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ALLOCATIVE EFFICIENCY OF COCOA FARMING IN MADIUN REGENCY

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ABSTRACT

The objectives of the study are: (1) to identify factors that affect the production of cocoa farming, (2) to measure the allocative efficiency of cocoa farming, and (3) to estimate the income and profit of cocoa farming in Madiun Regency. The general method used in this research is descriptive analysis. This research was conducted in District Dagangan and District Gemarang, Madiun Regency, from October 2017 to March 2018. The selection of research location and respondents used purposive sampling, with the total of the respondents were 50 farmers. The analysis methods used in this study are a regression analysis to determine the factors affecting the production of cocoa, allocative efficiency analysis, as well as revenue and profit analysis. The result showed that: (1) factors that increase the production of cocoa farming were the total of cocoa trees, the used of fungicide, and farming experience, while factor that decreases the production of cocoa farming is the age of cocoa trees, (2) total of cocoa trees and use of fungicide had not achieved efficiently, and (3) the average of income from cocoa farming is IDR 9,633,555.45/ha/year, and the profit is IDR 1,617,338.24/ha/year.

Keywords: *allocative efficiency, cocoa, income, profit*

INTRODUCTION

Cocoa (Theobroma cacao) is one of the agricultural commodities from the plantation sub-sector, which has an essential role in the national economy. These commodities play a role in encouraging the development of the region and the development of agro-industries. Indonesia is the third-largest cocoa producer in the world after Ivory Coast and Ghana. Indonesian cocoa plantations have experienced rapid development since the early 1980s, where the community manages 96% of the area, and the state and private sectors manage 4%. The area of Indonesian cocoa plants continues to increase every year; in 2016, the cocoa land area was approximately 1,722,315 hectares with cocoa bean production of around 760,429 tons per year (Ditjenbun, 2015).

According to Ditjenbun (2012), cocoa development faced several problems: crop productivity is still below the potential to normal, the pest attack is difficult to control by individual farmers, seed quality is low, the downstream industry in the country has not developed, and the difficulty farmers to get access to capital cocoa development. Of the various problems that exist, productivity becomes a critical thing considering its effect on production results, determining the amount of income and profit of cocoa farmers.

The existing production factors need to be used efficiently to produce the maximum possible benefit from cocoa farming activities. Inefficient use of production factors can result in high production costs and low production yields. One way to measure the efficiency of the use of production factors is by calculating the allocative efficiency.

METHOD

The research method used is descriptive analysis. This research was conducted in cocoa development centers in Madiun Regency, namely Segulung Village, Dagangan District, and Bathok Village, Gemarang District. The research location selection was carried out by purposive sampling that carried out deliberately with a specific purpose. The time of collection was carried out in October 2017 and March 2018. The sampling method used was purposive. The number of samples taken was 50 samples consisting of 25 samples in The Dagangan District and 25 samples in The Gemarang District.

Analysis of cocoa farming production factors employs multiple linear regression analysis through the Cobb-Douglas production function with the OLS (Ordinary Least Square) method. The formulation of cocoa farming production shown as:

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

The form of the equation is then transformed into a natural logarithm:

ln Y = ln a + b_1 ln X_1 + b_2 ln X_2 + ... + b_{12} ln X_{12} + b_{13} ln X_{13} + u ....(2)

Where:
ln Y = production of cocoa beans (kg)
ln X_1 = land area (ha)
lnX_2 = number of trees (stems)
lnX_3 = plant's age (years)
lnX_4 = organic fertilizer (kg)
lnX_5 = source N fertilizer (kg)
lnX_6 = SP 36 fertilizer (kg)
lnX_7 = NPK fertilizer (kg)
lnX_8 = fungicide (l)
lnX_9 = insecticide (l)
nX_{10} = labor of maintenance (AME)
lnX_{11} = labor of harvest & postharvest (AME)
lnX_{12} = farmer's age (years)
lnX_{13} = farmer's experience (years)
a = intercept
b = regression coefficient
u = error

Before the regression analysis is carried out, the classical assumption is tested to obtain the best model. The best model is a model that meets the requirements of BLUE (Best Linear Unavailable Estimator) or an estimator that is linear, unbiased, and has the lowest variance. Some of the classical assumption tests carried out include the normality test, multicollinearity test, and heteroscedasticity test. After the classical assumption test is carried out, it is necessary to test the model accuracy (Goodness of Fit Test) using the coefficient of determination (adjusted R^2), carried out by the F test and t-test.

