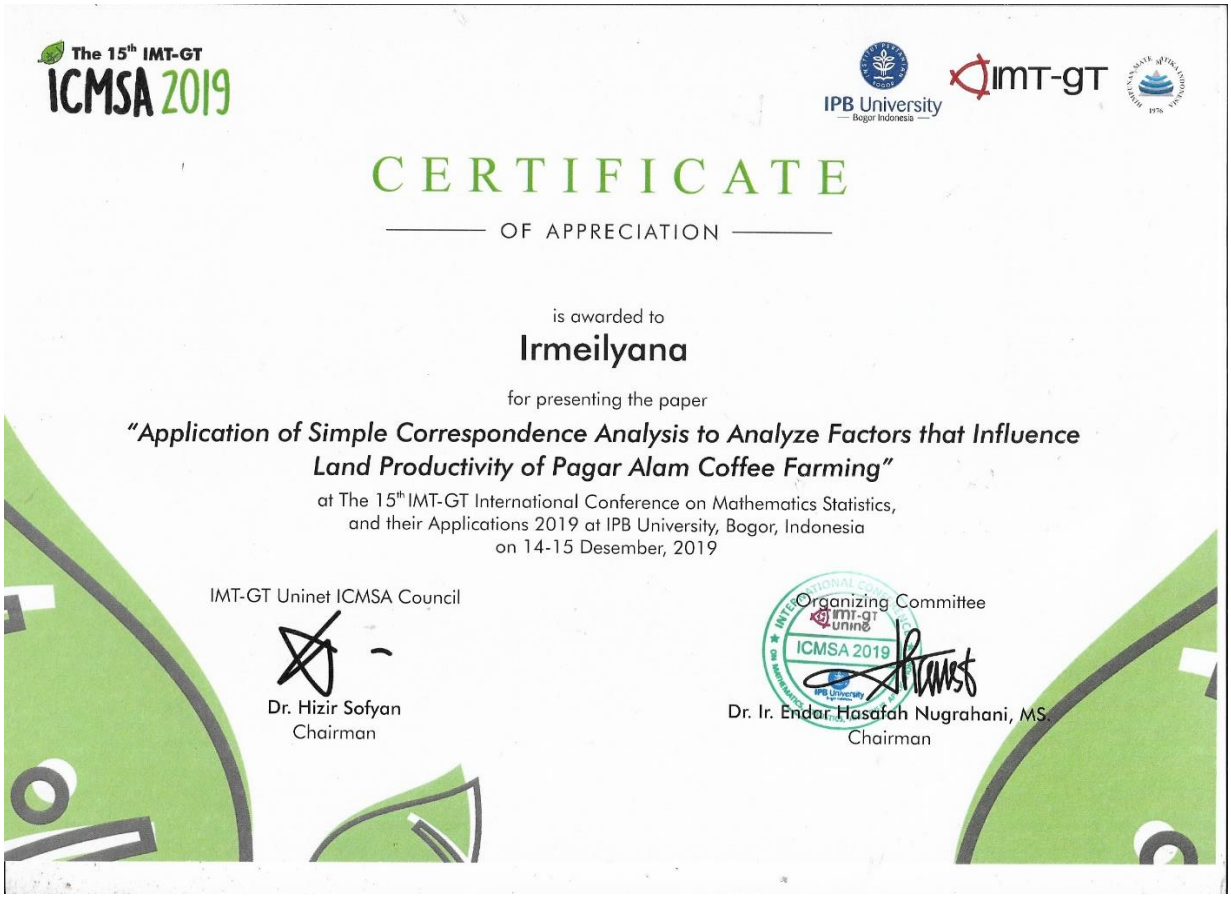
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"Application of Simple Correspondence Analysis to Analyze Factors that Influence Land Productivity of Pagar Alam Coffee Farming"
at The 15th IMT-GT International Conference on Mathematics Statistics, and their Applications 2019 at IPB University, Bogor, Indonesia on 14-15 Desember, 2019
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Sincerely yours,

Dr. Endar H. Nugrahani
Chair Person

APPLICATION OF SIMPLE CORRESPONDENCE ANALYSIS TO ANALYSE FACTORS THAT INFLUENCE LAND PRODUCTIVITY OF PAGAR ALAM COFFEE FARMING

IRMEILYANA, NGUDIANTORO, DESTY RODIAH

Abstract. Pagar Alam is one of the coffee-producing centers in South Sumatra that has existed since the Dutch era. Based on data from Ditjenbun in 2018, the average production of Pagar Alam coffee is 502 kg/ha, so it ranks 9th out of 11 districts producing coffee in South Sumatra. This is in contrast to the area and area of mature plants from the Pagar Alam coffee plantation, which is ranked 6th. In this paper, we study whether there is an effect of land slope, cropping pattern, area, number of trees, planting area for 1 tree, age of trees, number of laborers, frequency of fertilization, frequency of spraying herbicides, farmer's working hours, length of harvest time, harvest production, production cost, and the number of workers to the productivity of Pagar Alam's coffee farms. Questionnaires were distributed to 185 respondents by using purposive sampling. By using simple correspondence analysis, there are 7 factors that have a relationship with land productivity, namely area, number of trees, planting area of 1 tree, frequency of fertilization, frequency of herbicide use, length of harvest time, and harvest production. Based on the calculation of land productivity, its value is related to the area, number of trees, and harvest production. While the calculation of planting area of 1 tree is based on area and number of trees. In general, there are 3 influential factors aside from the factors used to calculate the land productivity, namely frequency of fertilization, frequency of herbicide use, and the length of harvest time.

Keywords and Phrases: Pagar Alam coffee, Coffee land productivity, Simple correspondence analysis, Correlation, Coffee farming

1. INTRODUCTION

The area of coffee plantations in Indonesia consists of 96.1% of Smallholder (Community) Plantation (PR), 1.8% of State Large Plantation (PBN) and 2% of Private Large Plantation (PBS). In the PR area, 73.4% were mature plants (TM), 14.7% were immature plants (TBM), and the remaining almost 12% were damaged plants (TR). Robusta production reaches 73% compared to Arabica (Ditjenbun, 2018) [1].

