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The Influence Of Farm Size Toward The Technical Efficiency Of Hybrid Maize In Panyipatan District, Tanah Laut Regency, South Kalimantan, Indonesia

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***Abstract*:** *Maize is one of the food commodities as a source of carbohydrates for human apart from rice and wheat. This plant plays an important role in the development of the agricultural sector in Indonesia. Besides being a substitute for rice which is consumed directly, maize is also a raw material for animal feed. As the main ingredient, domestic maize demand continuous increase. In 2015, the Association of Livestock Food Entrepreneurs (GPMT) estimated that the need for maize reached 8.5 million tons and only about 40% was fulfilled domestically, so the government continued to boost maize production to become a maize self-sufficiency country. One of the government's efforts is by launching a Special Efforts Program (Upsus) through the development of a three million ha maize planting area in various regions including South Kalimantan. Tanah Laut Regency is a maize production center in South Kalimantan where Panyipatan District is the highest maize production (34.2%). This study aimed to analyze (1) the effect of farm size on the technical efficiency of hybrid maize farming; (2) factors of production (land area, seeds, organic fertilizer, inorganic fertilizer, pesticides, and labor) on maize farming; (3) production elasticity and returns to scale. The study was conducted in two villages in Panyipatan District, Batu Tungku and Sukaramah Village, with 60 respondents. Cobb-Douglas type production function was used to analyze the data. The study showed no effect on farm size on the technical efficiency of hybrid maize farming. The coefficient of determination showed* $R^2 = 0.968$ *(96.8%). Furthermore, simultaneously the factors of production used significantly affect maize production. The production factors that partially had significant effects on maize production were land area, seeds, organic fertilizer, and inorganic fertilizer. While pesticides and labor had no significant effect. However, organic fertilizer had a negative effect on maize production. The elasticity of land area was 0.800; seed was 0.249; organic fertilizer was -0.216; inorganic fertilizer was 0.123, pesticide was 0.016, and labor was 0.029. The scale of business return (return to scale) was equal to 1.01 which is constant return to scale.*

Keywords: *Farm size, technical efficiency, production elasticity, return to scale*

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I. Introduction

Indonesia is a country that has a tropical climate and suitable for agricultural activities. Along with the increasing population, Indonesia has implications for increasing food needs that cause the agriculture becoming one of the most fundamental sectors for humans. This sector has a strategic role and is one of the biggest drivers in the economy in Indonesia. Agricultural development needs to be continuously developed in order to create an efficient, competitive farm, be able to increase the income and farmers' standard of living.

Maize is one of the food commodities and a source of carbohydrates for human. As an agrarian country, this plant plays an important role in the development of the agricultural sector. Besides being a substitute for rice which is consumed directly by the community, maize is also a raw material for animal feed. As revealed Pusdatin (2016) that the maize reaches a high proportion in the animal feed industry which was equal to 51.4%.

As the main feed ingredient, domestic maize demand continues to increase. In 2015 the Association of Livestock Feed Entrepreneurs (GPMT) estimated that the need for maize reached 8.5 million t year^{-1} and only about 40% was fulfilled domestically (Kementerian Perdagangan, 2017). Indonesia's maize production has continued to increase in the last five years. From 2013-2017, maize production increased by 9.44 million tons (51%), so that in the last two years Indonesia has succeeded in suppressing maize imports by 66% (Anonim, 2020).

The government continues to boost maize production with the hope that there will be no more imports to become a maize self-sufficiency country. One of the government's efforts to realize this is by launching a Special Efforts program (*Upsus*) through the development of 3 million ha of maize planting area in various regions in Indonesia, one of which is in South Kalimantan Province (Kementerian Pertanian RI, 2019), where Panyipatan District is the production center, along with Pleihari and Batu Ampar District.

Efficiency is a determinant of competitiveness. Efficient production will cause a decrease in production costs to increase farmers' income and competitiveness of the commodity. Improved technical efficiency can be done using more efficient production inputs (Tasman, 2006). In this case, understanding the technical efficiency that can be accessed by farmers in allocating production factors that are used to facilitate maximum production. It is also necessary to analyze the scale of business returns (return to scale)

Therefore, it is necessary to conduct a research on the effect of farm size scale on the technical efficiency of hybrid maize farming in Panyipatan District, Tanah Laut Regency.