The analysis of the allocative efficiency of cocoa farming in Madiun Regency can be seen with the following formula:

$k = \frac{NPMxi}{Pxi}$ ....(3)

Where:
NPM = Marginal Product Value
P = Price
Xi = Average input usage
k = The coefficient of the use of production inputs
k = 1, it means that the use of production inputs are efficient
k ≠ 1, when k >1 means the use of x input is not efficient yet; k<1 means the use of x input is not efficient

The Ki value obtained and tested by a one-sample t-test to determine a significant difference between the values of k obtained by the value of k = 1 indicates that the allocative efficiency, hypothesis testing as follows.
H_0 : k value =1
H_1 : k value ≠1

1. If t-count > t-table, then Ho is rejected, meaning that the value of k from the observation results is significantly different from k=1.
2. If t-value ≤ t-table, then Ho is accepted, it means that the k value of the observation results is not significantly different from k=1.

In research conducted, the costs used include variable costs and fixed costs. Variable costs are all costs whose amount depends on the amount of production desired, such as the cost of seeds, fertilizers, and pesticides. Fixed costs are fixed and are not affected by the amount of production, for example, tax costs and equipment depreciation costs. The sum of these two costs will produce a total cost which can be written as follows:

TC = FC + VC..(4)

Where:
TC = Total Cost
FC = Fixed Cost
VC = Variable Cost

Before calculating income, it is necessary to know in advance how much income the farmer receives. Revenue, or what can be called gross income, is all income obtained by farmers from farming activities during one period. The revenue can be calculated using the following formula:

TR = P x Q...(5)

Where:
TR = Total Revenue
P = Price
Q = Quantity (quantity / amount of product produced)

After knowing the value of revenue, the income obtained by farmers can be calculated. Income is the difference between gross revenue or income and total farm expenses. In a systematic form, the income can be written as follows:

I = TR-TC..(6)

Where:
I = Income
TC = Total Cost

Furthermore, to determine the profit obtained in cocoa farming, it is calculated by reducing the income with explicit and implicit costs incurred by farmers or reducing the income with implicit costs. This calculation can be written with the following formula:

$$\Pi = TR - (TC)_{eksplisit+implisit} \qquad (7)$$

Where:
Π = Profit

RESULTS AND DISCUSSION

Characteristics of Cocoa Farmers

Farmers who were respondents in this study entirely male sex by age ranges are still in the productive category (15-64 years) as much as 90%, the rest are in non-productive age (> 64 years). Seeing the age of the farmers who are still productive, it can be indicated that they can carry out their farming activities well. At the productive age, farmers still have a healthy physique to support their work productivity; their absorption of various information to support their farming business is also good.

The level of education pursued by the average farmer is finished elementary school (48%), junior high school graduation (18%), have completed high school (26%), and higher education (8%). Based on these data, it can be concluded that the education level of farmers, which mostly only reaches the primary school level, shows that the quality of education for farmers is still low.

Forty-eight percent of respondents state that cocoa farmers are their primary job, while the rest mention it as a side job. Regarding the cocoa farming experience, the average person has 11-20 years of experience. From these results, it can be said that farmers have been running cocoa for a long time. Experience is an essential factor because it will affect their skills in farming. Farmers with long enough farming experience will be more skilled in farming.

Land and Condition of Cocoa Trees

The land is an essential factor in farming because the land is a medium for plant growth. The land area will affect the size of the production. The wider the land, the more trees, and the farmers' production results will also increase, and vice versa. The average area of land owned by farmers is 0.53 hectares with self-ownership status. In an area of 0.53 hectares, 254 plants are yielding an average spacing of 5x4 meters. This number is still far from the recommendation, namely in one land, and it can reach 1000 trees with a planting distance of 3x3 meters (Pusat Penelitian Kopi dan Kakao Indonesia, 2010). Meanwhile, most of the cocoa plants are> 11 years old. At that age range, the cacao tree had to be done to maintain productivity rejuvenation.

