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Technical Efficiency of Madura Farmers on Hybrid and Local Corn Farming in Guluk-Guluk District, Indonesia

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Abstract
This research aimed is analyzing the level of technical efficiency of hybrid and local corn farming and analyzing the factors influenced technical inefficiency. Analysis of the data used stochastic frontier production function estimated by maximum likelihood method (MLE), used a computational program frontier version 4.1 developed by Coelli (1996). The results showed factors that significantly influence the technical efficiency are the seed and worker. The local corn farmers were more efficient than the hybrid ones. It cause by technical inefficiency such as age and education of farmers.
Keywords: Corn, Technical efficiency, Technical inefficiency, Maximum likelihood Method

1. Introduction

Corn is one of the strategic food commodities in Indonesia. Indonesian government has made corn as one of the commodities of the sustainable self-sufficiency. The policy has affected to corn farming in Madura, which is one of the largest corn producer in East Java, with the largest planted area about 400 thousand hectares. Roesmarkam et al. (2006) argued that the inclusion of hybrid corn increase the productivity in Madura, initially only about 1.4 tons per Ha increased to 4.2 tons per Ha.

However, the development of hybrids and composites corns didn't influence the decision of Madura farmers to plant local corn. Although, The goverment encourage the development, but the local corn planted area in Sumenep still reached 76% in 2011. Sugiarti et al. (2009) argued that madura farmers refuse new varieties of corn and decided to plant local ones. They still consider planting local corn, although the results of Nurmansyah (2011) shows that benefits of local corn lower than hybrid one. Local corn farming income of Rp 2,019,491.15 / ha, while revenues hybrid corn Rp 5,349,747.54 / ha. Suprapti (2012) explain, although local corn farming had low benefits but its had technical efficiency.

Condition of corn farmer preference, concerning with the existence of local corn, had not showed the use of inputs. It influence the produced, the level of productivity and an overview of the level of efficiency achieved by the farmers (Kumbhakar, 2002). It became the basis of this research to analyze the level of production efficiency of hybrid and local.

2. Materials and Methods

This research was held in the Guluk Guluk District, Sumenep Regency, as one of the centers of corn production in East Java province, which has featured local varieties. Primary and secondary data collected through observation and interview techniques. Respondent samples of 100 respondents at the farmer household level both perform hybrid corn farming or farming of local corn.

This study uses a *stochastic production frontier* function model of *Cobb-Douglas* with parameter *Estimated Maximum Likelihood* (MLE) to analyze the production *function.* The calculation uses Maximum Likelihood Estimates (MLE) in the form of computing Frontier program version 4.1 developed by Coelli (1996). So the production function parameter estimation and inefficiency function performed simultaneously. Frontier Program 4.1 following 3-step procedure estimation, namely: (i) OLS, to acquire all of the parameter values allegations (except the intercept) is not biased, (ii) Grid search value γ, (iii) The value obtained in step (ii) is used as the initial value of the iterative procedure to obtain maximum likelihood estimators value.

Stochastic frontier production function used is formulated in the following equation:

$$\ln y = \alpha_0 + \alpha_1 \ln x_1 + \alpha_2 \ln x_2 + \alpha_3 \ln x_3 + \alpha_4 \ln x_4 + \alpha_5 \ln x_5 + (v_i - u_i)$$

Note :
y = the production of hybrid corn / local corn (kg)
x1 = seed (kg)
x2 = Labor (manpower days)
x3 = Chemical Fertilizer (kg)
x4 = Organic Fertilizer (kg)
x5 = Pesticides (kg)
α0 = intercept
αi = coefficient of parameter estimators, where i = 1,2,3, ..., 10
0 <αi <1 (diminishing return)

vi - ui = error term (ui = technical inefficiency effects in the model)
The level of technical efficiency can be calculated using the following equation :

$$ET_i = \frac{Y_i}{\exp(X_i\beta)} = \frac{\exp(X_i\beta - u_i)}{\exp(X_i\beta)} = \exp(-u_i) \quad \ldots$$

The level of technical efficiency (ET) for each individual comes from the comparison between the actual level of output, Yi, with a *predicted* level of output, exp (Xi, β). As for determining the value of the distribution parameters (μi) technical inefficiency effects in this study using the following formula:

$$\mu_i = \delta_0 + \delta_1 \ln z_1 + \delta_2 \ln z_2 + \delta_3 \ln z_3 + \delta_4 \ln z_4 + \delta_5 \ln z_5 + \delta_6 \ln z_6 + \delta_7 \ln z_7$$

Note :μi = technical inefficiency effects
z1 = farming experience (years)
z2 = aged farmer (years)
z3 = farmer education level / school
z4 = tenure (dummy)
z5 = membership in farmer groups (dummy)
z6 = other farming (dummy)
z7 = other income (dummy)
δ0 = intercept
δi = coefficient of parameter estimators

Aigner et al. (1977) and Jondrow et al. (1982) defines $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\lambda = \frac{\sigma_u}{\sigma_v}$. Battese and Corra (1997) mention that σ_v^2 and σ_u^2 with $\sigma^2 = \sigma_v^2 + \sigma_u^2$dan $\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$.

