

TECHNICAL EFFICIENCY OF COFFEE FARMING IN LIMA PULUH KOTA REGENCY, WEST SUMATRA PROVINCE

Andini Puspa Yoga¹, Rahmat Syahni², Hasnah³

¹Master of Agricultural Economics Student, Faculty of Agriculture, Andalas University

^{2,3}Lecturer in the Agricultural Economics Study Program, Faculty of Agriculture, Andalas University

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E-mail:

andinipuspayoga@gmail.com

ABSTRACT

Technical efficiency is the ability to avoid waste by producing as much output as possible with existing inputs and technology or by using fewer inputs with the same technology that will produce the same output. Fifty Cities District is one of the areas that has the potential to develop Robusta coffee plants. The available production factors cannot guarantee high productivity. The purpose of this study was to analyze the factors that influence the productivity of Robusta coffee, analyze the level of technical efficiency of Robusta coffee farming and analyze the factors that affect the technical efficiency of Robusta coffee farming in the District of Fifty Cities. The method used in this study was a survey method on 60 samples through simple random sampling. Data analysis uses the Cobb-Douglas production function. The results showed that the factors that significantly influence coffee productivity in Fifty Kota District are the age of the plants and the number of trees. Factors of plant age and number of trees have a positive impact on coffee productivity. The technical efficiency level of coffee farming in Lima Puluh Kota Regency ranges from 0.54 to 0.99 with an average technical efficiency level of 0.83. This means that farmers are technically efficient but can still increase coffee productivity.

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1. INTRODUCTION

The plantation sub-sector is one of the agricultural sectors that has an important role. This can be seen from the role of the plantation sub-sector which is able to make a major contribution to the Indonesian economy and has an important role in the development process, such as a source of foreign exchange and a provider of employment. The plantation sub-sector provides high added value so that it can boost the agricultural sector in the national economy. Plantation commodities that have experienced rapid export development are palm oil, rubber, coffee, cocoa, tea, coconut and other plantations. This can be seen from its production which continues to increase so that it becomes a mainstay commodity for Indonesian exports on the world market.

Coffee is an important plantation commodity in Indonesia. Indonesia is the fourth largest coffee producing country in the world and is ranked fifth in the world's coffee exporting countries after Germany. Coffee is a plantation crop that has very good potential to be developed, considering the high consumption of coffee by the community. Currently, Indonesia's coffee production has reached 786,191 tons in 2021 and more than 80% comes from smallholder plantations (BPS Province of West Sumatra). Coffee is one of the plantation commodities which is a world-famous Indonesian asset. The results of coffee products in Indonesia are not only consumed for the local people themselves, but currently Indonesia is able to export coffee plants up to another country. There are generally two types of coffee cultivated in Indonesia, namely Arabica and Robusta coffee.

One of the largest robusta coffee producing regions in Indonesia is West Sumatra Province. The Robusta coffee commodity in West Sumatra is dominated by smallholder plantations. The area of Robusta coffee in West Sumatra from 2017 to 2020 has decreased, in 2017 the area of Robusta coffee in West Sumatra was 18,295 Ha and has decreased until 2020, namely 17,174 Ha. In 2021 the area of Robusta coffee land in West Sumatra will increase to 18,013.91 Ha. Robusta coffee production has fluctuated from 2017 to 2021, in 2017 it rose to 2018 with a production value of 9,660.12, decreased until 2020 to 9,186.00 Tons and experienced another increase in 2021. Fifty City District is one of the regions coffee production in West Sumatra. Of the 13 sub-districts in Lima Pluh Kota district, only one sub-district does not produce coffee, namely Kapur IX sub-district. Fifty Cities District has potential land resources that have the potential to be

developed as an agricultural area, especially the plantation sub-sector, with adequate land area and very favorable natural conditions, so it is not surprising that the plantation sub-sector, namely coffee plantations, is one of the mainstay commodities.

The area of the Robusta coffee planting area in the Fifty Cities District has fluctuated, from 2018 it increased to 2019, namely to 886 hectares, from 2019 it decreased until 2021 to 621.5 hectares. This decrease in land area is expected to occur because most of the coffee plants are cultivated by smallholder plantations. Other factors that have caused a decrease in the area of coffee fields are the narrow ownership of farming land, and the absence of recommended technology implementation in farming business development. Thus affecting coffee productivity which cannot reach optimal. As for the fluctuating Robusta coffee production, coffee production rose from 2018 to 2019 and decreased until 2021, namely 332.64 tonnes.

