Logistic Regression Model on Land Productivity of Pagar Alam Coffee Farming

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Abstract. Pagar Alam coffee farming is a smallholder plantation, the majority of which is a hereditary business. The success of this coffee farming cannot be separated from existing resources, including land productivity. Land productivity concerns the amount of production, land resources, and land management efforts. This paper discusses the factors that influence the land productivity of coffee farms in Kota Pagar Alam, using binary logistic regression analysis. In general, there are 5 factors discussed, namely the identity of farmers and their internal factors, agricultural land, the performance of farmers in the production process, yields, and external factors on the productivity of Pagar Alam coffee farms. The data used are 191 respondents with 33 independent variables and one dependent variable. Each variable is divided into categories. Land Productivity as the dependent variable is divided into 2 categories, namely low and high. Based on bivariate analysis, variables related to land productivity are land area, number of trees, frequency of fertilizer used, frequency of pesticides used, length of harvest, production, female labor in the family, gross income, net income, and production costs. Furthermore, based on the binary logistic regression model of land productivity probability, variables that significantly affect land productivity of Pagar Alam coffee farms are area, number of trees, crop production, and net income. The accuracy of the model simultaneously was 93.2%. The probability value of the model is predominantly influenced by the harvest production variable with an odds ratio of 49.505. If the category of harvest production and net income increases, the probability for high land productivity will also increase. Conversely, if the area of land and the number of trees increases, the probability of high land productivity will decrease.

Keywords: Land productivity, binary logistic regression, Pagar Alam coffee farming, harvest production, probability model

1. Introduction

The Pagar Alam coffee farming business is a smallholder plantation, the majority of which is a hereditary business. The success of this coffee farming cannot be separated from existing resources, including land productivity.

Land productivity is an indicator of the success level of agricultural production, including coffee farming. Land productivity refers to the amount of output (production) compared to the amount of input (resources). These resources may include coffee tree density (average land area for 1 tree), types of coffee varieties, age of coffee, soil fertility, soil slope and replanting techniques.

Increased coffee production can be caused by intensification efforts, conversion of other harvest lands to coffee fields, and planting on new land [1]. Coffee production can go hand in hand with environmental damage. Deforestation is an effort to plant coffee on new land. This shows that coffee production depends on the area.

TechnoServe's Farm College provides the training skills for farmers to increase productivity in Latin America and East Africa [2]. One of the Farm College curricula is land management, including fertilization application, pesticide use, and harvesting.

Based on [3], there are 17 factors analysed for their relationship with land productivity using correspondence analysis. There are only 7 factors related to this productivity, namely: area size, number of trees, average planted area of 1 tree, frequency of fertilization, frequency of herbicide use, harvest time, and harvest production. Land productivity will tend to be low if the area of land is higher, the number of trees (2,500 - 4,000), 1 tree area ≤ 3.33 m^2, fertilization is done 2 or 3 times in 1 year, herbicide application is not done or 2 or 3 times in 1 year, and harvest 1 till 2 months. Based on the matrix plot, the relationship between each of the 17 independent variables and land productivity has no clear trend (no specific pattern). Each variable value tends to have various productivity values. The frequency of a variable value can be different, there is a high frequency. This can also be seen from the small correlation value, even close to 0.

The correlation between land productivity and income is 0.058, so it can be interpreted that the linear relationship between the two variables is very weak (nothing). The average production of 1 tree and land productivity has a correlation of 0.945, so it can be interpreted that the relationship between the two variables is very strong; the higher the average production of 1 tree, the higher the productivity of the land [4].

Land productivity depends on the amount of production, land resources and land cultivation. Land processing depends on the cost of production or business capital obtained from the sale of the previous harvest. The main source of income for farmers is from the coffee harvest. Based on interviews with the majority of respondents, the income in the previous year will be a source of capital in land management in the form of fertilizers, herbicides, and wages for labor. The laborer usually helps with clearing the land and picking coffee beans.

Besides related to production costs, net income is also related to external factors in the form of coffee prices. According to data from the Directorate General of Plantation, Ditjenbun, [5], for the last 2 years, the local price of Robusta coffee beans is still in the average range (not fluctuating too much).

This paper discusses the factors that influence the productivity of coffee fields in Pagar Alam using a binary logistic regression model. Land productivity is divided into 2 categories, namely high and low. Factors related to land productivity are represented by a probabilistic model.

