

Production analysis of smallholding arabica coffee farm in the district of Solok, West Sumatra, Indonesia

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Abstract. Economically and strategically, coffee plays a significant role in economic development. Coffee is one of the agricultural commodities planted and developed in the District of Solok, West Sumatra. Most of the coffee plantations in this district are small scale plantations (smallholdings) owned by farmers' families. To increase the positive economic impact in improving income, the farmers should optimize the utilization of production inputs. This study aims to examine the correlation between the characteristic of farmers and coffee production to investigate factors affecting coffee production and to analyze the return scale of smallholding Arabica coffee farms in the District of Solok. This research used a survey method, and the data were gathered from 60 coffee farmers in two sub-districts, namely the sub-district of Lembah Gumanti and sub strict of Pantai Cermin. The research finds that the characteristic of farmers that positively and significantly correlates to coffee production are age, land area, experience in farming, and education. Moreover, the statistical test shows that all variables were simultaneously affecting the output. However, partially only variables of the utilization of organic fertilizer, labor, and capital, which significantly affect the output. Furthermore, the study finds that smallholding Arabica coffee farms in the district of Solok are in the condition of Increasing Return to Scale, which means the production increases by a more substantial proportion than the increase in input production utilization.

1. Introduction

Coffee is one of the crucial agricultural commodities that contribute to the economic development of Indonesia in terms of foreign exchange. The production of Indonesia coffee is mainly exported to India, the USA, Singapore, Europe, and China. West Sumatra Province, alongside Lampung, South Sumatra, North Sumatra and Aceh, are among the important production centers of Arabica Coffee. According to data released by the Central Bureau of Statistics, in 2016 total production of coffee in West Sumatra was 34.087 tons with a total area of 42.970 ha. This production will increase soon since 6.406 ha of coffee plantation are immature plants (TBM), will add to existing 35.417 mature plants I, and will replace the 1.147 ha of unproduced plants (TTM) [1].

The primary producer of Arabica coffee in West Sumatra is the district of Solok, with a total production of 2.466,8 ton in 2016. Two sub-districts give the most significant contribution to coffee production in this district, namely sub-district of Pantai Cermin and sub-district of Lembah Gumanti with a total output of 294 ton and 145 ton respectively [2]. Moreover, most of the coffee plantation in these sub-districts are small scale plantations (smallholdings) cultivated privately by individual farmers. Therefore most farmers cultivated their farms traditionally with a simple technology and



insufficient knowledge about good Arabica coffee cultivation. Consequently, the productivity of the smallholding Arabica coffee was still relatively low [3].

The strategy that can be applied by smallholding Arabica coffee farmers to increase the productivity and continuity of their farming is managing the utilization of inputs as effectively and efficiently as possible. Theoretically, inputs that should be managed adequately in the production process are land, capital, labors, and management [3]. Therefore, an effort to increase agricultural productivity is by optimizing the utilization of inputs. The usage of input production accurately by farmers will affect the production and ultimately could increase the farmers' income.

Concerning the correlation between input and output production, return to scale analysis is a critical analysis to establish an efficient business scale. Returns to scale describe the response of output to proportional changes of input production [4]. In this case, there are three possible correlations between input and output, namely: increasing return to scale, constant return to scale, and decreasing return to scale [5].

2. Material and Method

This research was conducted in two sub-districts of the district of Solok, Lembah Gumanti and Pantai Cermin. The study used the survey method, and the data were gathered from 60 coffee farmers who were randomly selected from 354 farmers. In general, the study used a combination of qualitative and quantitative methods. Quantitatively, the data were analyzed using correlation analysis and Cobb-Douglas Production function. Furthermore, the variables used in a correlation analysis are the age of farmer, land size, education attainment, and experience in farming. Meanwhile, variables for Cobb-Douglas production function are unit production of Arabica coffee, Number of plants, the utilization of organic fertilizer, Phonska fertilizer, SP 36 fertilizer, capital, and farming experience, plant age, and labors. The equation can be seen below:

$$Y = \beta_0 X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} X_5^{\beta_5} X_6^{\beta_6} X_7^{\beta_7} X_8^{\beta_8} X_9^{\beta_9} e$$

This function then was transformed into the logarithmic equation as follows:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + \beta_9 \ln X_9 + e$$

Where:

- Y = Production of Arabica coffee (kg)
- X1= Land (ha)
- X2= Number of plants (tree)
- X3= Organic fertilizer (kg)
- X4= Phonska fertilizer (kg)
- X5= SP36 fertilizer (kg)
- X6= Number of Labours (man)
- X7= farming Experience (years)
- X8= Age of plants (year)
- X9= Capital (Rp.)
- β_0 , = Constanta

Moreover, Soekartawi states that the return to scale of smallholding Arabica coffee farming can be measured by using the criteria in the Cobb-Douglas production function, as below [6]:

- a. Increasing return to scale ($\beta_1 + \beta_2 + \dots + \beta_9 > 1$)
- b. Constant return to scale ($\beta_1 + \beta_2 + \dots + \beta_9 = 1$)
- c. Decreasing return to scale ($\beta_1 + \beta_2 + \dots + \beta_9 < 1$)

3. Result and Discussion

3.1. Characteristic of farmers and smallholding arabica coffee

The characteristics of farmers and smallholdings Arabica coffee farming measured in this study are age, education, production, land area, experience in farming, organic fertilizer, phoska fertilizer, SP36 fertilizer, labors, plant age, and capital.