The objectives of this research were as follows: (1) to analyze the effect of business scale on the technical efficiency of maize farming in Panyipatan District; (2) to analyze the effect of production factors (land area, seeds, labor, organic fertilizer, inorganic fertilizer, pesticide, and labor) on maize production (3) to analyze the elasticity of the factors of production and determine the scale of business returns (return to scale). It was hoped that this research would be useful: (1) for the community, especially farmers, to be an input and reference in maize farming, (2) for the government, as a consideration in making decisions in agriculture, (3) for academics, this research was expected to provide information about the efficiency analysis of maize farming.

II. Method

The research was carried out in Panyipatan District, Tanah Laut Regency from April 2019 to January 2020. The research was using survey method. The data collected consisted of primary and secondary data. Primary data was collected through direct interviews with farmers who planted maize using questionnaires. Secondary data were collected from various related agencies such as the Central Statistics Agency, Office of Agriculture for Food Crops and Horticulture, as well as other references.

Respondents were farmers who plant maize in several maize-producing villages in the District of Panyipatan. Based on data from the Agricultural Counseling Center (BPP) of Panyipatan District (2018), the villages that cultivate maize were Suka Ramah, Batu Tungku, Bumi Asih, and Kandangan Lama Village. Other villages were relatively low in maize cultivation. The selected villages were Batu Tungku and Sukaramah.

To answer the first objective which was analyzing farm size scale on the technical efficiency, dummy was used as one of the variables (Gujarati, 2004). Dummy with the number 1 (D = 1) was intended for a large farm size. Whereas the dummy with the number 0 (D = 0) was denoted for a small farm size. Technical efficiency was shown by the amount of intercept of the production function and mathematically can be written as follows (Debertin, 2012):

$$\text{APP} = \frac{Y}{X}$$

$$APP = \frac{a\, X_1^{b1}\, X_2^{b1} \ldots\, X_i^{bi}\, \ldots X_n^{bn}}{X_1^{b1}\, X_2^{b2} \ldots X_i^{bi}\, \ldots X_n^{bn}}$$

$$APP = a \qquad \ldots\ldots 1$$

The second objective was to analyze the effect of production factors on hybrid maize yield by using multiple linear regression functions (Cobb-Douglas function model) as seen below:

$$y = a x_1^{b1} x_2^{b2} x_3^{b3} x_4^{b4} x_5^{b5} x_6^{b6} D_7^{b7} e^{u} \qquad \ldots\ldots 2$$

If transformed to a linear form by the least squares’ method, it becomes:

$$\ln y = \ln \alpha + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \beta_4 \ln x_4 + \beta_5 \ln x_5 + \beta_6 \ln x_6 + \beta_7 D + \epsilon_i \qquad \ldots\ldots 3$$

with: $\hat{Y}$ maize production (kg)
x_1 = land area (ha)
x_2 = amount of seeds (kg)
x_3 = amount of organic fertilizer (bag)
x_4 = amount of inorganic fertilizer (kg)
x_5 = amount of pesticides (L)
x_6 = number of workers (mwd)
α = coefficient of intercept or constant
ε = confounding factor
$\beta_1 \ldots \beta_7$ = regression coefficient variable.

To determine the effect of the whole variables, the F-test formula was applied:

$$F_{\{stat\}} = \frac{\{(MS)_{\{regression\}}\}}{\{(MS)_{\{SSE\}}\}} = \frac{\sum \hat{y}i^2/k}{\sum ei^2/n-k-1} \quad \ldots 4$$

where:
$\sum \hat{y}^2$ = number of regression squares
$\sum e_i^2$ = sum of squares of errors
n = number of samples (59 farmers)
k = total of variables (six).

Hypothesis: H_0: bi = 0
H_1: bi $\neq$ 0

Test criteria:
$F_{stat} > F_{table\ \alpha\ (k,\ n\text{-}k\text{-}1)}$ .... H_0 is rejected
$F_{stat} \leq F_{table\ \alpha\ (k,\ n\text{-}k\text{-}1)}$ .... H_0 is accepted

To find out the effect of each independent variable on the dependent variable the F-calculation formula was used as follows:

$$F_{stat} = \frac{b_i}{S_{bi}} \quad \ldots 5$$

where:
b_i = input free regression coefficient i
Sb_i = standard error coefficient of regression input estimated i.