Internal factors in the form of work motivation, business motivation, and work culture also play a role in raising the productivity of coffee farming. The same thing can be traced in [6] – [9]. These studies state the importance of these three internal factors in increasing the productivity of songket craftsmen in Ogan Ilir Regency.

In this paper, it is studied whether there is an effect of farmer identity (includes age, education, economic condition, dependents, length of farming, work motivation, business motivation, and work culture), agricultural land (includes area, number of trees, planting area for 1 tree, age trees), farmer performance in the production process (includes production costs related to farmer income, number of workers, frequency of fertilization, frequency of herbicide spraying, farmer working hours, length of harvest period), harvest yields (includes total production of coffee beans during harvest and beyond harvest), and external factors (coffee prices) on the productivity of the Pagar Alam coffee farm. The income variable value is the average income of farmers in the last 2 years. Gross income is assumed to be net income that has not been deducted by production costs. In this paper, we did not pay attention to the factors of coffee plant varieties, rejuvenation techniques on old coffee tree, climate and environmental influences.

The probability model from the binary logistic regression equation can be used to determine the probability of land productivity level based on the relationship of the influencing factors. The factors can be one of the references that must be considered for coffee farming. High land productivity is an internal factor that has a direct impact on increasing coffee farmers' income.

2. Research Methods

The subjects of this study were farmers in Pagar Alam, South Sumatra Province who run coffee farming. Respondents were chosen through purposive sampling technique. The data in this paper is the result of research on [10].

The data used is the data of 191 respondents with 33 independent variables and one dependent variable. Each variable is divided into categories. The division of categories on several variables is based on the results of correspondence analysis in [3] and [4].

The method used is binary logistic regression analysis. The dependent variable is the coffee land productivity which is divided into 2 categories, namely 0 as a notation of low land productivity and 1 as a notation of high land productivity.

The application of binary logistics modelling (in [11] – [15]) is as follows:

1. Conducting descriptive analysis to find out the characteristics of the independent variables (can be seen [4];
2. Conducting a bivariate analysis to see the relationship between the independent variables with the dependent variable (that has been done on [3]);
3. Estimating model parameters using the Maximum Likelihood method;
4. Perform parameters testing simultaneously and partially;
5. Choosing the best model using the forward stepwise elimination methods;
6. Interpreting the model and the results that have been obtained;
7. Make conclusions on the results of research.

Modelling was done with the help of Minitab 18 and SPSS 24 software.

3. Results and Discussion

Initial data descriptions of the 31 variables can be seen in [4]. These variables consist of 26 variables with ratio scale, 3 interval scale variables (namely: work motivation, business motivation, and work culture), and 2 variables with nominal scale (namely: land slope and farming pattern).

The data used in this study are data from 191 respondents with 33 independent variables and one dependent variable, namely land productivity (with notation *Y*). Land productivity (in 10^{-4} kg/m^2) is defined as the average production of coffee beans on a land area of 1 m^2, so that the productivity of this land is related to the number of trees in units of garden area (or as the average planted area for 1 coffee tree) generated divided by the land area.

The description and division of variable categories can be seen in [4] and [3]. But in this study, the division of land productivity variable categories is divided into 2, namely: low and high. Table 1 below describes the notation, number of categories, and categories of variables that have the highest percentage of respondents.

Table 1. Definition of notation, number of categories, and %age of respondents in variable categories

No	Variable	Notation	Number of Categories	Highest Category	
				Categories	%
1	Land Productivity	*Y*	2; that is 1 as Low and 2 as High	1 = Low	52.4
2	Ages		5	2 = (30, 40] years	41.4
3	Education		4	3 =SLTA:[9, 12]	39.26
4	Economic condition		3	2 = Enough	51.31
5	Dependents		5	3 = 2 persons	38.,7
6	The amount of family that		5	2 = 1 persons	56.55

