Economic Production Model of Independent Smallholder Oil Palm Cultivation in Batanghari Regency

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Abstract. Oil palm farming in Muara Tembesi District has the lowest productivity among other Districts in Batanghari Regency, namely 3.06 tonnes/ha. The low productivity figure is thought to have occurred due to the influence of production factors used by farmers. Therefore, this study aims to: 1) Know the description of Swadaya Oil Palm farming in Muara Tembesi District, Batanghari Regency 2) Analyze the effect of production factors (land area, number of stems, plant age, fertilizers, herbicides, and labor) on production yields. Independent oil palm in Muara Tembesi District, Batanghari Regency. This research was conducted on 1 August–1 September 2020 in Jebak, Ampelu, and Ampelu Mudo with a total sample of 54 farmers. Sampling was performed purposively (purposive) on farmers, including pure independent farmers. Primary data and secondary data are used in this study. This study used is descriptive analysis for analytical method and analysis of the Cobb Douglas production function. The results showed the average use of oil palm farming for a land area of 2.95 ha/farmer, number of stems 136.22 stems/ha, plant age 11 years, fertilizer 267.4 kg/ha, herbicide 2.13 L/ha. And a workforce of 79.35 HOK/Ha. The use of land production factors, plant age, fertilizer, herbicide, and labor simultaneously significantly affected oil palm production with an Adjusted R-squared value of 0.984026. Meanwhile, for the production factor, the number of stems simultaneously does not significantly affect the yield of oil palm. Partially, the production factor significantly affects the yield of oil palm farming with a sign of 10%. From the research results, it is hoped that assistance from the local government is needed in the form of fertilizer subsidies to provide relief for farmers in managing their farming.

Keywords: Oil Palm · Independent smallholders · Production economic · efficiency economics

1 Introduction

Presently, oil palm the world's most significant commercial crop [1, 2]. Many farms and nonfarm households in the tropics rely on oil palm cultivation and employment

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for their livelihoods. Oil palm has significantly improved rural poverty and malnutrition (Sibhatu, 2019: [2]. Oil palm adoption enables those rural households to earn a fair living regardless of the seasons. Due to population and wealth development, global demand for vegetable oils is expected to rise in the next decades [3, 4]. To meet this increased demand, it is anticipated that oil palm output would need to increase by 25 mill tons per year for the next decade [5]. The data (FAO, 2020) showed that Indonesia is the world's leading production and land area.

Palm Oil (Elaeis genesis jack) is an agricultural commodity that has an important role in Indonesia's industry and economic development. The results of palm oil can produce palm oil of high selling value. In addition, palm oil is also superior to other vegetable oils [6]. The many benefits of palm oil cause the demand for palm oil to increase. Therefore, efforts to increase palm oil production continue to increase the acreage area. So palm oil is experiencing fairly rapid development, and palm oil production is always increasing yearly. The development of palm oil production also extends to the island of Sumatra, especially in Jambi Province.

The development of oil palm in Jambi Province over the past five years (2014–2018) continues to increase with an area of 70,428 ha and production of 164,279 tons, with an average growth of 3.78% per year and an average growth of palm oil production of 4.17% (Jambi Provincial Plantation Office 2014–2018). As a result, oil palm plantations are one of the leading plantation sectors in the Batanghari Regency. As a result, Batanghari Regency has fairly high productivity after Merangin Regency with a productivity of 3.39 Tons/Ha, a land area of 52,351 ha, and production of 140,905 tons [7].

According to the Jambi Provincial Plantation Office data, Muara Tembesi District has the lowest productivity among other districts, 3.06 tons/ha. The low productivity figure is thought to occur due to the influence of production factors used by farmers. Factors of production in palm oil farming include land area, labor, fertilizer, and pesticides/drugs [8]. The availability of means or factors of production does not always provide products that can benefit farmers. However, how farmers do their farming towards the optimal use of factors of production so that they can get greater profits.