Hypothesis: H_0: bi = 0
H_1: bi $\neq$ 0

$F_{stat} > F_{table\ \alpha\ (k,\ n\text{-}k\text{-}1)}$ .... H_0 is rejected
$F_{stat} \leq F_{table\ \alpha\ (k,\ n\text{-}k\text{-}1)}$ .... H_0 is accepted

Then, to find out the accuracy of the model R^2 calculation will be used with the following formula:

$$R^2 = 1 - \frac{\sum e^2}{\sum y^2} \quad \ldots 6$$

where:
$\sum e^2$ = sum of error square
$\sum y^2$ = sum of square.

To answer the third objective, which was to analyze the elasticity of production of each input (land area, number of seeds, amount of organic fertilizer, amount of inorganic fertilizer, amount of pesticide, and number of labor), we applied the magnitude of the regression coefficient on the Cobb Douglas type production function. The value of the regression coefficient was also the production elasticity of each factor of production. Next, to determine the return to scale of maize farming was to add the regression coefficients or elasticity parameters as follows:

Increased, if $\beta_1 + \beta_2 + ... + \beta_6 > 1$
Constant, if $\beta_1 + \beta_2 + ... + \beta_6 = 1$
Decreased, if $\beta_1 + \beta_2 + ... + \beta_6 < 1$ 7

III. Result And Discussion

Age

Age of respondents in this study ranging from 34-62 years, an average of 44 years obtained. Most farmers have a young (productive) age of 58 people (96.67%).

Level of education

The highest level of education was senior high school and the lowest level of education was not completing elementary school. The last education taken by most maize farmers was elementary school, amounting to 36 people (60%).

The number of dependents

The average dependents were two persons in each household. The range of dependents were from 1-5 people. The most ranged from 1-2 people, which were 34 people (57%). The more dependents the more motivated to work because of their economic needs.

Land Ownership and Area

The average land area was 2,575 ha. Based on this condition, the land area was divided into two categories: small farm size, which was ≤ average (33 farmers) and large farm size, which was > average (27 farmers). In this study, the average labor required was during seedbed, land clearing, land management, planting, fertilizing, weeding, and harvesting as much as 119,76 mwd per farm or 46.51 mwd ha^{-1}. In fact, the quantity of labor in the cultivation was relatively small, however it was in line with Sidabutar, Yusmini, & Yusri, (2014) and Noorbah, (2018) which labor used were 48,63 and 49,04 mwd ha^{-1}, respectively. Farmers use machinery and equipment for land clearing and seed planting. In addition, the cultivation was in rainy season, hence there was enough water which usually required large workforces in maize farming. Furthermore, the compost used were from chicken manure, so it was not carrying much weeds as cow dung.

Effect of Farm Size on Technical Efficiency of Hybrid Maize Farming and Factors Affecting Maize Production

The production function is the physical relationship between the dependent maize yield variable and the input variable entered as independent (x). Based on the results of the regression analysis, the Cobb-Douglas type production function model for maize farming can be seen below:

$$\ln Y = 8{,}192 + 0.800 \ln x_1 + 0.249 \ln x_2 - 0.216 \ln x_3 + 0.123 \ln x_4 + 0.016 \ln x_5 + 0.029 \ln x_6 - 0.026\ D$$

The results of a brief evaluation of the Cobb-Douglas production function in maize cultivation activities are shown in Table 1.

Table 1. Regression results for the Cobb-Douglas production function

Input	Coefficient	Std Error	t-stat	Prob
Constant	8,192	0.460	17.791	0.000
Land	0.800	0.122	6.532	0.000
Seed	0.249	0.106	2.353	0.022
Org fert	-0.216	0.044	-4.965	0.000
Inorg fert	0.123	0.048	2.564	0.013
Pesticides	0.016	0.025	0.632	0.530
Labor	0.029	0.072	0.400	0.691
Dummy	-0.026	0.042	-0.621	0.538
R-Squared = 0.968 F-Statistic = 222.061				

Source: Primary data processing (2020).