	help			
7	Long time of farming	5	2=(11, 20] years	41.88
8	Land area	5	2=[0.9, 1.8) hectar	63.88
9	Number of trees	5	3 = (2,500, 4,000]	42.92
10	Area of 1 tree	4	2 = (3.33, 3.75]	31.94
11	Age of tree	6	2 = [10, 20]	44.5
12	Fertilizer frequency	4	2 = 1 time	42.41
13	Pesticide frequency	4	2 = 1 time	32.46
14	Harvest time	5	3 = 3 months	71.73
15	Harvest production	5	1 = <1,000	40.31
16	Average yield excluding harvest	6	3 = (50, 250]	40.31
17	Working hours	4	3 = 7 – 8 ours	48.7
18	Harvest hours	5	3 = 7 – 8 ours	69.11
19	Average Number of days worked in a week	4	3 = 6 days	47.12
20	Average Number of days worked in one week at harvest	4	3 = 6 days	51.31
21	Workers in the Family	6	2 = 1 person	42.41
22	Workers Outside the Family	6	1 = 0 (no one)	44.51
23	Male Workers in the Family	5	1 = 0 (no one)	41.36
24	Female Workers in the Family	5	2 = 1 person	58.64
25	Male Workers outside the family	5	1 = 0 (no one)	64.4
26	Female Workers outside the family	5	1 = 0 (no one)	80.63
27	Minimum Price	4	2 = [17,500, 19,000)	40.31
28	Maximum Price	4	3 = [19,000, 20,500)	33.5
			4 = ≥ 20,500	33.5
29	Gross Income	4	2 = (10, 25]	46.07
30	Net income	3	2 = (10, 25]	45.55
31	Production cost	6	2 = (1, 3]	40.31
32	Work motivation	3	3 = (3, 4]	55.5
33	Business Motivation	3	3 = (3, 4]	54.45
34	Work Culture	3	2 = (2, 3]	71.2

Bivariate analysis which states the relationship between each independent variable and land productivity based on the chi-square test χ^2. Bivariate analysis between age and land productivity follows as:

(i) Formulating Hypotheses

H_0: there is no relationship between age and land productivity
(the relationship between age and land productivity is mutually independent)

H_1: there is a relationship between age and land productivity

(ii) Determining the Significance Level. The significance level used is 5% ($\alpha = 0.05$)

(iii) Determine the Statistics Test, based on the cross frequency between 2 categories as in Table 2.

Table 2. Frequency of age and land productivity categories (O_{ij})

		Age categories (j)					Total
		1	2	3	4	5	(r_i)
Land productivity (i)	Low (1)	8	40	26	20	6	100
	High (2)	13	41	24	8	5	91
Total (c_j)		21	81	50	28	11	191

Based on expected frequency equation $E_{ij} = \frac{r_i \times c_j}{N}$; i = 1, 2; j = 1, 2, …, J and observed frequency O_{ij}, so we obtain $E_{11} = \frac{100 \times 21}{191} = 10.994$ ... $E_{25} = \frac{91 \times 11}{191} = 5.241$

The χ^2 value obtained is:

$$\chi^2 = \sum_{i=1}^{2}\sum_{j=1}^{5}\frac{(O_{ij}-E_{ij})^2}{E_{ij}} = \frac{(8-10.994)^2}{10.994} + \cdots + \frac{(5-5.241)^2}{5.241} = 6.106$$

Based on the calculation, it is obtained that χ^2_{count} is 6.106, where if α = 0.05 and df = 3, it is obtained χ^2_{table} = 9.487, then $\chi^2_{count} < \chi^2_{table}$, so H_0 is accepted. It can be concluded that there is no relationship between age and land productivity.

Bivariate Analysis on Education with Land Productivity follows as:

(i) Formulating Hypotheses

H_0 : there is no relationship between education and land productivity

H_1 : there is a relationship between education and land productivity

(ii) With a significance level of 5% (α = 0.05), the statistics test is based on the cross frequency between the 2 categories as in Table 3.

Table 3. Frequency of education and land productivity categories (O_{ij})

		Education categories (j)				Total
		1	2	3	4	(r_i)
Land productivity (i)	Low (1)	23	31	35	11	100
	High (2)	19	23	40	9	91
Total (c_j)		21	42	54	75	20

Based on expected frequency equation:

$$E_{11} = \frac{100 \times 42}{191} = 21.989 \quad \ldots \quad E_{24} = \frac{91 \times 20}{191} = 9.528$$

So, χ^2 value obtained is:

$$\chi^2 = \sum_{i=1}^{2}\sum_{j=1}^{4}\frac{(O_{ij}-E_{ij})^2}{E_{ij}} = \frac{(23-21.989)^2}{21.989} + \cdots + \frac{(9-9.528)^2}{9.528} = 1.679$$

Based on the calculation, it is obtained that χ^2_{count} is 1.679, where if α = 0.05 and df = 3, it is obtained χ^2_{table} = 7.814, then $\chi^2_{count} < \chi^2_{table}$, so H_0 is accepted. It can be concluded that there is no relationship between education and land productivity.