Fifty Cities Regency is one of the coffee producers in West Sumatra. Until now there are still many problems faced in plant development. One measure of success in farming activities is productivity. Production that is not optimal will affect low productivity as well. The potential prospects for coffee demand in the domestic and foreign markets have not been followed by an increase in productivity.

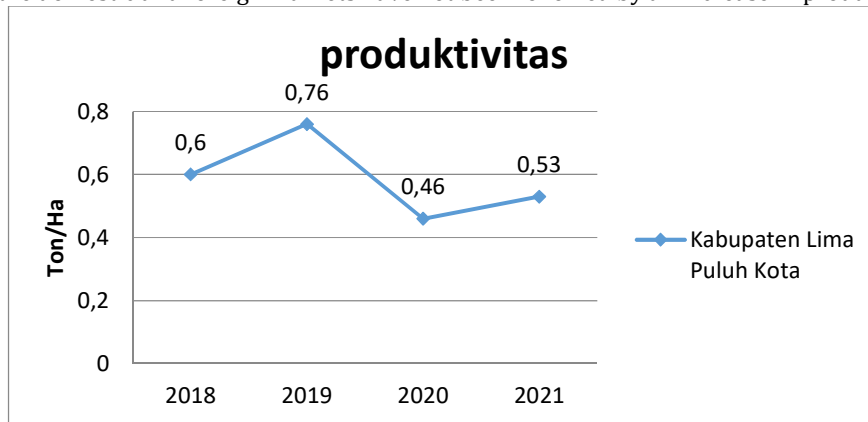


Figure 1. Productivity of Robusta Coffee in Fifty Cities District

Based on the figure above which shows the productivity of Robusta coffee in the Fifty Cities District is experiencing fluctuating conditions. The highest peak of Robusta coffee productivity in the Fifty Cities District was in 2019 at 0.76. However, this productivity value is still far below the potential productivity value of coffee, which is 1.2 tons/ha/year. This shows that coffee production in this area still has the potential to be increased. One indicator of efficiency is the response of the amount of production to changes in the number of factors of production. In increasing the technical efficiency of the use of factors of production, the use of technology in proper cultivation activities is very necessary. Another reason for the low productivity value of coffee is thought to be due to the old age of the coffee plants.

The allocation of production factors for land, labor, and capital such as fertilizer is one of the main determining factors for achieving optimum production. The use of these production factors will affect the level of limitations on land and labor resources, forcing farmers to allocate inputs as efficiently as possible so that maximum profits are obtained. Therefore, it is necessary to know how efficient the use of these factors of production is, whether they are already at their maximum capacity. Knowledge of the optimal allocation of input use is expected to increase the technical efficiency of coffee farming in the District of Fifty Cities.

Based on the description above, the problems that will be studied in this study are 1) Factors that influence the productivity of Robusta coffee in Fifty Cities District, 2) Level of technical efficiency of Robusta coffee farming in Fifty Cities District, 3) Factors that influence technical efficiency of Robusta coffee farming in Fifty Cities District.

2. LITERATURE REVIEW

Customer Loyalty

Consumer loyalty is a customer's commitment to a brand, store or supplier based on very positive traits in long-term purchases (2). This means that brand loyalty is obtained because of a combination of satisfaction and complaints.

Shopping Attributes Online

Brusch et al (2019) (3) define the attributes of online shopping, namely when the website design can save buyers time, make it easy to use, offer information about product variations, and deliver goods quickly, customers can be very satisfied.

Shopping Experience Online

The shopping experience is the impact of persuasive communication and consumer feelings after using the product. People who consume many types of products for the sensations, feelings, images, and emotions produced by a particular product they choose can also be defined as a consumer experience. So that the consumer shopping experience is very influential on the desire of consumers to shop again, consumers will return to buy these products if consumers are satisfied with the product they bought then (4).

Customer Satisfaction

According to (5) Customer satisfaction is the level of one's feelings after comparing the performance or results he feels compared to his expectations.

