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Analysis of Productivity of Soybean [Glycine max (L.) Merr.] for Production for Farmers in Indonesia

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Abstract

Productivity is an average measure of the production efficiency. This study was aimed at identifying the soybean productivity in Indonesia, including production and land area. Total Factor Productivity (TFP) was conducted on 100 farmers in Grobogan Regency, Central Java, which is determined by stratified random sampling. The result shows that the productivity value of soybean is 76.8%. This number can potentially increase output as big as 23.3% using the same input factors. The productivity of soybean in 2014 was 2.03 ton/ha and 2015 the number increased by 4.5% became 2.12 ton/ha. The average value of TFP soybean farming in Grobogan regency was 1.007. It indicated a positive progress of productivity by 0.7% in the last two years. The Productivity of Soybean will have an average value of 1.675 ton/hectare for 8 years, i.e. from 2017 until 2024.

Keywords: DEA; Soybean; Technical Efficiency; Total Factor Productivity

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INTRODUCTION

The economic growth in Indonesia have problem about food and energy. A problem food production in Indonesia is caused by land restricted, climate change extreme, the phenomenon of degradation of agricultural resources, and limited support agricultural infrastructure Saptana [6].

According The Central Bureau of Statistics [1], Production of Soybean in Indonesia was 850,000 ton per year. A demand of soybean is 2.3 million ton per year. The government has been soybean import as big as 1.5 million ton per year. Currently, Indonesia has become one of the largest importers in the world.

The problems of production soybean are less productivity and not profit if was compared with production rice and corn. The other problems are not development

soybean seed industry, optimization land, pricing for local and soybean imports in market. [8].

Grobogan Regency, Central Java is one of the largest production soybean areas in Indonesia. Currently, Grobogan District Government continued to increase production of soybean in this region with local soybean varieties. The number of Grobogan varieties production are 3.40 ton/ha.

During 2007 until 2011, soybean farming in Grobogan was implemented technological and development for increase production. The harvesting soybean in Grobogan regency as big as 19.804 hectares, a total production of soybean is 45254.26 ton and productivity soybean by 2.285 ton/hectare in 2014.

Total factor productivity is the value to detect production efficiency with a various factors. The aspects of production such as the productive area, soybean production, post-harvest handling, as well as aspects of production others associated with the demand and the price of soybeans. In addition to increased production in quantitative factors, another factor is required to achieve that productivity.

The productivity level can be used as an indicator to measure the magnitude of the impact of technological limitations on the performance of the sector through the Total Factor Productivity (TFP) [4]. Total Factor Productivity is the ratio between output and all inputs used in production. TFP reflect the high production efficiency and high productivity. The efficiency is the ability of a business to generate an output (output) by using a certain number of inputs (input) optimally particular. While the technical efficiency (technical efficiency) illustrates the company's ability to achieve the maximum output level using certain input level [7].

Determining the value of technical efficiency and changes in total factor productivity approach Data Envelopment Analysis (DEA). DEA is methods for measuring the performance efficiency use input and output on ventures that have the same input and output by weighting the variables used. [8].

In fact, in many countries a certain TFP growth rate has been set as a target within their national development plans. In this study, the sampling technique was used stratified random sampling. Stratified random sampling is a sampling technique with regard strata in the population [5].

The measurement productivity of soybean is not only from the factor of land, but also the factors of production soybean in Grobogan Regency, Central Java.

This study aimed to identify and analyze the use of the allocation of production factors affecting soybean production in Grobogan; analyze the relative efficiency of

soybean farming in Grobogan with Data Envelopment Analysis method, and analyze the changes in productivity and Total Factor Productivity (TFP), which reflects the progress of soybean production in Grobogan Regency, Central Java.

METHOD

Sampling Techniques

Grobogan, Central Java is the biggest production soybean in Central Java province. The location was determined by purposive on the consideration were selected in five districts in Grobogan, namely District Pulokulon, District Toroh, District Purwodadi, District and Sub-district Wirosari and District Ngaringan. Stratified random sampling method selected for the present population is a region of generalization consists of a set of objects that have the quantity and specific characteristics, the study population is farming soybeans Grobogan where farming activities are activities on farm so the topography factor influence on activities the farming business.

Data

The primary data was conducted by 100 farmers who cultivate yellow soybean crop from five districts sampling in Grobogan Regency with deep interview method for farmers. The input data consist of the area of land, seed, fertilizer, pesticides, labor and operational costs soybean production 2014 and 2015.

