THE TECHNICAL EFFICIENCY OF THE PALM OIL PLANTATION IN JAMBI PROVINCE, SUMATRA, INDONESIA

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Abstract— This study tested the technical efficiency of the company's palm oil plantation in the Jambi province, Sumatra-Indonesia using stochastic frontier production function procedure. The data collected in the last 3 years (2013-2015) random sample of 36 against companies that are spread on the 7th District in the region by using a structured questionnaire and schedule interviews for research. The research results reveal that the technical efficiency of the palm oil plantations ranging 11-99% with an average of 66%. This indicates a broad opportunity for Palm oil plantation companies to improve their productivity through improved technical efficiency. Age of the estate, the ratio of the land, the status of the land, the source of the seeds, and training the workforce found significantly associated with technical efficiency while the status of the labor, extension, partners with the community, and the topography of the land was not significantly related to technical efficiency.

Keywords— Stochastic Frontier, Technical Efficiency, Productivity.

I. INTRODUCTION

Palm oil plantations are developed in Indonesia since 1911 which was originally developed on Sumatra. Because of the suitable agro-climate, the current palm oil plantations has already spread across Sumatra, the western part of Java, Borneo, Sulawesi and Papua with up to 10.9 million acres total area in 2014 that makes Indonesia become the largest palm oil producer in the world. The estate is owned and managed by the Country, private companies, and individual, where private parties have a total area 51.62%, the individual based organizations with 41.55% while the country estates only with 6,83% of palm oil plantations in Indonesia. (Ministry of agriculture, 2014).

Rapid growth of vast palm oil plantations in Indonesia was strongly influenced by the increased demand for Palm oil from various countries. The increase was caused by the growing number of derivative products produced from Palm oil, such as margarine, soap or detergent, the extra fat for food, and that is being continuously developed is biodiesel fuel, because these products have a prospect that will continue to improve along with the arrangement to use renewable energy, particularly in the developed countries that care about the preservation of the environment.

Current management of palm oil has not been paying attention to efficiency and productivity but still drip-focused on volume, whereas the efficiency and productivity of oil palm sector is important for Indonesia as a manufacturer and exporter of palm oil (Sari, 2014). To survive into the largest palm oil producing countries in the world, Indonesia needs to carry out oil palm plantation management efficiently. Palm oil plantations which consist of the private plantations, governmental estates plantations and the non-governmental estates should increase its productivity. Based on the findings in the field, although the vast acreage of land and the production of CPO Indonesia ahead of Malaysia, but in terms of the advantages Malaysia still far above Indonesia (Dermawan, 2010). Indonesian palm oil plantations generally have lower productivity compared to Palm oil Malaysian plantations, as well as the palm plantation in Jambi province.

Indonesia is the largest producer of palm oil in the world, with production growth of 7.8% per year. About 70% of land producing palm oil in Indonesia was in Sumatra (MP3EI, 2011). Jambi province is one of the largest producers of palm oil in Sumatra. But the level of efficiency of the production of palm oil plantation in the province of Jambi has never been discussed in detail (the estate agency of the Jambi province, 2014).

Based on the issues above, this research aims to recognize the level of technical efficiency and to analyze palm oil plantation in the Jambi province. Technical efficiency values are obtained by using the production frontier function. The production frontier function is the production function used to measure how the actual production function towards the position of its frontier. Because the production function is the relationship between the physical factors of production and production with the production frontier function within isoquant line. (Soekartawi, 1994). Through this function, will be recognized the level of technical efficiency occurs in Palm oil plantation in Jambi province.

II. MATERIALS AND METHODS

The theory and the analytical framework: The results of technical efficiency when the maximum output is obtained from a combination of the

resources given (the ability to produce at the frontier of production). The technology of production of oil palm plantations that are represented by the stochastic frontier production as:

$$Y_{it} = f(X_{it} ; \beta) \exp(V_{it} - U_{it}), \quad (1)$$
$$i = 1,2, \dots , n ; \quad t = 1,2,3.$$

Y_{it} = Output of palm oil plantations i at time t

X_{it} = Vector of the input quantities used palm oil plantations i at time t

β = Unknown parameter Vector that will being estimated

$f(X_{it};\beta)$ = Production Function (Cobb-Douglass, translog, etc.)