Based on the description that has been explained, the author is interested in 1)—describing the picture of self-help palm oil farming in Muara Tembesi District of Batanghari Regency. 2). Analyze the influence of production factors (land area, number of stems, age of plants, fertilizers, herbicides, and labor) on the production of self-help palm oil in Muara Tembesi District of Batanghari Regency.

2 Research Methods

This research was conducted in the Muara Tembesi District of Batanghari Regency. The selection of research locations was carried out deliberately (purposive) considering that in Muara Tembesi District has the lowest productivity among other sub-districts in Batanghari Regency. Therefore, the population in this study was chosen based on three villages that have the largest mature area of 13 other villages in the Muara Tembesi Subdistrict. Determination of sample withdrawal is determined using the Taro Yamane method [9]. So that the number of research samples obtained is 54 people with a proportional allocation of 23 people in Jebak Village, 20 Ampelu villages, and 11 Ampelu Mudo villages.

The data analysis method used is descriptive and quantitative. To find out about the picture of self-help palm oil farming in Muara Tembesi Subdistrict is explained descriptively. As for analyzing the influence of palm oil production factors, quantitative analysis is used. Regression analysis is used to predict causal relationships between independent and dependent variables. Furthermore, regression analysis can be formed a model of production functions that can be mathematically described as follows [10]:

$$Y = a X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} Ei \quad (1)$$

The solution of the *Cobb-Douglas* function is always first converted into a double linear form by way of the equation:

$$LnY = Ln\,a + b_1 Ln\,X_1 + b_2 Ln\,X_2 + b_3 Ln\,X_3 + b_4 Ln\,X_4 + b_5 Ln\,X_5 + b_6 Ln\,X_6 + e \quad (2)$$

where:
Y = Palm oil production (Kg/Year)
A = Constant
X_1 = Land Area (Ha/Year)
X_2 = Number of Bars (Rods)
X_3 = Age of the Plant (Year)
X_4 = Fertilizer (Kg/Year)
X_5 = Herbicides (Liter/Year)
X_6 = Manpower (HOK/Year)
$b_1 \ldots b_6$ = Variable regression coefficient X_1–X_6
e = error (2,71828)

Furthermore, to examine whether the factors of production used simultaneously affect palm oil production are used F test (Simultaneous Test). The F test steps are as follows:

1. H0: R2 = 0, This means that there are no real free variables.
2. H1: R2 ≠ 0, This means that free variables have a real effect on bound variables.

Based on the value of significance with α (10%), the hypotheses that can be used are as follows:

1. H0 is accepted, and H1 is rejected upon sign. > α, which means that simultaneous independent variables do not significantly affect dependent variables.
2. H0 is rejected, and H1 is accepted when the sign < α, which means that independent variables simultaneously affect dependent variables significantly.

Partial tests are performed to show how far one independent variable's influence is in explaining the variation of a dependent variable. So that each factor of production has a real effect or not on palm oil production (Y), with the following hypothesis:

1. H0: βi = 0 is thought to be partially independent variables that do not affect dependent variables.

Table 1. Average Identity of Respondent Farmers in Research Area

No	Identity of Respondent Farmer	Information
1	Age of the Farmer	47
2	Level of Education	SMA
3	Number of Family Members	5
4	Experience of Trying to farm	19

Source: Primary Data Processed.

2. H1: βi > 0 is thought to be partially independent variables that positively affect dependent variables.

The t value can be further compared to the α. For example, at the α signification rate (10%) then:

1. If sign. < α then rejects H0, meaning that the factor of land area production, the number of stems, the age of plants, fertilizers, herbicides, and labor has a real effect on palm oil production.
2. If sign. > α then receives H0, meaning that the factor of land area production, number of stems, age of plants, fertilizers, herbicides, and labor has no real effect on palm oil production.
3. Classical assumption testing is intended to qualify BLUE (Best Linear Unbiased Estimator) for estimators. It uses the OLS method. The classical assumption test to qualify blue detects multicollinearity, autocorrelation, normality, and heteroskedasticity.