Cobb Douglas Function

The function of Cobb Douglas is determined the production scale assumption as Variable Return to Scale (VRS) to calculating technical efficiency and total factor productivity. The Cobb Douglas function is formulated as follows:

$$\mathrm{Ln}\, Yi = \ln a + b_1 \ln X_1 + b_2 \ln X_1 + \cdots + b_9 \ln X_9 \quad (1)$$

Where:

Yi = Soybean production (Output) X1 = area of land

X_2 = Total use of seeds

X_3 = Number of liquid pesticide

X_4 = Total use of organic fertilizers

X_5 = Number of NPK fertilizer use Phonska X6 = Number of Urea fertilizer

X_7 = Total fertilizer use TSP / SP36 X8 = labor

X_9 = Operating costs of production b1.....b8 = regression coefficient

a = intercept

Data Envelopment Analysis (DEA)

DEA method is non-parametric methods based on linear programmers. The function of DEA is to determine production soybean for farmers as the relative efficiency. In addition, DEA is the best a tool of analysis of performance productivity from the other. DEA consider all factors as the basis for the analysis of labor.

The relationship between the factors with each other can communicate in a cross so that the validity of performance may be higher. This study uses an analytical tool used DEA model is the model Banker, Chamer, and Cooper (BBC) with VRS (variable returns to scale) is oriented so that output can be known target output which can be enhanced with a number of inputs available.

The Calculation of Total Factor Productivity changes using Malmquist index approach.

The index of TFP can measuring changes in proportion to the output, *yt + 1,* and the input provided, *xt + 1,* with the technology in period t, and can also be calculated proportional change in output, yt, and input provided, xt, with the technology in period t + 1. So the index Malmquist productivity change between period's t and t + 1 is [2]:

$$M_0^{t,t+1} = \left[\left(\frac{D_0^{t+1}(x_{t+1}, y_{t+1})}{D_0^t(x_t, y_t)} \right) \left(\frac{D_0^t(x_{t+1}, y_{t+1})}{D_0^{t+1}(x_t, y_t)} \right) \right]^{1/2} \quad (2)$$

RESULTS AND DISCUSSION

Harvested Area, Production, Productivity of Soybean

Performance of soybean harvested area in 2005 - 2015 fluctuated, but tended to increase with the average value of 600.646 ha and an average rate increase of 1.71%.

Each year an estimated 80 thousand hectares of agricultural land is lost and change the function to another sector, or the equivalent of 220 hectares per day [1].

Soybean production in the year 2005 - 2015 fluctuated, but tended to increase with the growth rate of 3.8%. Soybean production in 2010-2013 has decreased by 6.92%

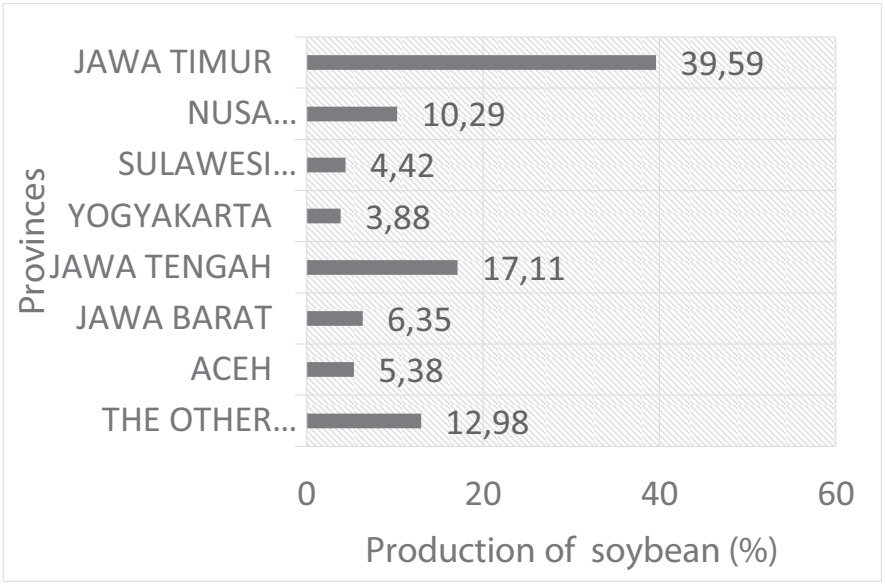

Figure 1: Contribution Production of Soybean in Indonesia 2005 – 2015.

(2011), 6.15% (2012), 0.96% (2012) and 7.49% (2013). The increase in soybean production can be realized for 22.44% (2014) and 4.59% (2015).