Table 1. Characteristic of the farmers and Smallholding Arabica Coffee in District of Solok, 2017

No	The characteristics	Value
1.	Average Farmers' age (year)	47,75
2	Education (%)	>high school: 40 <high school: 60
3.	farming experiance (year)	3,5
4.	Production (kg)	2.719,89
5.	Number of plant (tree)	1.269
6.	Land area (ha)	1,263
7.	Organic fertilizer (kg)	1135,01
8.	Phonska fertilizer (kg)	404,84
9.	SP36 fertilizer (kg)	404,84
10.	Number labours (man)	5
11.	Average Plant age (year)	4,5
12.	Capital (Rp)	9.975.000

3.1.1. Farmers' age

Table 1 shows that the average age of farmers in the district of Solok is 47.75 years old. This finding indicates that most coffee farmers in this district are relatively young and physically strong. Soekartawi states that the age of farmers would influence the way of thinking and productivity [6]. Therefore this study implies that the productivity of Arabica coffee in the district of Solok could be increased since most farmers have strong physical abilities and relatively young.

3.1.2. Education

Education is one of the factors affecting the way farmers in managing their farming. The level of education also greatly affecting the farmers' way of thinking and also in decision making and in adopting technology [7]. The research finds that 40% of farmers have an education level of high school and bachelor degrees and 60% are at the level of elementary and middle school. Formal education of the farmers could affect the farming, the higher the education of the farmers, the more careful the farmers in managing their farm. This finding implies that most of Arabica coffee farmers in the district of Solok have a relatively low educational

3.1.3. Farming experience

Farmers' experience is related to the ability of farmers in managing, maintaining, and marketing their agricultural products. This study finds that the average experience of the farmers in these two sub-districts is 3,5 years. It means most Arabica coffee farmers in the district of Solok have little expertise in cultivating and managing Arabica coffee farming.

3.1.4. Production

The average production of Arabica coffee in 2017 was 2.719,89 kg per land area or equal to 2.154,07 kg per ha. The harvesting was carried out in the plant age range of 1.5 - 2 years. Moreover, the collection was carried out unscheduled, depending on the maturity of the coffee

fruit. However, in sub-district of Lembah Gumanti, the main harvest of Arabica coffee usually takes place in July

3.1.5. Number of plants

The average Number of Arabica coffee plants owned by farmers in these two sub-districts is 1.267 trees per land area or equivalent to 1.005 trees per ha. Good Agricultural Practices (GAP) on coffee states that the recommended Number of arabica is 1.600 trees/ha [8]. This fact implies that the Number of coffee plants on a smallholding is still below the recommended coffee population per ha, and this could affect the production.

3.1.6. Land area

The land is one of the input factors significantly affect the production. The wider the land owned by farmers, the higher the output that can be produced. Furthermore, the average land area owned by farmers in the study area is 1.26 ha [9].

3.1.7. Organic, Phonska and SP36 fertilizer

The average utilization of organic fertilizer in the research sites was 1.135,01 kg per land area or equivalent to 898,90 kg per ha. Each farmer using organic fertilizer varies depending on the land area they have. The farmers usually get the fertilizer from the Federation of Farmer Group (*Gapoktan*) and cooperatives. Meanwhile, the average utilization of phoska fertilizer and SP 36 fertilizer was 404,84 kg per land area or equal to 320,62 kg per ha. The use of these fertilizers also varies depending on the land area they have.

3.1.8. Labors

The usage of labor in smallholding Arabica coffee farms in the District of Solok ranges from 1-9 men per farming with an average usage of labor is five men per farming. Generally, the labor is male workers who come from within the smallholding family. Additionally, the smallholding Arabica coffee only use a little number of paid labor; it is normally during the harvest season to avoid delays in picking coffee bean.

3.1.9. Plant age

Research finds that the average age of coffee plants is 4.45 years. Coffee plants start producing for the first time in the age range of 2.5 - 3 years. So it can be seen that the majority of Arabica coffee in the district of Solok has just started productive age so that its production has not been fully maximized.

3.1.10. Capital

The average capital for inputs used by farmers is Rp 9.975.000 per land area or equivalent to Rp 7.899.947 per ha. This financial capital is used for land processing, wages of labor and cost of fertilizers.