Conceptual framework

Based on the description above, it can be built research framework as follows:

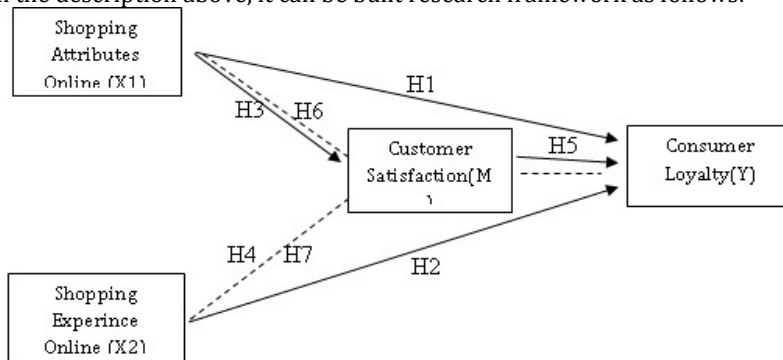


Figure 2. Research Framework

Research Hypothesis

Based on the problem formulation and conceptual framework above, the research hypothesis put forward by the researcher is as follows:

1. Shopping attribute online has a positive and significant influence on loyalty.
2. Shopping experience online has a positive and significant influence on loyalty.
3. Shopping attribute online has a positive and significant influence on satisfaction.
4. Shopping experience online has a positive and significant influence on satisfaction.
5. Satisfaction has a positive and significant effect on loyalty.
6. Shopping attribute online has a positive and significant influence on loyalty through satisfaction.
7. Shopping experience online has a positive and significant influence on loyalty through satisfaction.

3. METHODS

This research was conducted in Mungka and Guguak Districts which are areas with the highest productivity in Fifty Cities District. Fifty Cities District is one of the coffee producing areas Robustain West Sumatra Province. The method used in this study is a survey approach. to know directly the activities of coffee farming Robustaby coffee farmers Robustain the area. The sample used in this research is coffee producing farmers Robustain the Fifty Cities District. Fifty Cities District consists of 13 districts. Then, the sub-districts were selected based on the highest productivity and the Mungka and Guguak sub-districts were selected as sample locations. Sampling by means of Simple Random Sampling, the number of samples obtained 60 Robusta coffee farmers.

The types of data collected are primary data and secondary data. Primary data obtained through direct interviews with respondents, namely Robusta coffee farmers using a structured questionnaire that had been prepared beforehand. Data collection was carried out by direct observation and systematic

recording of research subjects. Secondary data was collected from the Directorate General of Horticulture, Ministry of Agriculture of the Republic of Indonesia, BPS, the Office of Food Crops and Horticulture and from various references relevant to this research.

Variables and Observables

The variables used in measuring the factors that influence coffee production are

1. Productivity (Y), namely the amount of coffee production Robusta produced by farmers per hectare of land. Productivity will be recorded in tons per hectare (Tons/Ha).
2. Labor force (X1), namely the number of workers involved in the cultivation of coffee plants to produce including fertilizing, weeding, eradicating pests and diseases, harvesting and post-harvesting. Labor is recorded in units of working days (HKP/Ha/year).
3. The use of manure (X2), namely the amount of manure used in Robusta coffee cultivation. The use of manure is recorded in kilograms (Kg/Ha/year).
4. Use of NPK fertilizer (X3), namely the amount of NPK fertilizer used in Robusta coffee cultivation. The use of NPK fertilizer is recorded in kilograms (Kg/Ha/year).
5. The age of the Robusta coffee plant (X4), expressed in years (Years).
6. Number of trees (X5), namely the number of trees in the area planted by farmers. The unit is tree (tree/Ha).

The variables used to analyze the factors that influence the technical efficiency of coffee farming are:

1. Farmer age (Z1), the age of coffee farmers at the time of the study expressed in years (Years).
2. Farmer education (Z2), namely the length of education of coffee farmers with units of years (Years).
3. Farming experience (Z3), length of experience of farmers working on coffee plantations expressed in years (Years).
4. Dummytraining (Z4), namely the participation of farmers in participating in training, which is stated in units 1 = attending training, 0 = not attending training.
5. Land area (Z5), namely the total area of coffee land owned by farmers (Ha)

Stochastic frontier production function analysis

The form of the Cobb Douglas stochastic frontier production function in this study is shown in the equation

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + v_i - u_i$$

Where:

- Y = productivity Robusta coffee. (tonnes/ha)
 X1 = number of workers (HKP/ha/year)
 X2 = amount manure (kg/ha/year)
 X3 = amount of NPK fertilizer (kg/ha/year)
 X4 = plant age coffee (yr)
 X5 = number of trees (trees/ha)
 β_0 = intercept or constant
 β_i = coefficient of production factor regression / estimator parameter
 $v_i - u_i$ = term error (v_i is the noise effect, u_i is the model's technical inefficiency effect)

Technical Efficiency Analysis

Technical efficiency analysis can be analyzed using the formula:

$$TE_i = \frac{y_i}{y_i^*}$$

TE_i is the technical efficiency of the i th farmer, y_i the actual output produced and y_i^* is the output of the frontier function. Technical efficiency values range between zero and one. This value is inversely related to the value of technical inefficiency which also ranges from zero to one.