3 Results and Discussions

Identity of Respondent Farmer

Respondent farmers are farmers who are considered to represent the circumstances where the farmer is following the respondents' criteria in the study. Respondents in this study were farmers who worked on oil palm farming in Jebak Village, Ampelu, and Ampelu Mudo Muara Tembesi Subdistrict, with a sample size of 54 farmers. In detail, the identity of the respondent farmers is described in Table 1.

Based on the respondents', farmers are reviewed from the farmer's age, the level of education, the number of family members, and the experience of trying to farm. Farmers on average aged 45–49 years, which is 33.33% and still classified as productive age. A person will have a high spirit in doing his business and faster to adopt innovation at a productive age. The results showed that the level of education taken by sample farmers was 12 years or equivalent to high school education/equivalent, with a percentage of 42.59%. Most of the sample farmers had a family member of 5–6 people with a percentage of 44.44%. The experience of trying to farm in sample farmers has the largest percentage with 19–22 years of farm experience, which is 25.93%. The experience of farming will provide lessons for farmers in cultivating oil palm. It shows that farmers in the research area are already quite experienced in farm palm oil.

Overview of Palm Oil Farming in Research Areas
The independent farming pattern in Muara Tembesi Subdistrict has been since 2005. They are seeking palm oil farming business and manage rubber farming businesses. Farmers' palm oil seeds in the research area are marihat seeds, topaz, and non-legitim seeds. The most widely used planting distance for farmers is 9 × 8 m, which is as much as 47 farmers or with a percentage of 87.04%. Farmers in the research area sell fresh fruit bunches (TBS) to factories, loading, and intermediaries.

The implementation of mature palm oil (Crop Producing) in the research area is carried out through several stages ranging from maintenance, fertilization, spraying to harvesting. First, land maintenance activities consist of cleaning plates as well as wickets. Farmers routinely carry out this maintenance activity at least once a month. Next, farmers must do fertilization activities. This activity is usually done 1–3 times a year. The type of fertilizer that farmers usually use is Urea fertilizer. Spraying or administering herbicides, including activities that farmers rarely do, is usually only 1–2 times a year. Finally, this harvesting activity includes fruit harvesting activities, fruit transportation, to *pruning*. (cutting). Farmers usually do harvesting within 14–20 days, depending on the condition of the fruit. According to farmers, high yields occur in October–December or during the rainy season.

Classic Assumption Test

a. **Multicollinearity Test**
The multicollinearity test using *Variance Inflation Factor* (VIF) showed that the value of > 10 on land is 172.76, the number of stems is 128.27, fertilizer is 11.08, and labor is 42.85. Therefore, it is not free from multicollinearity. While other variables show, the value of VIF, which is < 10 with the value of Centers VIF at the age of the plant is 1.12 and herbicide is 7.96, which means the variable is free from multicollinearity.
b. **Normality Test**
The data is declared normal distribution if the significance is greater than 0.05. The normality test results obtained a Jarque-Bera value of 0.473787 with a Probability value of 0.789075 greater than 0.05 so that it receives H0, which means residual normal distribution.
c. **Autocoleration Test**
The autocorrelation test concluded that H_0:no autocorrelation and H1:there is autocorrelation, with the Breush-Godfrey Serial Correlation LM Test method. So that if probability value *Obs*R-square* < α (0.05), then H0 is rejected. The autocorrelation results concluded that the probability value of *Obs*R-square* of 0.624123 > 0.05 is accepted with a confidence rate of 95%. It can be said that there is no autocorrelation in the regression model.
d. **Heterocedasticity Test**
To detect the problem of heteroskedasticity, the Breusch-Godfrey Serial Correlation LM Test with probability value Obs*Square = 13.49841 > 0.05 then H0 is accepted with a confidence level of 95%, it can be said that there is no heteroscedasticity.

Analysis of the Use of Factors of Production

Analysis using factors of production to determine the extent of the influence of the use of factors of production. The results of the restoration of production functions that describe the influence of land area ($X_{1)}$, number of stems (X2), Plant age ($X_{3)}$, fertilizer ($X_{4)}$, herbicides ($X_{5)}$, and labor ($X_{6)}$ on bound variables, i.e., palm oil production variables (Y) can be seen in Table 2.