V_{it} = Random error in the output of the random variation accounted for by factors which are beyond the control of the company's palm oil plantations such as disease outbreaks, weather, errors of measurement and is assumed to be independent and identically distributed ($Vi \sim N \mid 0, \sigma_v^2 \mid$) independent from the Ui.

U_{it} = A non-negative random variable, associated with technical inefficiencies in production and is assumed to be independent and identically distributed as half of normal, ($Ui \sim N \mid 0, \sigma_u^2 \mid$)

The technical efficiency of a palm oil plantation company is defined in terms of the ratio of the observed output to output the appropriate frontier, given the available technology. Technical efficiency:

$$(TE) = Y_i / Y_i^* = f(X_{it} ;\beta)\exp(V_i - U_i)/f(X_{it} ;\beta)\exp(V_i) = \exp(-U_i) \quad (2)$$

Y_i : Output Observed

Y_i^* : Output Frontier

The parameters of stochastic frontier production function being estimated using the method of Maximum Likelihood Estimation (MLE).

Data and area studies: Figure 1 presented in this research was conducted in the Jambi province – Sumatra – Indonesia. 36 palm oil plantations companies are examined in Jambi province spread over 7 regencies including; Muaro Jambi Regency, Tebo Regency, Tanjung Jabung Barat Regency, Batanghari Regency, Bungo Regency, Merangin Regency and Sarolangun Regency. Data taken for the last 3 years (2013-2015). Sampling procedure is carried out by simple random method (simple random sampling). Total data used for research are 108 observations. The information about the socio-economic characteristics of the companies' palm oil plantations and their production activities (input, output, and prices) were collected by well structured questionnaire and scheduled interviews.

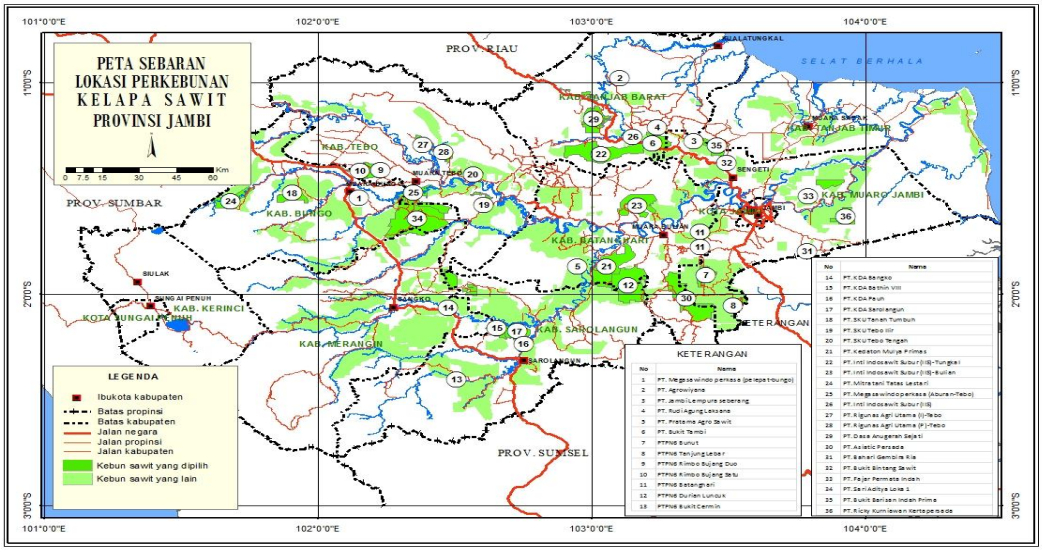


Figure 1. Location map of the research of palm oil plantation in the province of Jambi