The stochastic frontier approach produces two conditions simultaneously, namely the level of technical efficiency as well as the influencing factors. From the output side, the technical efficiency of each i -th farmer is obtained through observing the output of the stochastic frontier. The farmer's technical efficiency value is categorized as quite efficient if the value is ≥ 0.7 and is categorized as inefficient if the value is < 0.7 (Kumbhakar 2000).

The u_i variable is a random variable that describes technical inefficiencies in production activities and is related to internal factors. The greater the value of u_i , the greater the technical inefficiency carried

out by farmers or the smaller the technical efficiency achieved by farmers. The value of the distribution parameter (u_i) for the effect of technical inefficiency in this study is mathematically indicated by the equation

$$u_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6$$

Where:

- u_i = technical inefficiency effect
- δ_0 = constant
- Z_1 = farmer's age (years)
- Z_2 = farmer's education (years)
- Z_3 = farming experience coffee (year)
- Z_4 = dummy training ($d_1=1$ participated in coffee cultivation training, $d_1=0$ did not participate in coffee cultivation training).
- Z_5 = land area (Ha)

Research Hypothesis

1. Factors affecting productivity
 - a. H_0 = Production factors (labor, amount of manure, amount of NPK fertilizer, plant age and number of trees) have no effect on coffee productivity in Lima Puluh Kota District.
 - b. H_1 = Factors of production (labor, amount of manure, amount of NPK fertilizer, plant age and number of trees) are thought to have an effect on coffee productivity in Lima Puluh Kota District.
2. Factors affecting technical efficiency
 - a. H_0 = The factors of farmer age, farmer education, coffee farming experience, training, and land area have no effect on the technical efficiency of coffee farming in Fifty Kota District.
 - b. H_1 = The factors of farmer age, farmer education, coffee farming experience, training, and land area have no effect on the technical efficiency of coffee farming in Fifty Kota District.

4. RESULTS AND DISCUSSION

A. Robusta Coffee Cultivation in Fifty Cities District

This research focused on Robusta coffee farming activities on coffee plants that have produced (TM) including fertilization, pest and disease control, weed control, and harvesting.

Fertilization, fertilizer is one of the important factors in cultivation activities. Giving fertilizer to plants can support plant growth so as to increase production and produce quality fruit. There are two types of fertilizer used by the respondent farmers, namely manure and NPK fertilizer. Not all of the respondent farmers use NPK fertilizer, there are also farmers who only provide manure. The reason is because the price of fertilizer is expensive so that farmers prefer manure and also they think that the application of inorganic fertilizers such as NPK has no effect on Robusta coffee production. From the results of observations in the field, the application of fertilizer by farmers is done manually by making fertilizer holes around the plants, then the fertilizer is put into the fertilizer holes.

Weed control is a plant that lives around cultivated plants whose presence is not desirable because it can interfere with plant growth so that it does not achieve maximum production. Weed control on Robusta coffee plants is carried out by farmers in two ways, namely manually using machetes and hoes and chemical methods by spraying round up doses of 0.3 l/ha.

Pest and Disease Control is one of the pests that can reduce the quality and quantity of coffee cherries. There are two types of pests that often attack Robusta farmers' coffee plants in Lima Puluh Kota District, namely fruit borer and stem borer. Coffee berry borer pests or often known as coffee powder pests (BBK) usually attack starting from the tip of the fruit or seeds that are still on the tree or those that have fallen to the ground. Meanwhile, stem borer pests that attack coffee plants come from female moths that lay their eggs on the surface of the coffee stem bark, after the eggs hatch, the larvae will drill the upper stem of the coffee plant. It is these larvae that will drill the bark down to the cambium and xylem which results in the death of the coffee plant.

Control of fruit borer and stem borer can be done chemically using insecticides. However, only a few of the respondent farmers exercised control using insecticides. Many of the respondent farmers did not carry out pest control or only left their coffee plants affected by pests and diseases. The reasons are 1) because farmers do not know how to control these pests, 2) because the costs are expensive and 3) because the coffee yields are reduced due to these pests which are still <25%.