Use of Production Inputs

Farmers quite a lot use a variety of production inputs ranging from cacao trees, fertilizers, pesticides, and labor. Fertilizer is the input of production with the most types. Cocoa farmers use organic fertilizers, namely manure and petrochemical fertilizers. In addition to organic fertilizers, farmers use inorganic fertilizers, which are applied twice a year to meet the cocoa plant's nutrient needs, namely at the beginning of the rainy season and the end of the rainy season. In the study area, various types of inorganic fertilizers used by cocoa farmers were found, namely NPK phonska, urea, ZA, and SP36.

Meanwhile, to reduce the risk due to pests, farmers use insecticides and fungicides. In carrying out farming activities, labor is an important factor. In this study, labor based on their activities is divided into maintenance, harvest, and post-harvest labor. Maintenance includes fertilization, pest control, pruning, and weeding, while harvest and post-harvest activities include picking, peeling pods, fermentation, and drying of cocoa beans. In detail, the use of production inputs can be seen in table 1.

Production and Productivity

Production in the form of dry cocoa beans per farm is 323.60 kg/year, cocoa productivity per year reaches 605.44 kg/ha or 12.11 kg/tree. The productivity achieved by cocoa farmers in Madiun Regency is still lower than the national cocoa productivity in 2016, which reached 799 kg/ha on smallholder plantations (Ministry of Agriculture, 2016). When viewed from the average age of the cocoa plant, which is 11.5 years, it is still in the age with high production potential. The low production of cocoa in the Madiun Regency is undoubtedly influenced by several factors, such as using production factors and natural factors. When viewed from the cacao tree population in one hectare, it is still far from recommended, so production is still low. Besides, there was an attack by the cocoa pod borer (CPB) in one location, namely Dagangan District, which resulted in a significant decrease in production.

Table 1. Average Usage Input Cocoa Production in Madiun Regency in 2018

Input Type	Amount per Farming	Amount Per Hectare	Recommendations Per Hectare
Number of trees (stems)	254.00	476.00	1,000.00 [1]
Manure (kg)	2,248.00	4,205.85	3,469.00 [1]
Petroganic Fertilizer (kg)	53.57	100.22	-
NPK Phonska Fertilizer (kg)	135.87	254.20	238.00 [2]
Urea Fertilizer (kg)	36.50	68.29	105.00 [1]
ZA fertilizer (kg)	75.22	140.72	-
SP 36 Fertilizer (kg)	9.25	17.31	98.00 [1]
Fungicide (lt)	0.17	0.31	500.00 [1]
Insecticide (lt)	1.11	2.08	-
Labor of Maintenance (HKO)	29.98	56.09	-
Labor of Harvest & Post-Harvest (HKO)	54.39	101.76	-

Source: Primary data analysis, 2018

Description: [1] = Recommendation from Pusat Penelitian Kopi dan Kakao Indonesia (2010)

[2] = Recommendation from PT. Petrokimia Gresik

Analysis of Factors Affecting Cocoa Production

In this study, the factors of production used in the regression analysis were land area, number of trees, plant age, organic fertilizers, N source fertilizers, SP36 fertilizers, NPK phonska fertilizers, fungicides, insecticides, maintenance labor, harvest and post-harvest labor, age of farmers, and farming experience. The production factors analyzed in the regression function underwent several changes. The organic fertilizer production factor combines two types of fertilizers, namely manure and Petroganic fertilizer. The N source fertilizer production factor is a combination of single N fertilizers, namely urea, and ZA, calculated as the percentage of each fertilizer's N content.

Based on the results of the regression analysis of the production function, it can be seen that the coefficient of determination (adjusted R-squared) is 0.92. This value means that 92% of the independent variables in the model are land area, the number of trees, plant age, organic fertilizer, N-source fertilizer, SP36 fertilizer, NPK Phonska fertilizer, fungicide, insecticide, the labor of maintenance, the labor of harvest and post-harvest, farmer’s age, and farming experience can explain the dependent variable, namely cocoa production. Meanwhile, 8% of the variation is explained by variables not included in the model. The analysis results can be seen in table 2.