The development of national soybean productivity from 2005 to 2015 showed a pattern with fluctuating value of the average productivity of 1.391 ton/hectare with value growth of 1.93%. Soybean production centers in 7 provinces have contributed 87.03% of national production over the last 10 years, while other provinces have contributed to 12.97%. The largest contribution was given by the East Java province by 46% (an average production of 330,750 tons). Furthermore, the province of Central Java amounted to 19.66% (average production of 142,940 ton) and West Nusa Tenggara with 11.83% (85,961 ton). Four other provinces contribute between 5-10%, namely West Java, Aceh and South Sulawesi. As shown in Figure 1, there are 10 provinces as center production of soybean contribution in Indonesia:

Farmers on the island of Java, particularly in Grobogan Regency, Central Java Province which is the largest soybean production centers in Central Java has the potential productivity. The cropping pattern common are three: (1) cropping pattern of rice - soybean - corn, (2) rice - rice - soybean, (3) rice - soybean - other seasonal crops.

The use of inputs affects the growth and yield of soybean. Old crop soybeans from planting to harvest takes an average of four months.

From Table 1, it can be seen that the average production per hectare (productivity) soybean in Grobogan regency 2014 was higher (2.03 ton / ha) than the national average (1.55 ton / ha), and experienced rise 4.5% in 2015, the productivity of soybean Grobogan regency still higher (2.12 ton / ha) on average soybean yield (1.56 ton / ha).

Table 1: The Average increase of Farming Soybean per Hectare.

Districts	Output					
	2014			2015		
	Land Area (ha)	Production (ton)	Productivity (ton/ha)	Land Area (ha)	Production (ton)	Productivity (ton/ha)
Toroh	7,60	14,67	1,93	7,35	13,67	1,86
Purwodadi	6,91	15,44	2,23	6,59	16,14	2,45
Pulokulon	8,68	24,46	2,76	8,60	26,70	3,10
Wirosari	9,02	14,37	1,60	9,02	14,52	1,61
Ngaringan	6,13	8,94	1,46	6,13	9,02	1,47
	38,34	77,87	2,03	37,69	80,04	2,12

Source: Primary Data, 2016

Determining Assumptions constant return to scale (CRS) and variable returns to scale (VRS)

The relative efficiency and Total Factor Productivity with DEA approach requires assumptions pattern of returns to scale are patterned constant return to scale (CRS) or variable returns to scale (VRS), increasing returns to scale and decreasing returns to scale) to be able to apply a linear model programing right. According to Cooper, et al [3], when the preliminary survey on the production function can be identified by linear regression analysis, the type of regression Cobb-Douglas more appropriate to use or you may also use expert opinion to determine the assumptions pattern of returns to scale, so it can be selected DEA model assuming that in accordance with the existing situation.

Multiple regression analysis method Fixed Effect Model (FEM) is used for regression analysis of the Cobb Douglas production function that is performed to determine the contribution of each factor of production simultaneously. The results of data were processed by software Eviews 6.1 produces an estimate of the Cobb Douglas production function. Table 2 below provides a summary of the processing results.

Because the value of the sum of the regression coefficient of each independent variable ($b1 + b2 + b3 + b4 + b5 + b6 + b7 + b8 + B9) > 1$ then returns to scale production efforts farming soybeans Grobogan including increasing returns to scale so that the assumption DEA is used in modeling the variable returns to scale (VRS).

Table 2: The Results of Cobb Douglas.

Independent Variables	Coefficients	Error value	t-test	Probabilities
(1)	(2)	(3)	(4)	(5)
a (*intercept)*	0,971572	2,039082	0,476475	0,6349
ln X_1	0,598940	0,130695	4,582740	0,0000
ln X_2	0,475086	0,132358	3,589402	0,0005
ln X_3	0,061068	0,050767	1,202910	0,2321
ln X_4	0,004148	0,017574	0,236012	0,8140
ln X_5	-0,056265	0,096128	-0,585314	0,5598
ln X_6	-0,010464	0,092081	-0,113637	0,9098
ln X_7	0,355748	0,156413	2,274414	0,0253
ln X_8	-0,000618	0,180953	-0,003415	0,9973
ln X_9	0,244446	0,115165	2,122566	0,0365
R^2	0,997452	F - test		329,7831
Adjusted R^2	0,994427	Probability		0,000001

Source: Primary Data, 2016

Table 3: Efficiency Level Soybean Farming in Grobogan Regency.

Years		**District**					**Average**
		Toroh	Purwodadi	Pulokulon	Wirosari	Ngaringan	
2014	Production of soybean farming	0.877	0.676	0.932	0.635	0.699	0.699
	Inefficient	38.46%	72.72%	30.76%	70%	57.89%	54%
2015	Production of soybean farming	0.870	0.640	0.951	0.666	0.704	0.704
	Inefficient	46.15%	81.81%	26.92%	65%	47.36%	53%

Source: Primary Data, 2016

Production

Table 3 below shows a summary of the efficiency level soybean farming in Grobogan regency period in 2014 and 2015 were calculated using the software Max DEA 6.4.