The declining coffee production is not only due to the decrease in planting area, but also because of the low business capital of coffee farmers so that the plantation management system is not good. According to Aradi (2008) [2], problems faced by coffee farmers in Central Aceh are soil conservation, fertilizer recommendations, shade trees that are not well maintained, pruning is rarely done, spacing is too tight, pest and disease attacks.

According to Irmeilyana (2019) [3], by using data from [1], coffee production correlates very strongly with the area for each type of plantation. Coffee production has very strongly correlation with Robusta coffee production and TM land area on smallholder plantations (PR). Average production (*tons / ha*) tends to be very weak correlated with total area and production. The relation of land area and production correlates quite strongly with the number of farmers. If the total area is connected with production, then not all large areas can produce higher production. For example, for South Sumatera (Sum-Sel), the area coffee farm is

higher than Lampung, but its production is almost the same as Lampung.

Coffee production is very dependent on many things, including: maintenance, especially rehabilitation of old plants, fertilization, pest control, soil management, and maintenance of shade plants. Hulupi and Martini (2013) [4], stated that coffee production and quality of coffee are generally influenced by the variety or clone factors used, shade plants site maintenance, management of the garden including the use of shade trees, appropriate dosage fertilization, pruning and maintenance, harvesting techniques, processing, drying, and storing coffee beans.

Based on data from the Directorate General of Plantation; Ditjenbun (2018) [1] and BPS (2018) [5], South Sumatra (Sum-Sel) is province with the largest robusta coffee producing in Indonesia. In Irmeilyana (2019) [3], there are 4 clusters of 31 provinces that each consisting of 1 province, namely: Sum-Sel, Aceh, Lampung, and East Java. The characters of Sum-Sel cluster are the highest land area, highest coffee production, highest TM-PR (mature plants of smallholder plantation) area, highest robusta area, and the highest robusta coffee production, high TBM area, TR area, and high number of farmers.

Land area (in ha), production (in tons), and the number of farmers (in households; *KK*) continually increase from 2015 to 2017. The average production (in kg per ha) and the number of farmers (in *KK*) are not directly proportional to the area of land. According to Irmeilyana (2019) [6], a high area is also marked by high area of TM and TR as well. High production is characterized by high of TBM and TM area as well. The total area, especially TM area and high production have very strongly correlation with the number of farmers.

Besemah Coffee is a designation of coffee obtained by the results of coffee plantations in several regions in South Sumatra. The most popular Besemah coffee is coffee originating from the Pagar Alam plantation. Pagar Alam is one of the coffee-producing centers in South Sumatra that has existed since the Dutch era. The production of Pagar Alam coffee could reach the Netherlands, because at that time the queen Yuliana liked the taste of the coffee (http://www.lintaskopi.com/kopi-robusta-besemah-sumatera-selatan/) [7].

Based on data from [1], the average production of Pagar Alam coffee is 502 kg / ha, so it ranked 9th out of 11 regencies / cities producing coffee in South Sumatra. This contrasts with the area and mature of Pagar Alam coffee plantations which ranked 6th. Mature Plants in Pagar Alam is 3.6% of all TMs in Sum-Sel. The area of Pagar Alam coffee plantations is 8,384 ha, with a production of 3,770 tons and the number of farmers 8,745 households (Irmeilyana, 2019) [6].

In BPS data, the area of coffee plantations is not clarified regarding the type of land, namely: the area of mature plantations (TM), immature plantations (TBM), and damaged plants (TR). This can be seen from the average coffee production in Kota Pagar Alam (477.7 kg / ha), which is different from the data from the Ditjenbun (2018) of 502 kg / ha [1]. Data on average production in Ditjenbun used TM area.

Coffee production is related to several factors. According to Zuraida (2011) [8], the factors that influence coffee production in Central Aceh District are the number of workers, land area, and age of coffee trees. The lack of time allocation and farmers' attention in cultivating coffee land affects the productivity of coffee plants in Boafeo Village, Maukaro District, Ende Regency to be less than optimal.

Coffee is considered as only one source of livelihood (Rofi, 2018) [9]. Area variable has a significant effect on Arabica coffee production in Simalungun District (Saragih, 2010) [10].

Reference Asmani, et al. (2008) [11] examined the productivity and export of coffee in Sum-Sel, namely South OKU, Lahat, and Pagar Alam Regencies. The regression equation of productivity (in tons / ha) was based on area, interest rates, regional minimum wages, fertilizer prices, rainfall, and coffee prices variables by using time series data from 1991 till 2006. Coffee productivity in the three central regions was significantly affected by the area of coffee, rainfall, labor costs, coffee prices, and productivity of one previous year. While fertilizer prices only have a significant effect on coffee productivity in South OKU and Pagar Alam.

Input factors that influence the production per area of Arabica coffee in Enrekang Regency are Urea fertilizer, ZA fertilizer, herbicides, manure, and labor (Thamrin, 2014) [12]. According to Ginting, et al. (2018) [13], the land area and business capital variables had positive and significant effects on the production of coffee farming in Humbang Hasundutan Regency. According to Silitonga, et al. (2010) [14], there are differences in productivity and average income of monoculture and intercropping coffee farming in Dairi Regency.

Based on the theory of production in relation to agriculture, important factors in the management of production resources are natural factors (include land), capital, labor, and also management. Soil and land management factors greatly affect crop production. Land management depends on the human resources (labor) who process it and the production costs incurred (capital).

Land productivity determines the production of crops so that it impacts the income of farmers. The purpose of this study was to analyze the factors that influence the land productivity of coffee farms in Kota Pagar Alam by using simple correspondence analysis. Each factor is divided into several categories of variables. Factors related to land productivity can be described through graphical representation of every categories of a variable with categories of land productivity variable.

In this research, we study whether there is an effect of land slope, cropping pattern, area, number of trees, planting area for 1 tree, age of trees, number of laborers, fertilizing frequency, frequency of spraying herbicides, farmer's working hours, harvest period, amount of coffee beans production, the amount of labor, and the cost of production to the land productivity in Pagar Alam's coffee farming. In this study, the factors of varieties of coffee plants, rejuvenation techniques of old coffee trees, the influence of climate and environment are not considered. Factors that affect land productivity can be one of the references that must be considered for coffee farming. High land productivity is one of the internal factors that can has a direct impact on increasing the income of coffee farmers.