The empirical model: Cobb-Douglass production frontier fuction are used in this research. Taylor and Shinkwiler (1986) noted that all the interest based on the measurement of efficiency and not on the general structure of production technology, Cobb-Douglass' production functions gives an adequate representation of production technology. It is widely used in the analysis of agricultural efficiency either at developing countries or developed countries (Battese, 1992; Bravo-Ureta and Pinheiro, 1993; Onyenweaku et al., 2004;. Onyenweaku and Ohajianya, 2005; Raphael, 2008). Estimation of specific model is given by:

$$\text{Ln } Yit = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + (V_i - U_i) \quad (3)$$

Y_{it} : The output of palm oil plantations into-i in time to-t (kg/hectare)
X_1 : Extensive plantation area (hectare)
X_2 : Seeds (rod/hectare)
X_3 : Labor (people/hectare)
X_4 : Organic fertilizers (kg/hectare)
X_5 : Inorganic Fertilizer (kg/hectare)
X_6 : Pharmaceuticals (kg/hectare)
β_o : Intercept
β_i : (i = 1.2, ..., 6) regression coefficients which are being estimated, while Vi and the Ui are defined in the beginning and in the natural logarithm.

In order to determine the factors that contributed directly to technical efficiency, the following model was formulated and being estimated stochastic frontier model together in one stage of the procedure of maximum likelihood estimation (maximum likelihood estimation) using computer software Stata13 Version 10.1 (Coelli, 1996):

$$TE = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \delta_9 Z_9 \quad (4)$$

TE : Technical efficiency of palm oil plantations into-i in time to-t.
Z1 : Palm age (years)
Z2 : Peat ratio against the plantation (%)
Z3 : Land status (variable dummy = 1, if there is conflict; and = 0, if otherwise)
Z4 : Seed source (variable dummy = 1, if standardized ISO; and = 0, if otherwise)
Z5 : Labor status (variable dummy = 1, if the status remains; and = 0, if otherwise)
Z6 : Extension (variable dummy = 1, if any; and = 0, if otherwise)
Z7 : Partnership with communities (variable dummy = 1, if any; and = 0, if otherwise)
Z8 : Labor Training (variable dummy = 1, if any; and = 0, if otherwise)
Z9 : Land topography (variable dummy = 1, if flat-surging; and = 0, if flat-hilly), whilst the δ1, δ2, δ3, δ4, δ6, δ7, δ5, δ8, and δ9 is the will be estimated parameter.

1. RESULTS AND DISCUSSION

Table 1 presents the maximum likelihood estimation of stochastic frontier production functions. All estimated parameters have signs that enable and all statistically significant. The results are similar to findings Bravo-Ureta and Evenson (1994), Onyenweaku et al. (2004), Onyenweaku and Ohajianya (2005) and Iheke Onwuchekwa Raphael (2008). The estimated value of Sigma-square of 0.45 implies that 55% of the total variation in output of palm oil plantations is because of technical inefficiency.

Distribution of technical efficiency of the palm oil plantations (Table 2) reveals that technical efficiency index ranges 11-99% for Palm oil plantations. Technical efficiency average is 66%. The implication is that the average for oil palm plantations in order to achieve the technical efficiency of colleagues who are most efficient, then palm oil plantations could realize cost savings of 33% (1-66/99). For Palm oil plantations are the most technically inefficient, he had to achieve cost savings of 89% (1-11/99) in order to become palm oil plantations are the most efficient.

Table 1. The parameters of the Maximum Estimated Likelihood (MLE) of stochastic frontier production function

Variabel	Coef. parameters	Std. Err	Sig.
Cons	*21,47065*	0,0008902	0,000
Land area (X1)	0,0692267	4,21e-06	0,000
Seed (X2)	-2,507113	0,0001841	0,000
Labor (X3)	0,1017007	2,90e-06	0,000
Organic fertilizer (X4)	-0,00021	2,42e-06	0,000
Inorganic fertilizer (X5)	0,1085649	3,28e-06	0,000
Pharmaceuticals (X6)	*-0,2031525*	5,29e-06	0,000
Sigma- Square	0,45513		
Lamda	8,07e+07		
Log likelihood	-35,878183		
Wald chi-Square	3,63e+09		
Mean TE	**0,659747**		

Source: Privilege of survey data (2013-2015).