The analysis showed that the average technical efficiency of soybean farming in Grobogan is 0.767 or 76.7 percent based on the variable returns to scale (VRS). Technical efficiency of 76.7 percent indicates that soybean farming in Grobogan potentially still could increase output by 23.3 percent using the same amount of input. On the average two periods of the growing season can be seen there is a 57% DMU inefficient.

Based on the value of slack calculation input and output parameters are used, it can be illustrated diagram of inefficiency in the use of input parameters, so that it can also use the input parameters which need improvement so that farming can achieve an efficient condition.

Changes in Total Factor Productivity

Total factor productivity growth consists of the change in efficiency (efficiency change) and technical change indices. Based Fare et al in Cheng [2], the index can be demonstrated by measuring changes in proportion to the output, yt + 1, and the input provided, xt + 1, with the technology in period t, and can also be calculated proportional change in output, yt, and the input provided, xt, with the technology in period t + 1. So the index Malmquist productivity change between period's t and t + 1 is:

$$M_0^{t,t+1} = \left[\left(\frac{D_0^{t+1}(x_{t+1}, y_{t+1})}{D_0^t(x_t, y_t)} \right) \left(\frac{D_0^t(x_{t+1}, y_{t+1})}{D_0^{t+1}(x_t, y_t)} \right) \right]^{1/2} \quad (3)$$

Changes efficiency (efficiency change) and technological change (technical change) are the two components of the change in TFP.

$$\text{Efficiency Change (EC)} = \frac{D_0^{t+1}(x_{t+1}, y_{t+1})}{D_0^t(x_t, y_t)} \quad (4)$$

$$\text{Technical Change (TC)} = \left[\left(\frac{D_0^t(x_{t+1}, y_{t+1})}{D_0^{t+1}(x_{t+1}, y_{t+1})} \right) \left(\frac{D_0^t(x_t, y_t)}{D_0^{t+1}(x_t, y_t)} \right) \right]^{1/2} \quad (5)$$

$$M_0^{t,t+1} = EC \cdot TC. \quad (6)$$

$M_0^{t,t+1}$ 1 indicate positive TFP growth from period t to period t + 1, while values less than one indicates a negative TFP growth. In Table 4 below the mean change in total factor productivity of soybean farming in Grobogan planting year period from 2014 to 2015 was calculated using software DEAP 2.1.

As can be seen in Table 4, the average value of total factor productivity change Grobogan is 1.007, in other words, total factor productivity growth overall Grobogan

Table 4: Average *Total Factor Productivity Change*.

Sample area	Efficiency Change (a)	Technical Change (b)	Pure Efficiency change (c)	Scale Efficiency (d = a.c)	Total Factor Productivity Change (e = a.b)
Toroh	0.924	0.984	0.943	0.983	0.943
Purwodadi	1.062	1.021	1.063	0.999	1.081
Pulokulon	0.901	1.029	0.963	0.941	0.947
Wirosari	1.080	1.041	1.005	1.077	1.075
Ngaringan	0.951	1.035	0.914	1.160	0.976
Average	0.984	1.025	0.981	1.028	1.007
Source: Primary Data, 2016					

region by 0.7 percent. The increase in the average annual positive influence on the growth of technology in total factor productivity index, otherwise the negative growth of the average annual change in technical efficiency for 100 farming show that the change of technical efficiency is the main constraint on the achievement of high growth in total factor productivity over the period 2014- 2015. Can also be done through technological progress (technological change) and improved management. The basic technology components and options, including the use of improved varieties, seed quality, pest control (Plant Pest Organisms) in an integrated manner, good land preparation, fertilization in accordance with the needs of plants, watering, and harvesting and post-harvest technology

CONCLUSION

The soybeans farming input usage per hectare in Grobogan regency includes the number of seeds are 60.5 kg, pesticide is 910.5 ml, organic fertilizer is 1205.5 kg, NPK Phonska fertilizer is 155.06 kg, urea- based fertilizer is 103.91 kg, TSP fertilizer is 77.85 kg, the number of labors are 179 people per term, and production operational costs is IDR 10,427,112.00.

The average increase of soybean farming production in Grobogan regency is 76.8% which shows that it can potentially increase the output as big as 23.3% using the same input. The Productivity of Soybean will have an average value of 1.675 ton/hectare for 8 years, i.e. from 2017 until 2024.

The soybeans farming result which is not efficient can be improved in terms of the input management and the role of farmer groups. The increasing of relative efficiency

value can be done by adjusting the actual results and the target value which is recommended on the DEA analysis. The Soybean farming productivity should be improved through research and development policies as well as education and training of good production techniques by government for farmers.

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