Harvesting Robusta coffee plants can be harvested after they are 2.5 - 3 years old. Ripe coffee cherries can be seen from the change in the color of the fruit skin. Dark green coffee cherries indicate young

fruit, yellow cherries indicate half-ripe fruit and red cherries indicate ripe fruit. Robusta coffee can be harvested 2 times a year in stages. In contrast to the method of harvesting which is generally carried out by coffee farmers, where there is a regular harvest and a big harvest. The Robusta coffee farmers in the study area did not carry out regular harvests and large harvests. They harvest every time there is fruit that is ripe and ready to be harvested. Usually in a month they can harvest 2 times and get a yield of 50-150 kg/month, depending on the area of land they have.

B. Characteristics of Respondents

Table 1. Characteristics of Robusta Coffee Farmers in Fifty Cities District

| No | Characteristics | Number of people) | Percentage (%) | Average |
|----|----------------------------------|-------------------|----------------|---------|
| 1 | Age (Years) | | | 46 |
| | 28-35 | 15 | 25 | |
| | 36-45 | 17 | 28 | |
| | 46-55 | 14 | 24 | |
| | 56-64 | 11 | 18 | |
| | > 64 | 3 | 5 | |
| | Education Level (Year) | | | 7,8 |
| | No school | 11 | 18 | |
| | Elementary school (1-6 years) | 17 | 29 | |
| | Junior High School (7-9 years) | 11 | 19 | |
| | High School (10-12 years) | 16 | 26 | |
| | College (13-16 years) | 5 | 8 | |
| 3 | Coffee Farming Experience (Year) | | | 7,7 |
| | ≤ 5 | 12 | 20 | |
| | 6-10 | 42 | 70 | |
| | >10 | 6 | 10 | |
| 4 | Followed training | | | 0.5 |
| | Yes | 30 | 50 | |
| | No | 30 | 50 | |
| 5 | Land Area (Ha) | | | 1.24 |
| | 0.25 - 1 | 33 | 55 | |
| | 1,1 - 2 | 22 | 37 | |
| | 2,1 - 3 | 5 | 8 | |

C. Use of Factors of Production

Production factors in this study are production inputs used in coffee cultivation. Production factors used include labor, use of manure, use of NPK fertilizer, plant age and number of trees

a. Labor

The workforce considered in this study is the use of labor on productive plants which include fertilizing, weed control, pest and disease control and harvesting. Based on the research results, the use of labor varies between farmers, depending on the area of land owned by farmers and the cultivation carried out by coffee farmers. The workforce used by coffee farmers ranges from 25 HKP to 49 HKP. The average number of use of HKP by 60 respondent farmers is 37HKP/Ha for all activities.

b. Use of Manure and NPK

It is assumed that the use of manure and NPK will increase coffee production. The inorganic fertilizer used in this research is only NPK fertilizer. However, not all coffee farmers use NPK fertilizer due to limited funds and also the opinion of the respondent farmers that the use of chemical fertilizers does not affect farmers' coffee yields and that the land treated with chemical fertilizers will become arid. While the organic fertilizers used by farmers in the research location only use manure.

Table 2. Fertilizer distribution data for respondent farmers

| No | Fertilizer Type | Average Dosage (Kg/Ha/Year) | Which use (Person) | Those Who Don't Use (Person) | Percentage (%) |
|----|-----------------|-----------------------------|--------------------|------------------------------|----------------|
| 1 | Manure | 627 | 36 | 24 | 60 |
| 2 | NPK fertilizer | 92.5 | 37 | 23 | 61 |

c. Plant Age

The age of the coffee plant will affect the resulting production. Coffee plants can be harvested when the coffee plants are 2.5-3 years old. The ideal age for productive coffee plants is from 5 to 20 years. Respondent farmers have coffee plants that vary from 3 years to 20 years.

d. Number of trees

The number of coffee trees owned by farmers varies. Starting from the lowest of 600 sticks to the highest, namely 1500 sticks. The number of trees owned by the respondent farmers varied depending on the area of land owned and the spacing. The number of coffee plants will affect the production produced. The more trees a farmer has, the higher the productivity of the coffee plant.