2. RESEARCH METHOD

This research is a case study, with the assumption that the coffee farming is run by the owner and cultivator of the coffee farms. The population in this research is coffee farmers who run coffee farms in Pagar Alam. Samples taken are farmers who have their own land and have been operating coffee farming for more than 5

years. The sampling technique used was purposive sampling technique.

This research used primary data and secondary data. Secondary data includes Pagar Alam's demographic and geographic data. While the primary data is in the form of factors that can affect the productivity of coffee fields. Land productivity in this study is defined as the average production of coffee beans per unit area of m^2.

Primary data were obtained through field observations, interviews and questionnaires. Natural conditions, soil conditions, and farm land topography are assumed to be stable conditions.

The steps in this research are:
1. Arrange questionnaire questions
2. Distributing questionnaires, with the initial stages of testing the validity and reliability of questions that state attitudes.
3. Interpretation of descriptive statistics of the data obtained
4. Perform bivariate analysis
5. Perform simple correspondence analysis.
6. Interpretation of results.

3. RESUTS AND DISCUSSION

In this study, questionnaire questions in the form of factors that can affect land productivity include: land slope, cropping pattern, area, number of trees, age of trees, number of labors who help farming both labors in the family and labors from outside the family, frequency fertilization, frequency of spraying herbicides, farmer's hours of work, long harvest time, the amount of coffee bean production, the amount of labors, and production costs. The average planting area for 1 tree is calculated based on the area of land divided by the number of trees. The number of labors in the family means the number of workers who still have family relation. While, the number of labors outside the family means the number of workers who do not have family relation.

The land productivity is defined as the average coffee bean production in an area of 1 m^2, so that the land productivity is related to the number of trees in the unit of farm area (or in the form of average planting area for 1 coffee tree) divided by area land.

For example, a farmer owns 0.5 ha of land, with 1,500 coffee trees, and produces 400 kg per harvest in one year.

Planting area for 1 tree = $\frac{\text{land area}}{\text{number of trees}} = \frac{0.5 \times 10^4\ m^2}{1500} = 3.33\ m^2$ per 1 tree.

Average production for 1 tree = $\frac{\text{production}}{\text{number of trees}} = \frac{400\ kg}{1500} = 0.26667\ kg$ per tree.

Land productivity = $\frac{\text{amount of production}}{\text{land area} \times \text{number of trees}} = \frac{400\ kg}{0.5 \times 10^4\ m^2 \times 1500\ \text{trees}} = 5333.3 \times 10^{-4}\ kg/m^2$ of land.

3.1 Descriptive Statistics Analysis

Questionnaires were distributed to coffee farmers in Kecamatan Pagar Alam Utara, Kecamatan Dempo Utara and Kecamatan Dempo Selatan in Kota Pagar Alam. There are about 57 villages (kelurahan) as sampling locations.

Table 1 below is the result of descriptive statistics of the factors that can affect land productivity based on questionnaire data. While the slope of the land is distinguished between flat and sloping, with the percentage of respondents respectively 69% and 31%. The cropping pattern is divided into two namely intercropping and single with a percentage of respondents respectively 12% and 88%.

Table 1. Descriptive Statistics of the variables based on data from 180 respondents

No	Variable	Unit	Mean	StDev	Min	Q1	Median	Q3	Max
1	Num. of assist.	Person	1.3799	1,1122	0	1	1	2	6
2	Area	ha	1.4468	0.9182	0.5000	1	1	2	8
3	Number of trees	Trees	3894	3664	400	2000	3000	4000	30000
4	Area for 1 tree	m^2	4.834	3.627	0.333	3.333	3,750	5,000	37,500
5	Age of tree	Year	26.34	14.66	0	15	21	35	100
6	F. of Fertilizer	Times	0.8444	0.8176	0	0	1	1	3
7	F. of Herbicide	Times	1.6056	1.0384	0	1	2	2,75	3
8	Harvest time	Month	3.0444	0.8705	1	3	3	3	11
9	Production	Kg	1206.7	894.1	100.0	700.0	1000.0	1500.0	7000.0
10	Prod. out harvest	Kg	121.1	203.0	0	0,0	52,5	187,5	2000,0
11	Working hours outside harvest	Hours	37.74	13.76	0	25	42	48	70
12	Working hours at harvest	Hours	46.694	13.329	0	42	48	55.5	105
13	Labors in fam.	Person	1.847	1.502	0	1	1	3	12
14	Labors out fam.	Person	1.888	2.260	0	0	1	3	10
15	Production costs	IDR	4316639	6039042	45000	1700000	3000000	5000000	55500000
16	Prod. of 1 tree	*kg*	0.4547	0.6150	0.0167	0.2000	0.3267	0.5000	7.0000
17	Land Prod.	kg/m^2	3622	3583	33	1333	2500	5000	20000