If the value of the parameter γ as the contribution of technical efficiency in the residual error (ε), whose value ranges between zero to one, so the value of γ close to zero indicates that the deviation from the frontier lead to the effects of residual (error). If the value close to one, indicates the deviation is leading to technical inefficiency effects.

The level of efficiency referred to previous studies (Ogundari and Ojo, 2007; Nwaru et al, 2011; Laha and Kuri, 2011), by dividing the level of efficiency as follows:

a) Very efficient: TE ≥ 0.90
b) Simply efficient: 0.70 ≤ TE <0.90
c) Not efficient: TE <0.70.

2. Result and Discussion

Technical efficiency becomes imperative requirement to measure cost efficiency and economic efficiency. Technical efficiency requires the production process that can utilize fewer inputs to produce the same amount of output (Miller & Meiners, 2000). The estimation results of stochastic frontier production function on hybrid and local corn Guluk Guluk can be seen in Table 1.

Table 1. Stochastic Frontier Production Function of Hybrid and Local Corn in Guluk Guluk

		Hybrid Corn				Local Corn			
Parameter	Variable	Coefficient	Error	t-Ratio		Coeffisient	Error	t-Ratio	
	Stochastik frontier								
β0	Constant	4.453629	0.802157	5.552064	a	5.357447	0.808244	6.628499	a
β1	Seed	0.366060	0.133406	2.743955	a	0.621726	0.121157	5.131591	a
β2	Labor	0.509675	0.100564	5.068148	a	0.275116	0.105740	2.601812	b
β3	Chemical Fertilizer	0.101770	0.201357	0.505421		-0.203347	0.167009	-1.217582	
β4	Organic Fertilizer	-0.025391	0.023969	-1.059331		-0.004499	0.019868	-0.226427	
β5	Pesticide	-0.004099	0.015904	-0.257746		-0.002229	0.056724	-0.039297	
σ^2	Sigma Square	0.180414	0.158857	1.135696		0.661075	0.599344	1.102999	
γ	Gamma	0.247837	0.170185	1.456274		0.929691	0.072908	12.751520	
ln (Likelihood)		-26.190605				-28.403705			
RTS		0.948015				0.686768			
LR		1.17E+01				1.55E+01			
TE Average		0.545718				0.655836			

Source : Primary Data Analysis, 2016
Note : a significance at α 1% (2.677793)
b significance at α 5% (2.008559)

Table 1, explained that σ ^{2} value of hybrid corn was different with local corn. The value of local corn higher (0.6611) than hybrid corn (0.1804). It's mean that the *error term* of inefficiency (u_i) on both functions is distributed normally. The value of γ is the ratio of the technical inefficiency deviation (u_i) to the deviations that might be caused by random variables (v_i). Statistically, γ on local corn (0.9297) also is higher than the hybrid corn (0.2478), means that that 92.97% (on local corn) or 24.78% (on hybrid corn) of *errors* in production function caused by technical inefficiency variables. The rest, 7.03% on local and 75.22%, due to the random variable.

Return to Scale (RTS) Analysis is obtained by summing all of the coefficients variables in the model. The RTS value of hybrid corn (0.948015) is higher than local corn (0.686768). The values show that the production of both corns are in stage II (decreasing positive returns to scale), means that if all inputs jointly coupled by 1 percent, corn production will be increased by 0.948 % (hybrid corn) and 0,687% (local corn).

Based on the estimation results of *the Cobb-Douglas* production function with MLE method on both types of corn, seeds and labor are positively significant affect to corn production, while three other variables did not significantly affect. The coefficient value or elasticity are 0.366060 on hybrid corn and 0.621726 on local corn mean an increase of seed by 1% will increase the production by 0.366060 and 0.621726, *ceteris paribus.* Availability and ease in obtaining seed, both hybrid and local corn, can be a significant production factor to total production. It because there are large amount of hybrid corn seeds on the market and the behavior of local corn farmers who often keep most of their crops to be used as seeds in the next planting season. Fauziyah, E (2010) and Sukiyono, K (2004) also shows that the seed production is a factor that significantly and positively related to the production.