Table 3. Distribution of Respondent Farmers' Coffee Plants

| No | Number of Plants | Number of people) | Percentage (%) |
|---------------|------------------|-------------------|----------------|
| 1 | 600 – 900 | 20 | 33 |
| 2 | >900 – 1200 | 29 | 49 |
| 3 | >1200 – 1500 | 11 | 18 |
| Amount | | 60 | 100 |

1. Preliminary Analysis of the Production Function

The model used in the analysis of coffee production is the Cobb Douglas stochastic frontier production function. This production function consists of five independent variables that are thought to affect coffee production, namely labor, manure, NPK fertilizer, age of coffee plants, and number of coffee trees. The following presents descriptive statistics of the Cobb Douglas production function variable of coffee farming.

Table 4. Statistical Descriptive Variables of the Production Function of Coffee Farming

| Variable | Symbol | Average | Standard Deviation | Minimum | Maximum |
|----------------------|--------|---------|--------------------|-----------|----------|
| Productivity (kg/ha) | Y | 777,2 | 183.9 | 400 | 1300 |
| Labor (HKP) | X1 | 37 | 7.00 | 25 | 49 |
| Manure (kg) | X2 | 638.4 | 537.00 | 0 | 1500 |
| NPK Fertilizer (kg) | X3 | 92.7 | 87.00 | 0 | 300 |
| Plant Age (years) | X4 | 7.90 | 2.80 | 4 | 20 |
| Number of Trees | X5 | 1017 | 203,9 | 600 | 1500 |
| Farmer Age | Z1 | 46 | 11.84 | 28 | 78 |
| Farming Experience | Z2 | 7,76 | 2.69 | 3 | 19 |
| Farmer Education | Z3 | 7,8 | 47,9 | No school | Bachelor |
| Training | Z4 | 0.5 | 0.50 | - | - |
| Land area | Z5 | 1.24 | 0.69 | 0.25 | 3 |

Based on Table 4. the average value (mean) for the dependent variable of productivity is 777.4 kg/ha with a minimum productivity value of 400 kg/ha and a maximum of 1300 kg/ha. It can be seen in table 14. The number of respondent farmers who have a minimum productivity of 400 kg to a maximum of 1300 kg. The standard deviation value is 183.9, this shows that the data is less varied because the standard deviation value is less than the average value. The labor variable has an average of 37 HKP with a minimum value of 25 HKP and a maximum of 49 HKP. While the standard deviation value is 7.00. Manure and NPK variables have a minimum value of 0, this shows that there are farmers who do not use manure and NPK and the maximum value of using manure is 1500 kg while the maximum value of the NPK variable is 300 kg/ha. Furthermore, the variable age of the plant with the average age of the plant owned by farmers is 7.90 years, with a minimum plant age of 4 years and a maximum of 20 years. The number of trees variable has an average value of 1017 with a minimum number of trees of 600 and a maximum number of trees of 1500. The data on the number of trees is less diverse as seen from the standard deviation value which is lower than the average value of 203.9. This is because farmers generally use the same spacing in research. with a minimum plant age of 4 years and a maximum of 20 years. The number of trees variable has an average value of 1017 with a minimum number of trees of 600 and a maximum number of trees of 1500. The data on the number of trees is less diverse as seen from the standard deviation value which is lower than the average value of 203.9. This is because farmers generally use the same spacing in research. with a minimum

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This research was conducted in two stages: the first stage used the Ordinary Least Square (OLS) method to estimate the parameters of production factors used for coffee farming activities. Then proceed with the Maximum Likelihood (MLE) estimation method to estimate the overall parameters of production factors, intercepts and variances of errors v_i and u_i where this method can describe the maximum productivity relationship that can be achieved at the level of use of existing production factors. Next, look for the value of the technical efficiency of the respondent farmers and the factors that affect technical efficiency.

2. Estimating the Cobb-Douglas Production Function with the OLS Method

Analysis of the Cobb Douglas production function using the OLS method was carried out on 60 respondent farmers to calculate the coefficient of determination (R^2) resulting from the equation. The following is the result of estimating the Cobb Douglas production function using the OLS method

Table 5. Estimation results of the Cobb Douglas production function using the OLS method

| Production Input Variables | Coefficient | Q | Pr > t |
|----------------------------|-------------|-------|---------|
| Constanta | 0.409 | 0.60 | 0.553 |
| ln (Labor) | 0.112** | 1.76 | 0.084 |
| ln (Manure) | -0.003 | -0.71 | 0.484 |
| ln (NPK Fertilizer) | 0.009 | 1.24 | 0.219 |
| ln (Plant Age) | 0.144* | 2,16 | 0.035 |
| ln (Number of Trees) | 0.798* | 7.03 | 0.000 |
| R-Square | 0.71 | | |
| Adj R-Square | 0.69 | | |