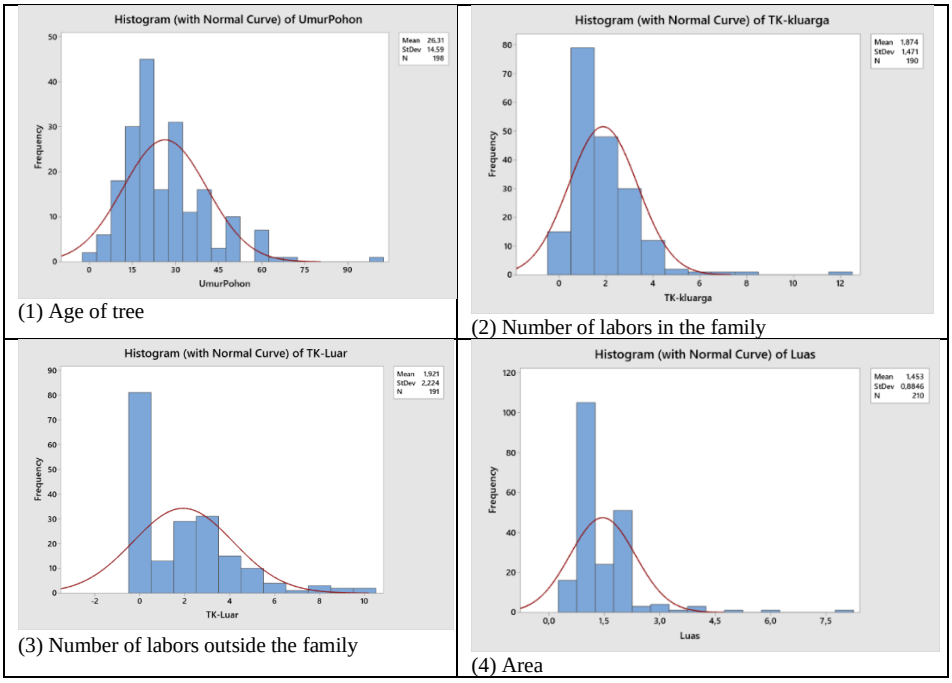
Based on Table 1, the average land owned is 1.4 hectares, the number of trees is 3,821 trunks, planting area per tree is 4.8 m^2, age of tree is 26 years, production per tree is 0.46 kg, coffee bean production in harvest period is 1,206 kg, production outside of the harvest period is 121 kg, and the length of the harvest period is 3 months. Land productivity is an average of 0.04031 kg of dried coffee beans (green beans) for 1 m^2 of land (403.1 kg of coffee beans per ha of land).

The majority of coffee farm is fertilized once a year or not fertilized. Spraying weeds with herbicides is done once or twice a year.

Coffee farmer's working hours is average of 38 hours for 1 week, but it is 47 hours at harvest period. The use of labor in the family to help in the farm during the harvest period is 1 to 2 people, on average there is 1 man and 1 woman. While the use of labor outside the family is also an average of 1 to 2 people, either 1 man or 1 woman.

The average production cost is about Rp 4,300,000 for one year. The average price range of coffee beans is about Rp 18,000 to Rp 20,000 per *kg*, so that an average net income is about Rp 16,400,000 a year.

While the histogram of several variables can be seen in Figure 1 until Figure 3. For variables marked with * states that the variables are divided into several categories.



(1) Age of tree

(2) Number of labors in the family

(3) Number of labors outside the family

(4) Area

Figure 1. Histogram of several variables

Figure 1 is a graphical representation of Table 1. Based on Figure 1, the average respondent uses more male labors in the family (on average 2 to 3 people, consisting of 2 men and 1 woman). If labors used from outside the family, they more use 2 people, both 1 man and 1 woman, or both men.

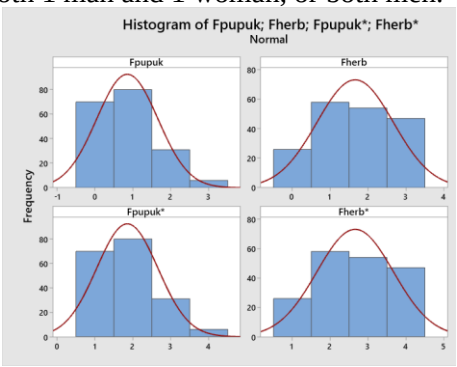
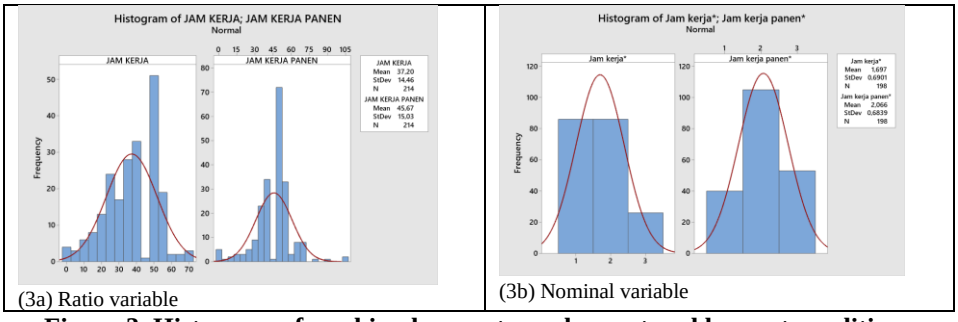


Figure 2. Histogram of fertilizing and herbicide frequency

Based on Figure 2, the majority of respondents fertilize 0 to 1 time in 1 year (before harvest period). The majority of herbicide use 1 to 3 times a year.



(3a) Ratio variable

(3b) Nominal variable

Figure 3. Histogram of working hours at non-harvest and harvest conditions

Based on Figure 3, at harvest period, respondents whose working hours are more than average, the frequency is higher than when not harvesting. The fact, at harvest time, farmers tend to use other labor to harvest and process the harvest. The work of picking and processing coffee fruits is generally done by women.

The method used in subsequent data processing is bivariate analysis and proceed with a simple correspondence analysis. The division of categories for average production per tree (in *kg* / tree) and land productivity ($\times 10^{-4}$ kg/m^2) is divided based on Q1, median, and Q3 values. The categories of land productivity with their percentage of respondent amount are:

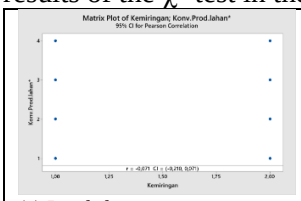
K1: <1333 (there are 48%)
K2: [1333, 2667) (there are 52%)
K3: [2667, 5000) (there are 56%)
K4: ≥5000 (there are 37%)

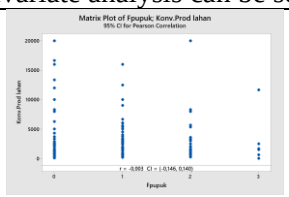
As for the average production of 1 tree is divided into 4 categories, namely:

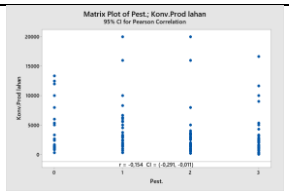
p1: <0.2 (there are 44%)
p2: [0.2; 0.32) (there are 53%)
p3: [0.32; 0.5) (there are 37%)
p4: ≥0.5 (there are 61%)

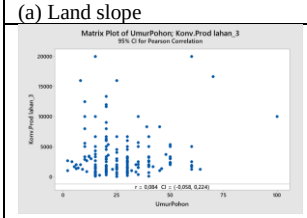
Based on descriptive statistics and histograms in Figures 1 to 3, each factor (or variable) studied was divided into several categories as in Table 2.