Based on table 2, it can be seen that the probability value of the F-statistic is 0.000; this value is smaller than α (1%). From these results, it can be said that the independent variables consisting of land area, number of trees, plant age, organic fertilizers, N source fertilizers, SP36 fertilizers, NPK fertilizers, fungicides, insecticides, maintenance labor, harvest and post-harvest labor, age of farmers, and farming experience have a significant effect on the dependent variable of cocoa production. Meanwhile, production factors that significantly influence cocoa production are the number of trees, plant age, fungicides, and farming experience.

The estimation results of the regression coefficients on the number of trees, fungicides, and farming experience have a positive effect, while the age of the trees has a negative effect. The number of trees' regression coefficient value is 0.937, significant at the 99% confidence level (α = 1%). It means that each additional 1% of the number of trees will significantly increase the production by 0.937%. The number of cacao trees will determine the amount of cocoa production obtained; the more plants will undoubtedly allow the higher production amount. Vice versa, if there are fewer cacao trees that can be planted, the production will also be less.

Table 2. Results of Multiple Linear Regression Analysis of Production Factors Affecting Cocoa Farming Production in Madiun Regency in 2018

Variable	Signs of Hope	Coefficient	t-Count	t-Significance
Ln C	+	0.463ns	0.451	0.655
Ln (land area)	+	0.085ns	1.024	0.313
Ln (number of trees)	+	0.937***	8.977	0.000
Ln (plant's age)	-	-0.436**	-2.393	0.022
Ln (organic fertilizer)	+	-0.002ns	-0.254	0.801
Ln (source N fertilizer)	+	-0.004ns	-0.414	0.681
Ln (SP 36 fertilizer)	+	-6.03E-5ns	-0.005	0.996
Ln (Phonska NPK fertilizer)	+	0.0124ns	1.283	0.208
Ln (fungicide)	+	0.034***	2.950	0.006
Ln (insecticide)	+	-0.016ns	-1.282	0.208
Ln (labor of maintenance)	+	0.018ns	0.257	0.799
Ln (labor of harvest & postharvest)	+	0.113ns	0.930	0.359
Ln (farmer's age)	-	-0.058ns	-0.285	0.778
Ln (farmer's experience)	+	0.404*	0.223	0.079
R-squared				0.939
Adjusted R-squared				0.917
F-statistic				42.753
Prob. (F-statistic)				0.000

Source: Primary data analysis, 2018

Description

*** = significance at the 99% confidence level (α=1%)

** = significance at the 95% confidence level (α=5%)

* = significance at the 90% confidence level (α=10%)

ns = not significant

The fungicide's regression coefficient value was 0.034, which was significant at the 95% confidence level (α = 5%), which means that each addition of 1% to the amount of fungicide will significantly increase the production by 0.034%. Most farmers use fungicides, especially during the rainy season. Some apply it as a preventive measure; some are applying it as an effort to eradicate it. The n accordance with its function, fungicides are a type of pesticide used to treat fungal attacks. In this study, fungicides were used to treat Phytophthora palmivora fungi. This fungus always attacks cocoa plants during the rainy season since humid conditions and poor land sanitation can cause this fungus. As a result of the attack of the Phytophthora palmivora fungus, yields can decrease due to 50% of the fruit ready for harvest experiencing rot, so the use of this fungicide is vital in preventing loss of production. The positive effect of fungicides on the cocoa production level indicates that the use of fungicides is effective in treating fungus.

The farmer experience's regression coefficient value is 0.404, significant at the 90% confidence level (α = 10%). It means that each additional 1% of farmer experience will significantly increase production by 0.404%. The experience farmers have become one of the production; the longer a farmer has experience in farming, the more experiences or lessons learned in farming. Farmers with long experience in cocoa farming usually have a better understanding of the problems faced in cocoa farming. However, it does not mean that farmers who have little experience do not understand the farming being carried out. The willingness of farmers to learn and seek information related to their farming will also determine their abilities.