Repetition of the same method applies to all independent variables to the dependent variable (land productivity), so that Table 4 is obtained.

Table 4. Results of bivariate analysis

No	Variable	χ^2_{count}	df	χ^2_{table}	Conclusion (at α = 5%)
1	Ages	6.106	4	9.487	Accept H_0
2	Education	1.679	3	7.814	Accept H_0
3	Economic condition	15.109	2	5.991	**Reject** H_0
4	Dependents	0.745	4	9.487	Accept H_0
5	The amount of family that help	4.660	4	9.487	Accept H_0
6	Long time of farming	9.362	4	9.487	Accept H_0
7	Land area	39.386	4	9.487	**Reject** H_0
8	Number of Trees	51.389	4	9.487	**Reject** H_0
9	Area of 1 tree	5.931	3	7.814	Accept H_0

10	Age of tree	9.793	5	11.07	Accept H_0
11	Fertilizer Frequency	21.873	3	7.814	**Reject** H_0
12	Pesticide Frequency	16.788	3	7.814	**Reject** H_0
13	Harvest Time	10.906	4	9.487	**Reject** H_0
14	Harvest Production	21.988	4	9.487	**Reject** H_0
15	Average yield excluding harvest	5.58	5	11.07	Accept H_0
16	Working hours	1.342	3	7.814	Accept H_0
17	Harvest hours	4.857	4	9.487	Accept H_0
18	Average number of Days worked in a week	2.715	3	7.814	Accept H_0
19	Average number of days worked in one week at harvest	0.302	3	7.814	Accept H_0
20	Workers in the family	2.129	5	11.07	Accept H_0
21	Workers outside the family	2.943	5	11.07	Accept H_0
22	Male workers in the family	1.8	4	9.487	Accept H_0
23	Female Workers in the Family	14.576	4	9.487	**Reject** H_0
24	Male Workers outside the family	4.335	4	9.487	Accept H_0
25	Female Workers outside the family	3.854	4	9.487	Accept H_0
26	Minimum Price	2.306	3	7.814	Accept H_0
27	Maximum Price	3.309	3	7.814	Accept H_0
28	Gross Income	13.289	3	7.814	**Reject** H_0
29	Net income	21.422	2	5.991	**Reject** H_0
30	Production cost	12.291	5	11.07	**Reject** H_0
31	Work motivation	2.186	2	5.991	Accept H_0
32	Business Motivation	2.191	2	5.991	Accept H_0
33	Work Culture	0.296	2	5.991	Accept H_0

Based on Table 4, the variables that have a relationship with land productivity at the significance level $\alpha = 0.05$ are economic condition, land area, number of trees, frequency of fertilizers used, frequency of pesticides used, harvest time, production, female workers in the family, gross income, net income, and production cost. In this case, the results of the bivariate analysis include all variables that have a significant relationship with land productivity in [3]. But, female workers in the family, gross income, net income, and production costs variables were not analyzed in this study.

Furthermore, multivariate analysis with binary logistic regression was carried out. The results obtained are:

(i) Initial Model Testing

The assumptions used are:

$H_0: \beta_i = 0 \, ; \forall \, i = 1,2,\dots,n$ (there is no influence of the independent variable with the dependent variable)

$H_1: \exists \beta_i \neq 0 ; i = 1,2,\dots,n$ (there is an effect of the *i* th independent variable on the dependent variable)
Initial model testing can be seen in Table 5.

Table 5. *G* test (on initial model)

Iteration History[a,b,c]

Iteration		-2 Log likelihood	Coefficients Constant
Step 0	1	264.358	-.094
	2	264.358	-.094

Based on Table 5, the value of *G* is 264.358, with *N* = 191 and degree of freedom *df* = *N* - 1 = 190, the chi square table is obtained at α = 0.05 of 223.16. Then, 264.358 > $\chi^2_{(190;00,5)}(223.16)$ so reject H_0. The conclusion that can be drawn is that the initial test shows there is an effect of the independent variable on the dependent variable. The process of forming the next model can be carried out, namely by paying attention to the β dan *p-value (sig)*.