Based on the test results, it turned out that the intercept (constant) is the measure of technically efficiency which is the average physical product (APP) (Doll & Orazem, 1984). Furthermore, the result showed that the farm size as the dummy variable was not significantly affect the technical efficiency of hybrid maize farming. This condition was shown from the Prob. of 0.538 which was greater than 0.05 (α = 5%). This means that there was no difference in the technical efficiency of hybrid maize farming on a small or large farm size.

The Ordinary Least Square method also showed that the model formulated to predict the factors that affect hybrid maize production was relatively accurate (Gujarati, 2004). This was indicated from the magnitude R^2 = 0.968. This means that 96.8% of the variation in hybrid maize production can be explained by the variation of the independent variables which include land area, number of seeds, amount of organic fertilizer, amount of inorganic fertilizer, pesticide, and labor. The remaining 3.2% was explained by other variables not included in the model.

Elasticity

The regression coefficient resulting from the use of the Cobb-Douglas type model on each independent variable also showed production elasticity of each of its production factors (Gujarati, 2004). This elasticity coefficient showed the percentage change in the amount of output (in this case hybrid maize production, measured in percent) due to changes (measured in percent) of the input variables (land area, seeds, organic fertilizer, chemical fertilizers, pesticide, and labor).

Thus, variable land area, amount of seeds, amount of organic fertilizer, and amount of inorganic fertilizer (chemical), pesticide, and labor had successive production elasticities of 0.800 (land area); 0.249 (seed); -0.216 (organic fertilizer), and 0.123 (inorganic fertilizer), 0.016 (pesticide), and 0.029 (labor). Positive or negative sign in the equation showed the direction of the relationship between input and output. A positive sign indicated that if the input increased by 10%, then output would also increase by 10%, but a negative sign resulted in the opposite result. In other words, if the input is increased by 10%, the output decreased by 10%.

This coefficient can be interpreted if the area of land was added by 10%, then hybrid maize production increased by 8.00%; if the amount of seeds was added by 10%, maize production would increase by 2.49%. If inorganic fertilizer increased by 10%, then hybrid maize production would increase by 1.23%, and if pesticide was added by 10%, then hybrid maize production would increase by 0.16%. Likewise, if the amount of labor was added by 10%, then hybrid maize production would increase by 0.29%. The situation was different if the amount of organic fertilizer added, for example by as much as 10%, then the production of hybrid maize would decrease by 2.16%.

Return to Scale

One of the advantages of using the Cobb-Douglas type model is that it can determine the return to scale of the farm being analyzed. Scale of return (return to scale) in a business can be calculated by adding up all the regression coefficients on each independent variable. By knowing this return to scale, it can be seen whether hybrid maize farming follows increasing return to scale, constant return to scale or decreasing return to scale (Soekartawi, 2003).

In this study, the sum of all independent variable regression coefficients showed that the hybrid maize cultivation was 1.01, which means it was on a constant return to scale (RTS). This condition implied that if all factors of production were doubled, then hybrid maize production would increase by the same proportion of two times. In other words, RTS occur when increasing the number of inputs leads to an equivalent increase in the output. Thus, the scale of hybrid maize farming at the research location could still be developed further through bulk buying of inputs, and marketing efficiency.

IV. Conclusion

There was no influence of farm size (either small or large scale) on technical efficiency in hybrid maize cultivation in Panyipatan District, Tanah Laut Regency. The model of Cobb Douglas type showed that the factors of production of land area, seeds, organic fertilizer, inorganic fertilizer, pesticide, and labor simultaneously had significant effects on the production of hybrid maize in Panyipatan District, Tanah Laut Regency. The use of production factors of land area, seeds, organic fertilizer, and inorganic fertilizer partially had a significant effect on hybrid maize production, while pesticide and labor had no significant effect. Nevertheless, organic fertilizer showed a negative effect. Production elasticity in four factors of production used in the model, namely land area, seeds, inorganic fertilizers, and pesticide, as well as labor showed positive elasticity, while the organic fertilizer showed a negative elasticity. The scale of return of hybrid maize farming was in constant return to scale.

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