*significant at the α level of 0.05; **significant at the α level of 0.1

Based on the results of testing the hypothesis above, the Cobb Douglas production function model is obtained as follows:

$$\ln Y = 0.409 + 0.112 \ln X_1 - 0.003 \ln X_2 + 0.009 \ln X_3 + 0.114 \ln X_4 + 0.798 \ln X_5$$

The interpretation of the Cobb Douglas production function equation above is as follows:

- If the independent variables (labor, manure, NPK fertilizer, plant age and number of trees) are considered constant, the production output will increase by 0.409.
- The magnitude of the regression coefficient of the labor variable is 0.112. This means that if the number of workers increases by 1 percent, the total production output will increase by 0.122 percent assuming other variables are constant.
- The magnitude of the regression coefficient of the manure variable is -0.003. This means that if the amount of manure increases by 1 percent, the total production output will increase by -0.003 percent assuming other variables are constant.
- The magnitude of the regression coefficient of the NPK fertilizer variable is 0.009. This means that if the amount of NPK fertilizer increases by 1 percent, the total production output will increase by 0.009 percent assuming other variables are constant.
- The magnitude of the regression coefficient of the plant age variable is 0.114. This means that if the total age of the plants increases by 1 percent, the total production output will increase by 0.114 percent assuming other variables are constant.
- The magnitude of the regression coefficient of the variable number of trees is 0.798. This means that if the number of trees increases by 1 percent, the total production output will increase by 0.798 percent assuming other variables are constant.

The coefficient value on the results of data analysis in table 18. Obtained an R-Square determination of 0.71, meaning that 71% of the variations in coffee productivity produced can be explained by the variables of labor, manure, NPK fertilizer, plant age and number of trees grown. used in the production function estimation model, while 29% is explained by other variables outside the equation model. Furthermore, this production function model is analyzed using the stochastic frontier production function approach.

From the results it can be seen that labor has a significant effect on coffee productivity at the α level of 10 percent and the number of trees and plant age has a significant effect on coffee productivity at the α level of 5 percent.

3. Estimating the Cobb-Douglas Production Function with the MLE Method

The second stage is the estimation of the Cobb Douglas production function using the Maximum Likelihood Estimation (MLE) method. The estimation results using the stochastic frontier production function approach using the MLE method describe the best performance of the respondent farmers.

Table 6 . Results of Estimating the Cobb-Douglas Production Function with the MLE Method

| Production Input Variables | Coefficient | Z | P > z |
|----------------------------|-------------|-------|--------|
| Constanta | 1.035 | 1.93 | 0.140 |
| ln (Labor) | 0.067 | 1.48 | 0.732 |
| ln (Manure) | -0.001 | -0.34 | 0.379 |
| Ln (NPK Fertilizer) | 0.004 | 0.88 | 0.022 |
| ln (Plant Age) | 0.113* | 2,28 | 0.000 |
| ln (Number of Trees) | 0.760* | 8.33 | 0.053 |

*significant at the α level of 0.05

Based on the results of the estimation of the stochastic frontier production function model using the MLE method above, it was found that the significant variables at the 0.05 and 0.10 levels were plant age and number of trees, so that these two variables could be included for further analysis. The difference in the estimated results with the OLS method occurs because the function estimation using the MLE method is based on the maximum production function which describes the best performance of the respondent farmers at the existing technology level, while the estimation of the production function using the OLS method is based on the average production function.

Based on the results of data processing above, it was found that the independent variables of plant age and number of trees had a significant effect on the dependent variable productivity at the 0.05 level in this study. The coefficient values of plant age and number of trees have a positive influence on coffee productivity in Fifty Kota District.

The variable plant age was found to have a positive and significant effect on productivity with a limit production value of 0.113. This means that every 1 percent increase in the age of coffee plants that are already producing will increase 0.113 percent of coffee productivity. The optimal age for coffee plants to produce is from 5 to 20 years old. In the study area, 92 percent of the respondent farmers had coffee plants of optimal age for production.