Variable regression coefficients age of the plant is -0.436 significant at 90% confidence level (α = 10%). It means that every 1% addition of plant age will significantly reduce the production by 0.436%. The age of plants is one of the determinants of productivity achieved by the cacao tree. The older the cacao tree, the lower the productivity of a plant. Seeing the negative coefficient results indicate that at the age of 11.5 years of cocoa trees owned by farmers, production has decreased. In contrast, according to the Cocoa Research Center, cacao trees have decreased production starting at the age of 15-20 years so that in that age range the efforts Rejuvenation efforts must be made so that decreased productivity can be overcome. Based on this, it can be indicated that the replanting process has not been carried out by the farmers properly, causing a decrease in production as the age of the trees.

Table 3. Analysis of Allocative Efficiency of Cocoa Farming in Madiun Regency in 2018

Factors of Production	bi	xi	NPMxi	Pxi	Ki	Prob-t	Description
Number of trees	0.94	254.00	24,467	20,000	1.22	0.000***	Not Efficient
Fungicide	0.03	0.17	1,354,018	189,588	7.14	0.000***	Not Efficient

Source: Primary data analysis, 2018
Description:
bi = Regression coefficient xi
xi = The average use of production factors to the cocoa-i
NPMxi = The value of the marginal product of factors of production to-i
*** = significance at the 99% confidence level (α=1%)
** = significance at the 95% confidence level (α=5%)
* = significance at the 90% confidence level (α=10%)
ns = not significant

After testing, it can be seen that the use of input production for the number of trees and fungicides has not reached an efficient level allocative, so there is still a chance to increase revenue by increasing the number of inputs to a more efficient level. The following are descriptions for each variable.

Number of Trees. The value of ki in the number of trees' production factor is 1.22 (larger than 1). The one-sample t-test then tests the value of ki, and a significance value of 0.000 is obtained, which is less than α 5% so that Ho is rejected, meaning that the number of trees is on the farmer's land not allocated efficiently. The average land-use area for cocoa in Madiun Regency is 5,345 m² or 0.53 hectares, with the number of trees produces an average of 254 plants. Cocoa farmers in Madiun Regency use an average spacing of up to 5 x 4 meters. With this spacing, the farmers think it will be easier to maintain, and the cacao plants can receive better sunlight because the shade around the cocoa plants is too dense. Meanwhile, shade cannot be reduced because the plants used for shade are also productive crops such as sengon, cloves, and coconut.

According to Karmawati (2010), in one hectare of land can be planted with 1000 cocoa trees with a spacing of 3 x 3 m. The use of 5 x 4 m spacing by farmers may cause inefficient use of cocoa land because the spacing used is too broad. The number of trees that can achieve allocative efficiency is if there are 311 stems of plants in a farmer's field. Comparing the number of trees and the land area currently owned by farmers with the number of trees that can achieve allocative efficiency, the 0.53-hectare land area can accommodate 311 trees with a spacing of between 4 x 4 m. If the farmers' land area is 0.53 hectares with a spacing of 4 x 4 m, the number of trees will be more than they currently have; in terms of production, it will also be more profitable. Farmers are advised to increase the number of trees by 22.4% to achieve efficiency.

Fungicide. The value of ki in the fungicide production factor is 7.14, which means more than 1. The one-sample t-test then tests the value of ki, and a significance value of 0.000 is obtained, which is less than α 5% so that Ho is rejected, meaning that the use of fungicide in the Madiun Regency is not allocated efficiently, so farmers need to increase their fungicide production input. The average use of fungicides is only 0.17 liters per farm or 0.31 per hectare. The amount is still too small and not following the recommendation from The Indonesian Coffee and Cocoa Research Center (2010), which is up to 500 liters per hectare. To achieve allocative efficiency, farmers can increase fungicides up to 1.18 liters per farm or 2.21 liters per hectare.

Based on conditions in the field, farmers admit that it is challenging to buy fungicides due to limited farming capital and the relatively high price of chemical fungicides. These constraints can be overcome with integrated control, which is more environmentally friendly and does not require a large amount of money. Integrated control is a combination of several suitable control techniques. The goal is to create conditions that are not preferred by pests and diseases while maintaining ecological balance. In the case of Phytophthora palmivora fungal attack, technical culture activities, namely pruning, balanced fertilization, weeding, improving drainage, harvesting infected fruit as often as possible, and sanitation of trees and gardens are highly recommended in addition to applying fungicides in a minimum amount. (Fulton, 1989, cit. Taufiq, 2016).