The model formation step with binary logistic regression using the forward method is that all independent variables are included in the model, then the independent variables whose significance value is below α = 0.05 are selected so that the right model is obtained. The following table shows the results of binary logistic regression with the forward method by using SPSS.

Table 6. Independent variables in the model

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Number of Trees	-1,324	,222	35,611	1	,000	,266
	Constant	3,756	,652	33,202	1	,000	42,798
Step 2[b]	Number of Trees	-2,301	,345	44,455	1	,000	,100
	Harvest production	2,196	,389	31,791	1	,000	8,990
	Constant	2,737	,746	13,452	1	,000	15,437
Step 3[c]	Land area	-4,961	1,045	22,523	1	,000	,007
	Number of Trees	-2,835	,539	27,659	1	,000	,059
	Harvest production	4,258	,709	36,061	1	,000	70,698
	Constant	11,213	2,430	21,288	1	,000	74099,863
Step 4[d]	Land area	-5,037	1,115	20,423	1	,000	,006
	Number of Trees	-2,874	,561	26,271	1	,000	,056
	Harvest production	3,902	,744	27,540	1	,000	49,505
	Net Income	1,091	,486	5,031	1	,025	2,977
	Constant	10,010	2,493	16,119	1	,000	22242,627

a. Variable(s) entered on step 1: Number of trees.
b. Variable(s) entered on step 2: Harvest production.
c. Variable(s) entered on step 3: Land area.
d. Variable(s) entered on step 4: Net Income.

(i) Goodness of Fit

The results of the model suitability test can be seen in the Hosmer and Lemeshow test in Table 7. Based on Table 7, the value of $\chi^2_{count} = 4.874$, where *df* = 8 and α = 0.05, then $\chi^2_{(8;0.05)} = 15.51$, so we get $\chi^2_{count} < \chi^2_{(8;0,05)}$. In this case, there is no difference between the observed results and the model or it can be said that the model was formed accordingly.

Table 7. Hosmer and Lemeshow Test

Hosmer and Lemeshow Test			
Step	Chi-square	df	Sig.
1	1.552	3	0.670
2	30.951	6	0.000
3	3.298	7	0.856
4	4.874	8	0.771

(ii) Model Forming

In this step, the equation of the model is formed as in Table 8.

Table 8. Model Forming

No	Variable	B	S.E.	Wald	df	Sig.	Exp(B)
1	Land area	-5,037	1,115	20,423	1	,000	,006
2	Number of Trees	-2,874	,561	26,271	1	,000	,056
3	Harvest production	3,902	,744	27,540	1	,000	49,505
4	Net Income	1,091	,486	5,031	1	,025	2,977
	Constant	10,010	2,493	16,119	1	,000	22242,627
	G Test Value			80,655			

Table 8 shows the Wald test, which is a significance test of the independent variables partially. The Wald statistical value follows the chi-square distribution, so that if the significant value is viewed, then on α= 5%, it is found that the independent variables of land area, number of trees, harvest production, and net income have a significant effect on land productivity.

Exp(B) is the odds ratio. The B value of the area and the number of trees is negative, which represents that for an increase in these two independent variables by 1 unit, the ratio of the possibility of high land productivity to low land productivity will decrease (for Exp(B) <1), with the assumption of other independent variables remains. The value of Exp(B), which is less than 1 (with a negative B value), can represent if the independent variable increases by 1 category level, then the ratio of the possibility of high land productivity to low land productivity will decrease by this factor, assuming the other independent variables remain. Each time there is an increase in area, the possibility of high land productivity decreases. However, in this case the odds ratio of the two variables is close to 0.

Meanwhile, harvest production and net income are positive. This represents that for an increase in the independent variable of 1 unit, the ratio of the possibility of high land productivity to low land productivity also increases (for Exp(B)> 1), assuming the other independent variables are constant.

If the harvest production variable increases by 1 category level, then the ratio of the possibility of high land productivity to low land productivity increases by a factor of 49.5, assuming the other independent variables are constant. Likewise, if net income increases by 1 category level, then the ratio of the possibility of high land productivity to low land productivity increases by a factor of 2.997, assuming the other independent variables are constant.