The variable coefficient of the number of trees is 0.760 with a coefficient value that has a positive effect on coffee productivity, meaning that every 1 percent increase in the number of trees that produce coffee plants will increase coffee productivity by 0.760 percent. The number of coffee trees varies in the study area, depending on the planting distance and the area of land owned by the farmers. The more the number of trees the higher the productivity of coffee plants. This is in accordance with Pane's research (2011), the regression coefficient value of 0.712 indicates that every time there is an increase in the number of producing plants of 1 tree/ha, there will be an increase in coffee production of 0.712 kg/year. Conversely, if there is a decrease in the number of producing plants, it will cause a decrease in coffee production.

D. Technical Efficiency Analysis

According to Kumbakar and Lovell (2000)The level of technical efficiency is between 0 and 1, where 0 means very inefficient while 1 means very efficient. The farmer's technical efficiency value is categorized as quite efficient if the value is ≥ 0.7 and not yet efficient if the value is < 0.7 . From the results of research on the technical efficiency of coffee farmers in the District of Fifty Cities, it was found that the technical efficiency level of coffee farming in the District of Fifty Cities was between 0.59 – 0.98. The average level of technical efficiency of coffee farmers is 0.83, meaning that coffee productivity in the study area has reached 83% of the maximum production limit that can be achieved assuming good management. This figure shows that on average the respondent farmers are technically efficient,

Factors Affecting Technical Efficiency of Coffee Farming

Table 7. Estimation of Technical Inefficiency Effects of the stochastic frontier production function of coffee farming

| Production Input Variables | Coefficient | Z | P > z |
|----------------------------|-------------|-------|--------|
| Constanta | -2,049 | -1.38 | 0.168 |
| Age (Z1) | -0.003 | -0.14 | 0.889 |
| Farming Experience (Z2) | 0.127 | 1.22 | 0.223 |
| Farmer Education (Z3) | -0.051 | -0.77 | 0.439 |
| Training (Z4) | -1,920 | -1.69 | 0.090 |
| Land Area (Z5) | -1,320* | -3.04 | 0.002 |

*significant at the α level of 0.05

Farmer's age variable has a negative effect but does not have a significant effect on the effect of technical inefficiency with a coefficient value of -0.001. That is, the older the farmer, the more efficient he is in doing coffee farming. This is because age is a proxy for coffee farming experience so that as farmers get older, the farmer's experience in coffee farming also increases. This is because in the research area the farmers already have coffee farming experience gained from helping their parents' farming activities. As many as 95 percent of the respondent farmers are productive age farmers, so they are quite efficient in farming.

Socio-economic factors of education have a negative coefficient and no significant effect. The education coefficient value is -0.051 indicating the lower the farmer's education, the lower the level of technical efficiency obtained. Due to the negative effect, farmers who have a higher level of education tend to be more technically efficient. This is because the level of education is low, the ability to manage farmers will not be optimal, because farmers only rely on their experience during farming activities. This states that education is an important variable that can increase efficiency,

The variable of farmer participation in coffee cultivation training is negative and has no significant effect. This illustrates that farmers who have attended training related to coffee cultivation can improve technical efficiency. Farmers who take part in the training will better understand how to carry out coffee cultivation in accordance with good coffee cultivation guidelines, so that farmers can apply it to farmers' coffee plants according to what is given in the training on coffee cultivation. However, the facts on the ground found that very few farmers attended coffee cultivation training, only 34 percent of the respondent farmers were due to the fact that training from related parties had not been carried out routinely and evenly to all coffee farmers.

The coefficient of land area owned by respondent farmers is negative and has a significant effect on technical inefficiency. This means that the wider the land owned by the farmer, the more technically efficient the farmer will be. However, this is not in line with Fauziah's research (2021), which found the variable land area to be positive and not have a significant effect. This means that the wider the land owned by farmers, the

5. CONCLUSION

Factors that significantly influence coffee productivity in Lima Puluh Kota District are plant age and number of trees. This happened because 92 percent of the farmers in the study area had coffee plants of the optimal age for production. while labor, manure, NPK fertilizer have no significant effect. Factor, plant age number of trees has a positive impact on coffee productivity. The technical efficiency level of coffee farming in Lima Puluh Kota Regency ranges from 0.54 to 0.99 with an average technical efficiency level of 0.83. This means that farmers are technically efficient but can still increase coffee productivity if they use production inputs properly and correctly, so that the technical efficiency of coffee farming in Fifty Cities District is increasing. The factor that significantly affects technical efficiency is land area. The wider the land owned by farmers, the more technically efficient farmers will be compared to farmers who have narrower land

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