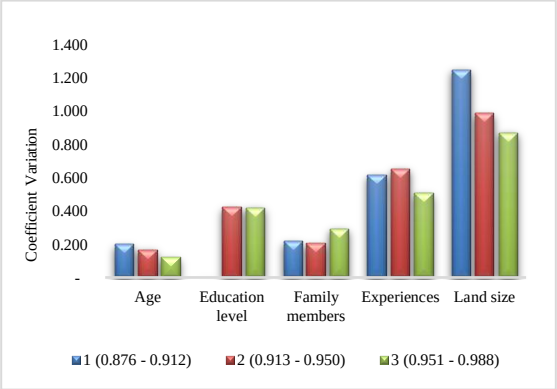


Figure 2. Coefficient variation and the respondent characteristics

Social characteristics and decision making by farmers in farming activities can affect the index of technical efficiency achieved. Based on the results, the farmers who achieve the technical efficiency index between 0.951 – 0.988 have characteristics, i.e. the age is 51 – 60 years old, the level of education is only basic education, farming is as the main job, the amount of household size is 3 – 4

people, the farming experience is 21–30 years, the variety used is BL (Bululawang) sugarcane variety, the farm size of sugarcane is 0.10 – 0.50 hectares, and the status of the sugarcane land is the owner.

CONCLUSION

There are some important points noted from this rsearch, which are:

1. Variables that affect the sugar cane production significantly are seeds and labour variables with significant level at 5%. The relationship between both variables towards sugarcane production is positive in decreasing return. The variables which are not significant in influencing the sugarcane production are farm size, ZA fertilizer, Phonska fertilizer, and herbicides. The relationship of Phonska fertilizer towards sugarcane production is negative, but for farm size variable, ZA fertilizer, and herbicides are positive.
2. The average of technical efficiency index was 0.950 with minimum index is 0.870 and the maximum index is 0.989. It depicts that farmers have relatively the same capability in growing sugar cane and this is supported by the picture of research location which has potential productivity and continuous production of sugar cane.
3. The characteristics of respondents who can reach the high level of technical efficiency mainly consists of the age between 51 – 60 years old, the last level of education is the primary education, farmer is as the main job of, the amount of household size is 3 – 4 people, sugarcane experience ranges from 21 – 30 years, using the BL (Bululawang) sugarcane variety, the farm size of sugarcane was 0.10 – 0.50 hectares, and the farmers are the owner of sugarcane land.

SUGGESTION

Sugestion can be made based on the discussion and conclusions above, there are:

1. The significant input production need to be considered carefully are seeds and labour. Those input productivity are analyzed in the point where the data collected. In the long run perspective of sugar cane farming, seeds and labor are not only the input of which the farmers should concern about but also the land of production. It is because the fertilizer applied do not affect significantly. It means the soil start decreasing in providing nutrients available for growing sugar cane. In this point, the soil quality improvement should be one of important factor considered by sugar cane farmers.
2. Bululawang variety provide good productivity but the performance of seed should be supported by the soil fertility. Therefore, the precision of using fertilizers should be developed by local experiment conducted by participative local experiment stations.
3. The partnership program of Kebon Agung Sugar Factory influence the achievement of farmers' technical efficiency. Therefore, this model should be strengthened in the future. The equal opportunity and mutualistic relationship between sugar cane farmers and Kebon Agung Sugar Factory will reinforce the competitiveness of reinforce not only Kebon Agung Sugar Factory but also sugar cane farmers

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