Table 2. Distribution of technical efficiency

Efficiency (%)	Technical Efficiency
>90	18
80<90	19
70<80	20
60≤70	7
50≤60	14
40≤50	12
30≤40	7
20<30	8
10≤20	3
Mean	0,66
Minimum	0,11
Maximum	0,99
Total	**108**

Source: Privilege of survey data (2013-2015).

Determining technical efficiency estimation are summarized and presented in Table 3. The age of oil palm, the ratio of the land, the status of the land, the source of the seeds, the workforce training everything is significant. Age of the oil palm is associated with positive technical efficiency implies that Palm oil plantations with more riding age up above the cusp of production (10-20 years) showed a level of technical efficiency. This result is in accordance with findings Ridho et al. (2012) noted that the rising age up to the cusp of production (10-20 yrs) then increased production increasingly efficient in production particularly in the use of input-input production. The ratio of land associated with positive technical efficiency. This indicates that the higher the ratio of peat against oil palm plantation wills increase efficient.

Table 3. Determining technical efficiency estimation

Variabel	Parameter	Coefficient	Sig.
Cons	δ_0	- 0,839	0,000
Palm Age	δ_1	0,041	0,000
Land Ratio	δ_2	0,001	0,065
Land Status	δ_3	- 0,059	0,043
Seed Sources	δ_4	0,845	0,000
Labor status	δ_5	- 0,089	0,452
Extention	δ_6	0,010	0,880
Partnership with communities	δ_7	- 0,015	0,839
Workforce training	δ_8	0,177	0,085
Land topography	δ_9	0,114	0,223

Source: Privilege of survey data (2015-2015).

Land status correlated negatively and significantly with technical efficiency. This indicates that the oil palm plantation that no conflict will decrease the efficiency of oil palm plantations is concerned, and vice versa. The source of the seeds is associated with positive significant and technical efficiency. This shows that the source of the seeds that are ISO standard (tenera seed) will raise the efficiency of technical, and this result is consistent with Pahan (2007).

The workforce training associated with positive significant and technical efficiency. This means that training will increase labor productivity and the efficiency of resource use in production. In contrast if there is not workforce training, will reduce the efficiency. This is in accordance with Saragih *et al.* (2013) who stated that the workforce with higher education levels is more efficient than working with lower education workers. It was in fact contrast with Ridho *et al*. (2012)

The labor status correlates negatively and not significantly with the technical efficiency. This condition shows that non remain employees are still more efficient than remain employees. The partnerships with communities are negative and also not significant. This indicates that partnership with communities carried out by oil palm plantation companies are less efficient than there is not partnership with the community.

The extension training are positive and not significantly relates to technical efficiency. These results are in accordance with the Raphael (2008) who stated that extensive contacts (extension) are insignificant but negatively correlated toward technical efficiency. Land topography is positively correlated and not significantly to technical efficiency. This showed that Palm oil plantations are more efficient in flat land if compared with the lands are not flat (hilly). These results are consistent with the Ridho *et al.* (2012), Pahan (2007), and Mangoensoekarjo (2005).

CONCLUSION

The results of the research, pointed out that the technical efficiency of the company's palm oil plantations ranging 11-99% technical efficiency with an average of 66%. This means that many opportunities for Palm oil plantation companies to increase productivity and income through utilization of the resources more efficiently. The results also revealed that the age of the garden, the ratio of the land, the status of the land, the source of the seeds, and training the workforce is the important factors that contribute to technical efficiency. Palm oil plantations with age until the cusp of production (± 10-20 yrs), had a peat land, the seeds are ISO standards (tenera type), increase the extension, and has a relatively flat topography of the land tends to be more efficient. The status of the land, and the status of the workforce, as well as partners with communities, has a negative influence on the technical efficiency.

Therefore, a policy that required a major palm oil plantations are; fix management of harvest time pattern of the age of the gardens reached the cusp of production (± 10-20 yrs), increasing the use of peat, plantation seed source using the ISO standard seeds (tenera type), increase training of workforce. All of these are important in improving the efficiency of the company's revenue and palm oil plantations.

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