Farmers can also use vegetable fungicides and biological agents of natural origin. According to Nurmansyah (2010), clove, oil, and citronella can inhibit the colony of Phytophthora palmivora fungi. Another plant that can be used as a vegetable fungicide is galangal. According to Widodo (2010) cit Taufiq (2016), the galangal content can inhibit the development of Phytophthora palmivora. Meanwhile, the biological agent that can be applied is Trichoderma spp. which can be sprayed directly on the pods as a preventive measure. In an environmentally friendly and inexpensive way, farmers are expected to deal with the fungal problem that attacks their crops.

Table 4. The Total Cost of Cocoa Farming in Madiun Regency in 2018

Kinds of Costs		Per Farming (IDR)	Per Hectare (IDR)
Explicit	Production input	809,119.99	1,513,805.55
	Labor effort	517,100.00	967,457.08
	Depreciation of Tool	46,114.81	86,277.51
	Others	113,765.00	212,846.17
Implicit	Manure	607,620.00	1,136,813.51
	Family labor effort	3,677,000.00	6,879,403.70
Total Cost		5,770,719.80	10,796,603.52

Source: Primary data analysis, 2018

Analysis of Cocoa Farming Income and Profits

This study's costs are divided into two types of costs, namely explicit costs and implicit costs. The explicit cost is the cost that is incurred by the farmer to run the farm. These costs consist of production facilities, labor, depreciation of equipment, loan interest, and other costs. Meanwhile, implicit costs are only calculated as costs and not incurred by farmers. Costs included in implicit costs are labor costs in the family, rent on own land, and interest on own capital (Kasim, 2006 cit Anita and Umi, 2011).

Based on table 5, it can be seen that in one year, cocoa farmer revenue at the prevailing price is IDR 20,504 / kg is IDR 6,635,028.00 per farm or IDR 12,413,941.76 per hectare. The income obtained from cocoa farming in one year of production is IDR 5,149,076.62 per farm or IDR 9,633,555.45 per hectare. Meanwhile, the profits earned by cocoa farmers were IDR 864,456.62 per farm or IDR 1,617,338.24 per hectare. The profit value can still be increased again by increasing productivity and improving the quality of cocoa beans. The price obtained by farmers is IDR 20,504 / kg, while the actual price can reach IDR 25,000 / kg depending on the cocoa beans' level of dryness.

The income and profits earned by cocoa farmers in Madiun Regency are still meager due to a drastic decrease in production in the Dagangan District due to cocoa pod borer (CPB). The dryness of the cocoa beans produced by farmers has not reached the moisture level categorized as dry by the buyer, so that the selling price obtained by farmers has not reached the maximum price level.

Table 5. The income of Cocoa Farmers in Madiun Regency in 2018

Description	Per Farming	Per Hectare
Production (Q)	323.60 kg	605.44 kg
Price (P)	IDR 20,504.00	IDR 20.504.00
Revenue (TR = PxQ)	IDR 6,635,028.00	IDR 12.413.941.76
Total Cost Explicit ($TC_{Explicit}$)	IDR 1,486,099.80	IDR 2.780.386.31
Total Cost Implicit ($TC_{Implicit}$)	IDR 4,284,620.00	IDR 8.016.217.21
Income (TR- $TC_{Explicit}$)	IDR 5,149,076.62	IDR 9.633.555.45
Profit (TR-$TC_{Explicit+Implicit}$)	IDR 864,456.62	IDR 1.617.338.24

Source: Primary data analysis, 2018

CONCLUSIONS

1. Factors that increase cocoa farming production are the number of cocoa trees, fungicides, and farming experience, whereas a factor that decreases cocoa farming production is the cacao tree's age.
3. The number of cocoa trees and the use of fungicides has not been efficiently allocated.
4. The average cocoa farm income is Rp 9,633,555.45 per ha per year, with a profit of Rp 1,617,338.24 per ha per year.

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