3.2. The correlation between the characteristics of farmers and production

The analysis of *Pearson Correlation* to investigate the relationship between the characteristics of Arabica coffee farmers in District of Solok and the output is presented in table 2 below:

Table 2. The correlation between the characteristic of farmers and production

Variable	Person Correlation	Significant (2-tailed)
Farmers' Age	0,104	0,427
Land Area	0,385	0,002
Experiance	0,759	0,000
Education	0,267	0,037

Table 2 shows that all variables have a positive correlation with the production of Arabica coffee. However, of all these variables, only experiences that have a positive and significant correlation to production. It means the longer the experiences of farmers in farming, the higher the production of Arabica coffee. Additionally, the experience in farming is one of indicators that could determine the success of farming. Farmers who have longer experience will have a better ability to manage their farming; therefore the productivity will increase [6, 9].

3.3. Factors affecting the production of arabica coffee

This study used Cobb-Dougllass Production Function to determine factors affecting the production of Arabica coffee in the District of Solok. The result of the analysis can be seen in Table 3 below:

Table 3. The result of regression analysis

Variables	Koefisien	t _{statistik}	Prob
Constant	-11,312	-4,818	0,000
Land area (X ₁)	-0,106	-0,773	0,443
Number of plant (X ₂)	-0,183	-0,872	0,387
Organic fertilizer (X ₃)	0,574	2,707	0,009*
Phonska fertilizer(X ₄)	-0,334	-0,363	0,718
SP36 fertilizer(X ₅)	0,022	0,023	0,982
Labours (X ₆)	0,362	2,339	0,023*
Farming experiences (X ₇)	0,246	1,396	0,169
Plants' age (X ₈)	-0,019	-0,117	0,907
Capital (X ₉)	1,091	6,771	0,000*
F _{value} = 27,341			
R _{square} = 0,828			
Production (Y)			

Note: * The level of significance is 5%

The regression equation of the analysis is as follows:

$$\ln Y = -11,312 - 0,106 \ln X_1 - 0,183 \ln X_2 + 0,574 \ln X_3 - 0,334 \ln X_4 + 0,022 \ln X_5 + 0,362 \ln X_6 + 0,246 \ln X_7 - 0,019 \ln X_8 + 1,091 \ln X_9 + e$$

From the equation above can be seen that the utilization of input factors, organic fertilizer, SP36, labors, and experience positively affecting the production of Arabica coffee. The value shows that the increase of the inputs by 1% will lead to the increase of production by the coefficient of each variable

in the equation. Meanwhile, the variables of land area, Number of plants, phoska fertilizer, and plant age have a negative sign. This indicates that the usage of each variable by 1% will reduce production by the coefficient of each variable.

Moreover, the coefficient of determination (R_2) obtained from the model is 0.828. This value of R_{Squared} indicates that 82.8% of production can be explained by all variables used in the equation, while the remaining (17.2%) could be explained by other factors that not included in this study.

Furthermore, the statistical test used to identify factors significantly affecting the production of Arabica coffee in District of Solok is F_{test} and t_{test} . The test finds that the F_{value} of the model is 27.13, it means all variables simultaneously affect the production. Moreover, t_{test} indicates that the partially only variable of organic fertilizer, labor and capital had a significant effect on the production of Arabica coffee at the significance level of 0.05.

Adriyansyah dan Marhaeni (2017), in their research findings, state that the utilization of fertilizer and labors was significantly affecting the production of coffee [10]. Dewi (2017) also has similar findings that the utilization of fertilizer and labor was significantly affecting the production of coffee [11]. This study finds that most smallholdings of Arabica coffee in the research area used labors in the family. They only use paid labors when harvesting in order to avoid rotten beans due to late harvest. Moreover, input factors of capital is an important production factor to increase production. The availability of capital for financing the production process and labor will greatly affecting production. Therefore lack of capital will lead the low production [6].

3.4. Return to scale analysis

Return to the scale of smallholding Arabica coffee farm in District of Solok is the sum of the coefficients of all variables in the Cobb-Douglas Production functions shown below;

$$\begin{aligned} &= \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \beta_7 + \beta_8 + \beta_9 \\ &= -0,106 - 0,183 + 0,574 - 0,334 + 0,022 + 0,362 + 0,246 - 0,019 + 1,091 \\ &= 1,653 \end{aligned}$$

The finding shows that smallholding Arabica coffee in the District of Solok was in the condition of Increasing Return to Scale, which means the production increases by a larger proportion than the increase in input production utilization. This might be happening due to the allocation in the use of input that has not been optimized. When the utilization of input factors has not optimal, then the increase in the utilization of input factors will lead to the increase in production. Nchare (2007) states that productivity can be improved by maximizing the usage of input factors [12].

4. Conclusion

All the characteristics of Arabica coffee farmers in the District of Solok, which consists of the age of the farmers, land area, experience, and education, have a positive correlation with the production of Arabica coffee. However, of all these variables, only experiences that have a positive and significant correlation to production. Moreover, the research finds that all variables simultaneously affect production. However, the partially only the variable of organic fertilizer, labor, and capital had a significant effect on the production. Furthermore, smallholding Arabica coffee in the District of Solok was in the condition of Increasing Return to Scale, which means the production increases by a larger proportion than the increase of the usage of input production.

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