If the farmer has 1 TKWL ($X_{9(2)}$), then it is 2.18 times more likely to increase the farmer's income, compared to if the farmer does not employ TKWL ($X_{9(1)}$). An increase in 1 category of TKWL will cause an increase in income from farmers by 2.18 times greater for each increase in category.

Based on Table 8, the G test value is 80.655. The value of the Chi square table with df = N − 3−1 = 187 and α = 0.05 is 341.39, so that 80.655 < $\chi^2_{(187;00,5)}$ (240,563). So, all the remaining independent variables in the model simultaneously influence the dependent variable. The factors that significantly affect the productivity of Pagar Alam coffee farmers' land are area (X_1), number of trees (X_2), harvest production (X_3), and net income (X_4) variables. The land productivity probability model formed in the binary logistic regression is as follows:

$$\pi(X) = \frac{\exp(-10.01 - 5.037X_1 - 2.874X_2 + 3.902X_3 + 1.091X_4)}{1 + \exp(-10.01 - 5.037X_1 - 2.874X + 3.902X_3 + 1.091X_4)}$$

In this equation, it can be seen that the significant effect of each variable through the coefficient of each variable. A variable with a positive coefficient gives an increase in the probability value $\pi(x)$ of the coffee land productivity model, and vice versa. The model accuracy value can be obtained from the classification table in Table 9.

Tabel 9. Classification Table

	Observed		Predicted: Land Productivity 1	Predicted: Land Productivity 2	Percentage Correct
Step 1	Land Productivity	1	87	13	87,0
		2	41	50	54,9
	Overall Percentage				71,7
Step 2	Land Productivity	1	73	27	73,0
		2	4	87	95,6
	Overall Percentage				83,8
Step 3	Land Productivity	1	93	7	93,0
		2	10	81	89,0
	Overall Percentage				91,1
Step 4	Land Productivity	1	90	10	90,0
		2	3	88	96,7
	Overall Percentage				93,2

a. The cut value is ,500

The Classification Table in Table 9 shows how well the model classifies land productivity cases into 2 categories. In step one to step four, the value of the model accuracy increases. In step 4 (where the model has been formed), the overall value of the model accuracy (prediction accuracy) is 93.2%. The accuracy value of this model is obtained from the corresponding column based on predictions divided by the number of data (respondents). While the predictions accuracy of farmers who have low and high land productivity is 90% and 96.7%, respectively.

The calculation of model probability is carried out by taking into account each existing category. For example, in the model probability calculation with an area of less than 0.9 hectares (category 1), the number of trees below or equal to 4,000-5,500 trees (category 4), harvest production below 1000 (category 1), medium net income (category 2), the model is

$$\pi(x) = \frac{\exp(-10.01 - 5.037(1) - 2.874(4) + 3.9029(1) + 1.091(2))}{1 + \exp(-10.01 - 5.037(1) - 2.874(4) + 3.9029(1) + 1.091(2))}$$

$$= \frac{\exp\,(-0{,}439)}{1 + \exp\,(-0.439)}$$

$$= \frac{\exp\,(-0.439)}{1 + \exp\,(-0.439)}$$

$= \frac{0.645}{1+0.645}$, so that

$\pi(x) = 0.392$

Based on these calculations, the probability to increase coffee land productivity is 0.392 or 39.2%. In the Exp (B) column on Table 8, which is the odds ratio value of the model, it is found that the odds ratio of the harvest production variable has the highest value, namely 49.505 compared to the area variable (that is 0.006), number of trees (that is 0.056), and net income (that is 2.977) .

4. Conclusion

Based on the results of the bivariate analysis, it was found that the variables of economic condition, land area, number of trees, frequency of fertilizers used, frequency of pesticides used, harvest time, harvest production, female labour in the family, gross income, net income, and production costs had a direct effect on land productivity.

Simultaneously, the variables that affect land productivity are land area, number of trees, harvest production and net income. The probability value of the model is dominantly influenced by the variable of harvest production with an odds ratio of 49.505. Increasing the category of harvest

production and net income will increase land productivity. Conversely, if the land area and the number of trees increases, then the land productivity will decrease.
Land area and number of trees have a negative effect on land productivity, so it is necessary to further investigate how the two variables influence the increase in harvest production. For further research, it can also be discussed how the influence of independent variables on land productivity in the form of quantitative variables using multiple linear regression models.

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