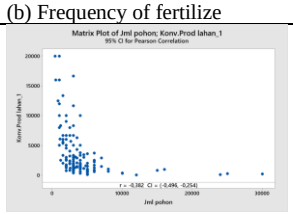
The relationship between variables (as factors) affecting land productivity can be seen from the matrix plot in Figure 4. The correlation matrix value and the results of the χ^2 test in the bivariate analysis can be seen in Table 2.

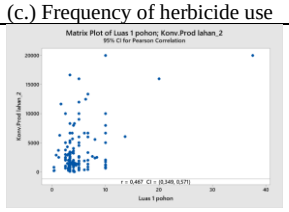

(a) Land slope

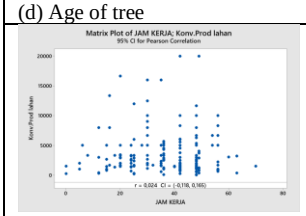

(b) Frequency of fertilize

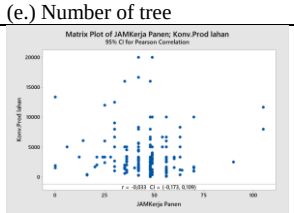

(c.) Frequency of herbicide use

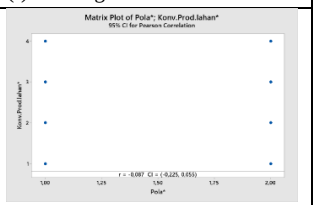

(d) Age of tree

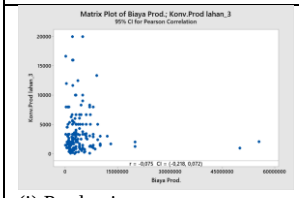

(e.) Number of tree

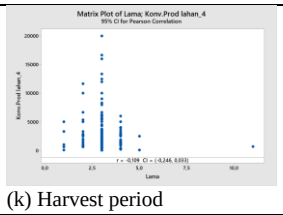

(f) Planting area for 1 tree

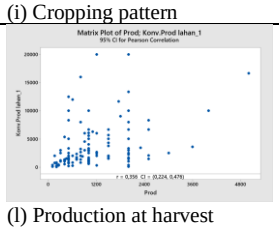

(g) Working hours

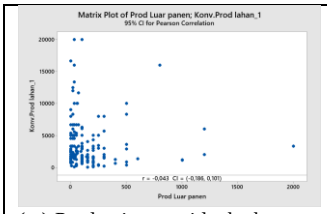

(h) Working hours at harvest


(i) Cropping pattern

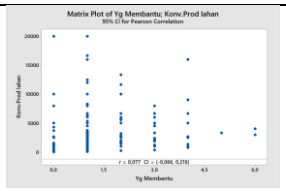

(j) Production costs


(k) Harvest period

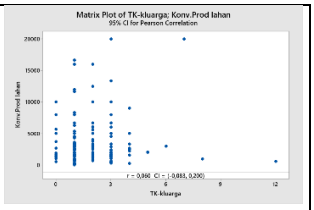

(l) Production at harvest



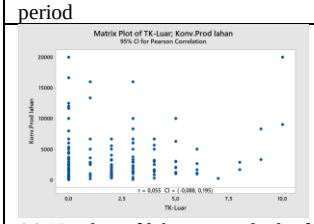
(m) Production outside the harvest period



(n) Number of family members who helped



(o) Number of labors in the family



(p) Number of labors outside the family

Figure 4. Matrix plot relationship of factors that affect land productivity

Based on Figure 4, the relationship of each variable to land productivity has no clear tendency (no specific pattern). Each variable value tends to have a variety of productivity values. The frequency of a variable value can be different, but there is a high frequency. This can also be seen from the small correlation value *r*, even close to 0. For example, for Figure 4f, respondents who have an area of 1 *ha*, the majority of land productivity is low, but a small portion of land productivity is high.

There is no differences tendency in land productivity if it is related to the amount of labor used, except for the use of labor ≥ 5 people. The use of labor or family members in large numbers can not to increase the coffee land productivity.

Table 2. Bivariate analysis on the relationship of factors that affect land productivity

No	Factor	Correlation *r*	Categories	χ^2 test	Related/ No relation
1	Land slope		1: flat 2: sloping	6.148 Df=3	No relation
2	Cropping pattern		1: single cropping 2: intercropping	2.409 Df=3	No relation
3	Area (ha)	-0.346	L1:< 0,9 L2: [0,9; 1,8) L3: [1,8; 3) L4: > 4	73.125 DF=12	Related
4	Number of trees	-0.382	J1: ≤ 1.000 J2: (1.000, 2.500) J3: **(2.500, 4.000]** J4: (4.000, 5.500] J5: >5.500	97.494 DF=12	Related
5	Area of 1 tree	0,467	Lp1: ≤ 3.33 Lp2: (3.33; 3.75] Lp3: (3.75; 5] Lp4: >5	22.829 Df=9	Related
6	Age of tree (in years)	0.084	U1: <10 U2: [10, 20] U3: (20, 30] U4: (30, 40] U5: (40, 50] U6: > 50	21.077 Df=15	No relation
7	Number of family members who helped (people)	0.077	m1: 0 m2: 1 m3: 2 m4: 3 m5: 4 m6 : ≥ 5	17.412 DF=12	No relation