Based on the results of the estimates in Table 2, logarithmic equations are written for palm oil farming in the research area as follows:

$$\begin{aligned} \text{Ln Y} &= \text{Ln a} + \text{b1 Ln X1} + \text{b2 Ln X2} + \text{b3 Ln X3} \\ &\quad + \text{b6 Ln X6} + \text{e} \end{aligned}$$

$$\begin{aligned} \text{Ln Y} &= \text{Ln } 7.3501 + 0.5026 \text{ Ln X1} - 0.1528 \text{ Ln X2} \\ &\quad + 0.0951 \text{ Ln X3} + 0.1121 \text{ Ln X4} + 0.0874 \text{ Ln X5} \\ &\quad + 0.4667 \text{ Ln X6} + 2{,}71828 \end{aligned}$$

Next is the results as follows.:

$$Y = 1556, 3445\ X_1^{0.5026} X_2^{-0.1528} X_3^{0.0951} X_4^{0.1121} X_5^{0.0874} X_6^{0.4667}$$

Table 2 shows that the Adjusted R-squared (Adj-R2) value was obtained at 0.984026. It means that 98.4% of the dependent variable (output) in the rate of palm oil production can be explained jointly by independent variables (land area, number of stems, plant age, fertilizer, herbicide, and labor). The lack of 1.6% is influenced by other factors outside the model used. The $F_{\text{statistic}}$ obtained by $0.0000 < \alpha$ (0.01) showed a very real effect, meaning that independent variables (palm oil production) simultaneously affect dependent variables. The value of $\Sigma\beta i = 1.11$ or ($Ep > 1$) means the use of production factors is in area I, which means farmers may still increase production, which is quite profitable. If several factors of production are added, in other words, the scale of palm oil farming is on the increasing returns to *scale* curve area.

The land area variable ($X_{1)}$ has a regression coefficient of $b1 = 0.502649$. This value indicates the magnitude of the elasticity of the influence of land use on production. It can be interpreted that if there is a change in land use increased by 10%, then there is an increase in palm oil farming production by 5.03% in conditions of use of other fixed inputs. The average land use in the research area is 2.98 Ha/Farmer. Testing the large coefficient b1 shows a probability value of $0.0172 < \alpha$ (0.1). Therefore, it can be interpreted that the use of the land area has a real effect on the production of palm oil farming. It is in line with [11] on palm oil farming which states that the widespread use of land affects palm oil production. The wider the land planted, the more plants planted will be more so that the production of fresh fruit bunches is greater.

The variable number of $\text{bars}_{(X2)}$ has a regression coefficient value of $b2 = -0.152788$. This value indicates the magnitude of elasticity of the effect of using the number of rods on production. It can be interpreted that if there is a change in the use of the number of stems increased by 10%, there is a decrease in palm oil farming production by 1.53% in conditions of use of other fixed inputs. The average use of rods in the research area was 136/Ha. Testing the large coefficient b2 shows a probability value of $0.3927 > \alpha$ (0.1).

Table 2. Results of Estimated Production Function of Cobb-Douglas Oil Palm Oil Farming in Research Area

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_X_1_Land	0.502649	0.203522	2.469752	0.0172
LN_X_2_Number of Bars	−0.152788	0.177118	−0.862634	0.3927
LN_X_3_Age of plants	0.095015	0.030081	3.158636	0.0028
LN_X_4_Fertilizer	0.112097	0.034057	3.291494	0.0019
LN_X_5_Herbicides	0.087406	0.041618	2.100220	0.0411
LN_X_6_ labor	0.466680	0.167341	2.788797	0.0076
C	7.350125	1.181233	6.222416	0.0000
R-squared	0.985835	Mean dependent var		10.56661
Adjusted R-squared	0.984026	S.D. dependent var		0.419677
S.E. of regression	0.053042	Akaike info criterion		−2.915060
Sum squared resid	0.132230	Schwarz criterion		−2.657229
Log likelihood	85.70661	Hannan-Quinn criter.		−2.815624
F-statistic	545.1634	Durbin-Watson stat		1.844974
Prob(F-statistic)	0.000000			

Source: Eviews 8,2021

Therefore, it can be interpreted that the use of the number of stems has no real effect on the production of palm oil farming. The results of this study are in line with [11] on palm oil farming which states that the use of the number of stems does not affect the production of palm oil farming.