Labor variable coefficient is also positively significant effect to stochastic frontier production function both on hybrids and local corn. Elasticity of labor on hybrid and local corn are 0.509675 and 0.275116, means that an increase of labor by 1% will increase the production of hybrid and local corn by 0.509675% and 0.275116%, *ceteris paribus.* The addition of these variables will be able to increase corn produaction through cultivating, fertilizing, and harvesting that requires a lot of laborer. The additions can be increase on working hours or the number of workers, because madura farmer usually use the labor from their family or relatives. The additional labour should pay attention to human resources, such as knowledge of commercial corn farming, managed post-harvest and marketing their crops or their value-added products. The labor effect also mentioned in Prathama (2012) on the farm caisim in Bogor and Ekaningtyas (2011) in Japanese spinach farming in West Java. They explained that the addition of workers make farming more technically efficient.

Analysis of technical efficiency described simultaneously using stochastic frontier production function, in which the distribution of the technical efficiency of corn farmers can be seen in Table 2.

Table 2. Distribution Efficiency of Hybrid and Local Corn Farming in Guluk Guluk District

TE Group	Amount of Farmer			
	Hybrid Corn	Percentage	Local Corn	Percentage
<0,7	44	88%	24	48%
0,70=<TE<0,90	3	6%	21	42%
>=0,90	3	6%	5	10%
Total	50	100%	50	100%
TE Average	0.54572		0.65584	
Maximum	0.97661		0.93519	
Minimum	0.30985		0.15092	

Source: Processed Data 2016

Table 2 describes that local corn farmer more fairly technically efficient than hybrid corn farmers. It is very interesting, although the profit level of local corn farming lower than the hybrid, but local corn farming more technically efficient. It means, local corn farming has large potential chance to be increased, because it is supported by the local wisdom of farmers in the cultivation.

Factors influencing the level of technical efficiency of farmer were analyzed using technical inefficiency effects model of stochastic frontier production function are presented in Table 3.

Table 3. Factors Affecting Technical Inefficiency in Hybrid and Local Corn Farming

		Hybrid Corn				Local Corn		
Parameter	Variable	Coeffisient	Error Standart	t-Ratio		Coeffisient	Error Standart	t-Ratio
δ 0	intercept	0.802164	1.053747	0.761250		-5.441414	14.868650	-0.365966
δ 1	farming experience	0.265493	0.169843	1.563169		0.473228	0.581499	0.813807
δ 2	age	-0.539743	0.203548	-2.651676	a	-1.819178	1.872995	-0.971267
δ 3	education level	-0.077407	0.032682	-2.368474	a	0.046936	0.101350	0.463109
δ 4	land ownership	0.802164	1.053747	0.761250		5.158652	7.483258	0.689359
δ 5	farming group membership	0.091466	0.292567	0.312633		-0.024444	0.335944	-0.072762
δ 6	other farming	0.326810	0.618780	0.528152		5.563608	11.870535	0.468691
δ 7	other income	0.058094	0.218903	0.265385		0.717652	0.818519	0.876769

Source : Primer Data Analysis, 2016
Notes : a significance at α 5% (2.008559)

Table 3 shows that age and educational level had significance value of techical inefficiency of hybrid corn. Both variables had negative correllation, or had possitive corellation on efficiency, means older farmer (especially in productive age) and higher level of educational will increase technical efficiency. Hussain (1999), Tzouvelekas et al. (2001), and Junaidi (2013) had same result that age had negative corellation to technical inefficiency. Jumiati (2013) and Thamrin (2013) also describe negative corellation of education level to technical inefficiency.

Local corn farming had differed result. There were no variable that had significance affects to technical inefficiency. This is due to several reasons such as : (i) corn is a Madura food that had cultivated since their ancestors, (ii) the farming of local corn has been inheritated from their ancestors, so the farmers has usual to manage farming patch up input and costs, (iii) local corn and it seed resists to pests, and shortly planting times or it need 60-75 days to reap, (iv) the farmers usually still plant corn although they have other farming in a year. The corn is make for consumption or sale, so it always available as a seed.

3. Conclution

Results estimate *Cobb-Douglas* production function with MLE method on both types of corn, there are two variables that significantly affect corn production, namely seeds and labor, while three other variables did not significantly affect corn production function. Local corn farming as much as 52% have been quite efficient and highly efficient, hybrid corn farming while only 6% of the total number of respondents. This indicates that the local corn growers, capable of technically efficient than hybrid corn farmers.

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