8	Number of labors in the family	0.060	Kl1: 0 Kl2:1 Kl3:2 Kl4:3 Kl5: 4 Kl6: ≥ 5	9.227 Df=15	No relation
9	Number of labors outside the family	0.055	lu1: 0 lu2: 1 lu3:2 lu4: 3 lu5: 4 lu6: ≥ 5	9.673 DF=15	No relation
10	Fertilization frequency (times)	-0.003	Pu1: 0 Pu2: **1** Pu3: 2 Pu4: 3	28.509 Df=9	Related
11	Freq. of spraying herbicides (times)	-0.154	Pe1: 0 Pe2: **1** Pe3: 2 Pe4: 3	24,84 DF=9	Related
12	Working hours outside harvest (hours in 1 week)	0.024	J1: < 40 J2: [40, 54) J3: ≥ 54	7.525 Df=6	No relation
13	Working hours at harvest (hours in 1 week)	-0.033	Jp1: <40 Jp2: [40, 54) Jp3: ≥ 54	9,768 DF=6	No relation
14	Harvest period	-0.109	Lp1: 1 Lp2: 2 Lp3: **3** Lp4: 4 Lp5: ≥5	23.786 DF=12	Related
15	Harvest Production (*kg*)	0.386	p1: <1.000 p2: **[1.000, 2.000)** p3: [2.000, 3.000) p4: [3.000, 4.000) p5: ≥4.000	38,523 Df=12	Related
16	Production outside harvest (*kg*)	-0.043	pl1: 0 pl2: (5, 50] pl3: **(50, 250]** pl4: (250, 500] pl5: (500,750] pl6: >750	19.974 DF=15	No relation
17	Production cost (in million Rp)	-0.075	b1: ≤ 1 million b2: **(1, 3]** b3: (3, 5] b4: (5,7] b5: (7, 9] b6: > 9 million	24.419 Df=15	No relation

Note: For $\alpha = 0.05$, the value of χ^2_{tab} for df = 3 is 7.815; the value of χ^2_{tab} for df = 4 is 9,488; χ^2_{tab} for df = 6 is 12.592; χ^2_{tab} for df = 8 is 15.507; χ^2_{tab} for df = 10 is 18.307; χ^2_{tab} for df = 12 is 21.026; χ^2_{tab} for df = 15 is 24.996; χ^2_{tab} for df = 16 is 26.296.
r is calculated on the value of the ratio variable (or interval).
Working hours: for farmers who have a coffee farm (not including working hours for labor).

Based on Table 2, the correlation (*r*) between each of the 15 variables whose values are still on a ratio scale (not yet divided into categories) with land productivity, ranges from -0,346 to 0.467.

Based on the results of bivariate analysis with chi-square test, there are only 7 of 17 factors related to land productivity, namely: area, number of trees, planting area of 1 tree, frequency of fertilization, frequency of herbicide use, harvest period, and harvest production. The seven factors have low correlation values, i. e. -0.382 (number of trees), -0.334 (area), -0.154 (frequency of application of herbicides), -0.109 (harvest period), 0.386 (harvest production), and 0.467 (area for 1 tree). The variable that does not correlate with land productivity is fertilization frequency, which is -0.003.

The calculation of land productivity is related to the area, number of trees,

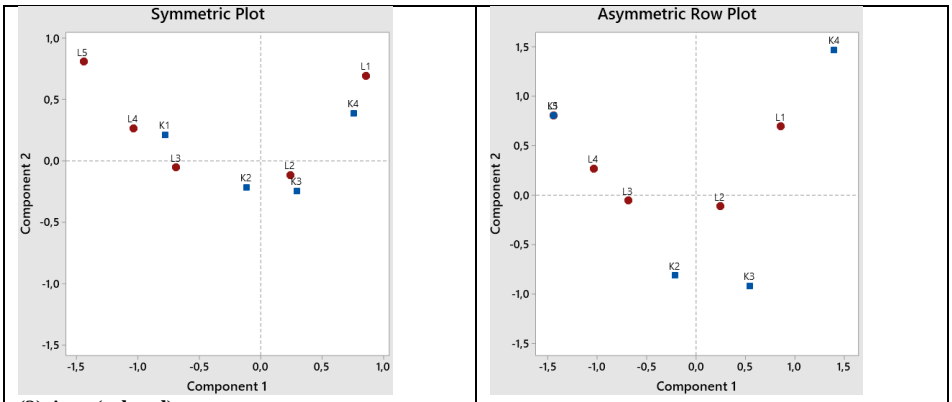
and harvest production. While the calculation of planting area of 1 tree is based on the area of the farm owned by farmers divided by the number of trees. In general, there are 3 influential factors in calculating the land productivity, namely fertilizing frequency, frequency of herbicide use, and harvest period.

3.2 Simple Correspondence Analysis

After obtaining the results of bivariate analysis, a simple correspondence analysis was also performed. The total inertia results obtained are multiplied by the number of respondents, so that the value of χ^2_{count} is the same as χ^2_{count} results from bivariate analysis.

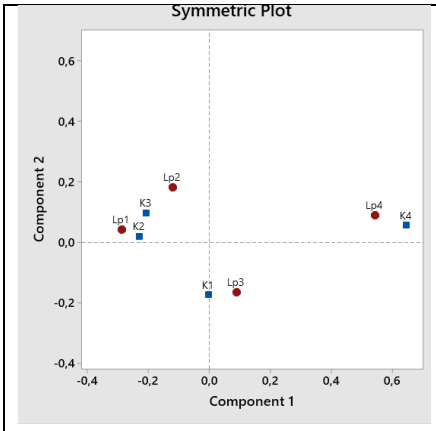
Figure 5 represents several plots of the result of simple correspondence analysis where the variables have relation with land productivity. All plots are obtained have cumulative inertia more than 91% even 100%. Symmetric plots represent the distance among categories of row variables and the distance among categories of column variables. Whereas the asymmetric row plot represents the distance among the column variable categories and the distance between the row variable categories and the column variable categories. These distance relationships are reviewed based on where the points are in the quadrant.