The plant age variable$_{(X3)}$ has a regression coefficient value of b3 = 0.095015. This value indicates the magnitude of elasticity of the effect of the use of plant age on production. It can be interpreted that if there is a change in the age of the crop increases by 10%, then there is an increase in palm oil farming production by 0.95% in conditions of use of other inputs remain. The average lifespan of plants in the research area was 11 years. Testing of the large coefficient b2 shows a probability value of 0.0028 < α (0.1). It can be interpreted that the use of plant age has a real effect on palm oil farming production. The results of this study are in line with [12] on palm oil farming which states that plant age variables have a positive and significant effect on palm oil production.

The fertilizer variable$_{(X4)}$ has a regression coefficient value of b4 = 0.112097. This value indicates the magnitude of elasticity of the effect of fertilizer use on production. It can be interpreted that if there is a change in fertilizer use increased by 10%, then there is an increase in palm oil farming production by 1.12% in conditions of use of other fixed inputs. The average fertilizer use in the research area was 267.4 kg/Ha. Testing of the large coefficient b3 showed a probability value of 0.0019 < α (0.1), it can be interpreted that the use of fertilizers has a real effect on palm oil farming production. This study follows the hypothesis that fertilizers influence palm oil production. It is in line with [11] on palm oil farming, which states that fertilizers affect palm oil production.

The herbicide variable$_{(X5)}$ has a regression coefficient value of $b5 = 0.087406$. This value indicates the magnitude of elasticity of the effect of herbicide use on production. It can be interpreted that if there is a change in the use of herbicides increased by 10%, there is an increase in palm oil farming production by 0.87% in conditions of use of other fixed inputs. The average use of herbicides in the research area was 2.13 L/Ha. Testing of the large coefficient b4 showed a probability value of $0.0411 < \alpha$ (0.1), it can be interpreted that the use of herbicides has a real effect on the production of palm oil farming. It is in line with Setiyanto's research (2018) on palm oil and rubber farming, which states that herbicides significantly affect production.

The labor variable$_{(X6)}$ has a regression coefficient value of $b_6 = 0.466680$. This value indicates the magnitude of the elasticity of the effect of labor use on production. It can be interpreted that if there is a change in labor use increased by 10%, then there is an increase in palm oil farming production by 4.67% in conditions of use of other fixed inputs. Testing the large coefficient b6 shows a probability value of $0.0556 < \alpha$ (0.1). It can be interpreted that the use of labor has a real effect on the production of palm oil farming. It is in line with [11] on palm oil and rubber farming, which states that labor has a positive and significant effect on production results.

4 Conclusion and Advice

The types of palm oil seeds farmed by farmers in the research area vary, namely *Marehat, Topas*, and non-legitim seeds (without certificates). The planting pattern used is square or square with an average distance of 9 × 8 m. Palm oil production resulting from oil palm farming activities in the research area averaged 14,313.23 kg/Ha/Year with an average selling price Rp. 1,413/Kg. Average use of production factors in oil palm farming for land area 2.95 Ha/Farmer, number of stems 136.22/Ha, crop age 11 years, fertilizer 267.4 kg/Ha, herbicide 2.13 L/Ha, and labor 79.35 HOK/Ha.

The use of land production factors, crop age, fertilizers, herbicides, and labor simultaneously has a real effect on palm oil production with an Adjusted R-squared value of 0.984026. While for the production factor of the number of stems simultaneously has no real effect on palm oil production. Partially, the production factor has a real effect on the production of palm oil farming with a sign at 10%.

It is expected that oil palm farmers in Muara Tembesi District pay more attention to existing production factors to be more optimal. For the local government, both the Provincial government and the Regency government are expected to provide incentives to farmers in the form of fertilizer subsidy assistance to provide relief for farmers in conducting their palm oil farming activities.

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