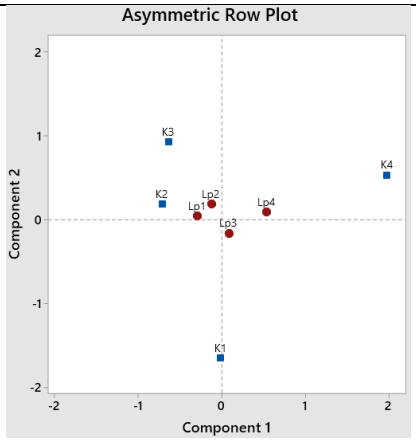
Every relationship on land slope and cropping patterns with land productivity cannot represented by plots, because the results of correspondence analysis are in 1 dimension. There is no relationship between land slope and land productivity. Sloping land tends to have lower land productivity than flat land. There is no relationship between cropping patterns and land productivity. Single cropping patterns tend to have higher land productivity than intercropping patterns.



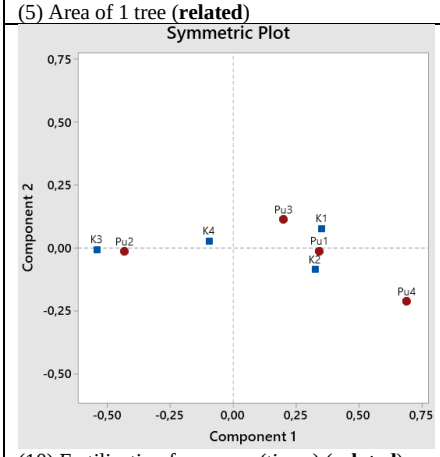
(3) Area (**related**)

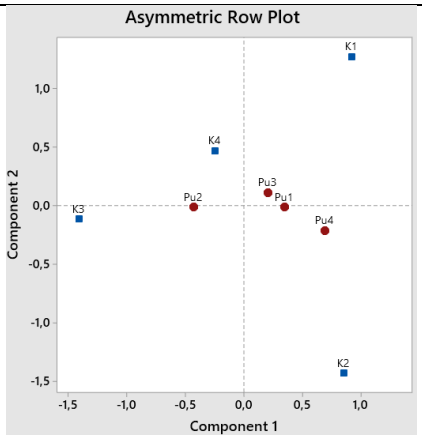
(4) Number of trees (**related**)



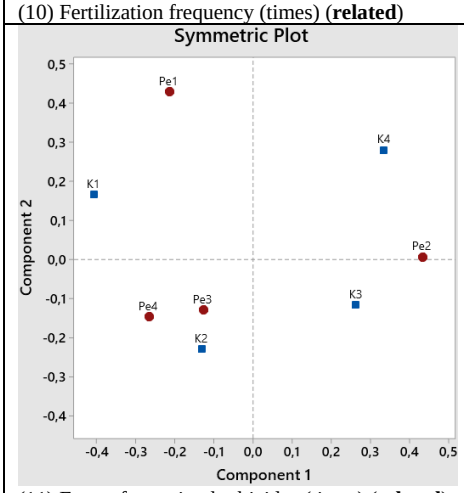


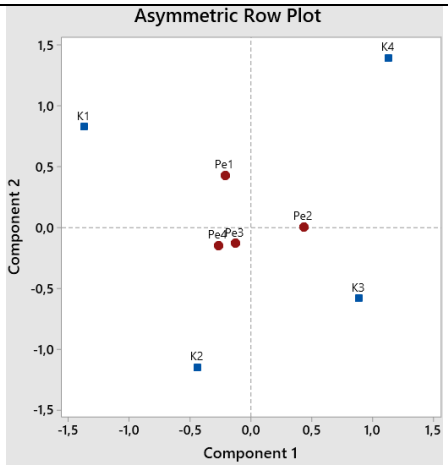
(5) Area of 1 tree (**related**)





(10) Fertilization frequency (times) (**related**)





(11) Freq. of spraying herbicides (times) (**related**)

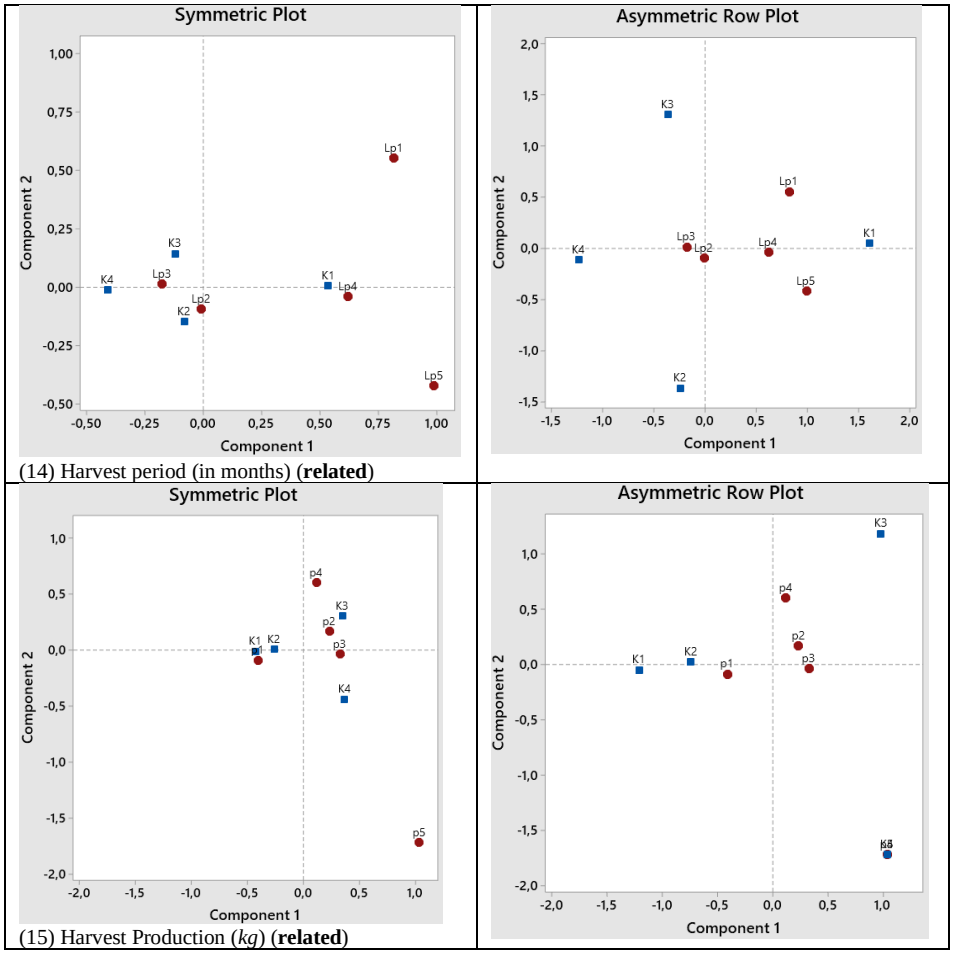


Figure 5. Plot of the results of simple correspondence analysis on the factors that have relation with land productivity

Table 3 below as explanation about the results of simple correspondence analysis and Figure 5 too.

Table 3. Explanation about the results of simple correspondence analysis

Fig.	Explanation about Figure 5
5.3	Area (ha): **there is a relationship** with land productivity Asymmetric plot: Adjacent category variables are L5-K1, L1-K4, L2-K3, L3-K2. It can be interpreted that there is a tendency that the more extensive the land, the lower the land productivity.
5.4	Number of trees: **there is a relationship** with land productivity Symmetric plot: categories J4-J5 are very close, so that both categories tend to be almost similar and can be combined. Asymmetric plot: Adjacent category variables are J3-K2 and J1-K4; there is a tendency if the number of trees is low; J1 (<1,000), then land productivity is high. But if the number of trees J3 ((2,500; 4,000]) then land productivity tends to be low.
5.5	Area of 1 tree: **there is a relationship** with land productivity Symmetric plot: the K2-K3 categories are very close, so that both categories are almost similar and can be combined. Asymmetric plot: The adjacent variables are K2-Lp1, so there is a tendency if the area of 1 tree $\leq$ 3.33 m^2, then land productivity tends to be low.
5.6	Tree age (years): there is no relationship with land productivity Symmetric plot: categories K1-K4 are very close, so that both categories are similar and can be combined. Asymmetric plot: no tendency.

5.7	The number of family members who helped (person): no relation to land productivity Symmetric plot: m4-m5-m2 categories are very close, so that both categories are similar and can be combined. Asymmetric plot: no tendency.
5.8	Labors in the family: there is no relationship with land productivity Symmetric plot: kl1-kl6 categories are very close, so that both categories are similar and can be combined. Asymmetric plot: no tendency.
5.9	Labors outside the family: there is no relationship with land productivity Symmetric plot: the lu2-lu1-lu6 categories are very close, so that the three categories are almost similar and lu1-lu2 can be combined. Asymmetric plot: The adjacent variable is K2-l6-lu1-lu2, so there is a tendency if the number of labors from outside the family is no one or 1 person or ≥ 5 people, then land productivity tends to be low.
5.10	Fertilization frequency: **there is a relationship** with land productivity Symmetric plot: Among categories of rows variables and among categories of columns does not group. Asymmetric plot: The adjacent variables are Pu2-K4, Pu3-K1, Pu4-K2, so there is a tendency if fertilization is done once a year, then land productivity tends to be high. If fertilizing is done 2 or 3 times in 1 year, then land productivity tends to be low.
5.11	Frequency of spraying herbicides (times): **there is a relationship** with land productivity Symmetric plot: between categories of rows variables and between categories of columns does not group. Asymmetric plot: The adjacent variables are Pe4-Pe3-K2, Pe2-K3, and Pe1-K1, so there is a tendency if herbicide application is done once a year, then land productivity tends to be moderate. If herbicide application is not carried out or 2 times or 3 times in 1 year, then land productivity tends to be low.
5.12	Working hours (hours a week): there is no relationship with land productivity Symmetric plot: Among categories of rows variables and among categories of columns are spread. Asymmetric plot: no tendency.
5.13	Working hours at harvest (hours a week): there is no relationship with land productivity Symmetric plot: among categories of rows variables and among categories of columns are spread. Asymmetric plot: no tendency.
5.14	Harvest period: **there is a relationship** with land productivity Symmetric plot: among row variable categories and among column variable categories tend to be spread. Asymmetric plot: The adjacent variables are Lp1-K1, Lp2-K2, Lp3-K4, it can be interpreted that there is a tendency if the harvest time is 1-2 months, then land productivity tends to be low. But if the harvest period is 3 months, then there is a tendency for high land productivity.
5.15	Harvest production (*kg*): **there is a relationship** with land productivity Symmetric plot: Every categories K1 - K2 and P2 - P3 are close together, so the two categories are similar and can be combined. Asymmetric plot: The adjacent variables are P5-K4 and P4-K3, it can be interpreted that there is a tendency if harvest production is high, then land productivity is also high.
5.16	Production outside harvest (kg): there is no relationship with land productivity Symmetric plot: the pl2-pl3-pl4 and K1-K3 categories tend to be close, so the categories tend to be similar and can be combined. Asymmetric plot: The adjacent variables are K1 and Pl3, it can be interpreted that there is a tendency if production outside the harvest period is 50-250 kg, then land productivity tends to be very low. This can be possible if the harvest is done in stages and selectively, so that outside the harvest period, coffee production is still available.
5.17	Production costs (in million rupiah): there is no relationship with land productivity. Symmetric plot: b3-b4 categories are very close, so that both categories are similar and can be combined. Asymmetric plot: The adjacent variables are K4 - b5. It can be interpreted that there is a tendency if production costs are high, then land productivity tends to be high.

4. CONCLUSION

Based on the results of data processing of 214 respondents who have coffee farming, the factors that have a relationship with land productivity are the area, number of trees, planting area of 1 tree, frequency of fertilization, frequency of herbicide use, harvest period, and harvest production.

There is a tendency if land area is getting higher, number of trees 2,500 - 4,000, area of 1 tree ≤ 3.33 m^2, fertilizing is done 2 or 3 times in 1 year, herbicide application is not done or 2 times or 3 times in 1 year, and harvest period 1-2 months, then land productivity will tend to be low.

If the number of trees is small (<1,000), fertilizing is done once a year, harvesting time is done within 3 months, then land productivity tends to be high. In addition, if the application of herbicides is done once a year, then land productivity tends to be moderate.

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