Hypothesis Testing in The Study of The Characteristics of Pagaralam Coffee Farmers as Herbicide Reductant Users

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Abstract. The use of herbicides in weed control must be done wisely so that negative impacts on land and cultivated plants can be minimized. Herbicide reductants were introduced to Pagaralam coffee farmers through an educational process. This study aims to analyse the characteristics of Pagaralam coffee farmers who are users of herbicide reductants. Comparison of the characteristics of users and non-users of reductants was carried out using the mean test, variance test, and chi squares test. The selection of respondents was using purposive sampling. The variables studied include the identity of the respondent, the identity of the land, and the culture of coffee farming. There were 125 respondents consisting of 55 users and 70 non-users of herbicide reductants. In the mean test results, only the average planting area per 1 tree, age of tree, maximum selling price of green beans, and number of workers are not the same between the two categories of respondents. While the results of the variance test, only five variables result H_0 rejection, namely the number of trees, planting area per 1 tree, age of tree, average price of green beans, and the use of female workers outside the family. The chi squares test showed that there was a relationship between the respondent's category and every categories variable, that education, land conditions, frequency of herbicide use, impact of chemical herbicides (no reductants) on coffee production, positive impact (good) reductant in coffee plants, the role of relevant department, the impact after using reductants on the amount of production, the impact after using reductants on net income, number of workers, and length of harvest period.

Keywords: Chi squares test, coffee farmers, descriptive statistics, herbicide reductant, Pagaralam coffee.

Introduction

The coffee industry is one of the priority sectors set by the Ministry of Industry in accordance with the National Industrial Development Master Plan (RIPIN) 2015-2035. It is the focus of the development commodity of the Ministry of Industry, especially the Directorate General of Small and Medium Enterprises (IKM) [1]. Coffee is one of Indonesia's leading export commodities, which ranks 8th. Coffee is the fourth largest foreign exchange earner after palm oil, rubber and cocoa [2

South Sumatra Province is the largest robusta coffee producer in Indonesia [3]. The area of smallholder plantations (PR) of South Sumatra is 19.9% of the national coffee area. South Sumatra's contribution to the total national coffee production in 2018 was 25% [4].

Pagaralam City is famous for its plantation and horticultural crop production. The people's plantation crops are mainly coffee. Most of the population in this area make a living as coffee farmers. In 2020, Pagaralam's plantation crop production is dominated by coffee with 12,782 tons, tea 3,240 tons and rubber 515 tons [5]. Based on data from the Directorate General of Plantation [3], there are 6,914 heads of families (KK) coffee farmers in Pagaralam.

Weeds are unwanted plants because they can interfere with growth, can reduce the productivity and quality of other cultivated plants, and compete for nutrients (nutrients), water, and light. The presence of weeds around coffee plants will indicate plant morphological abnormalities, including yellowing leaves, stunted or thin plants, dead plagiotrope branches, smaller fruit, low production and symptoms of nutrient deficiency [6].

The use of herbicides is used by coffee farmers to control weeds. Pagaralam coffee farmers rarely control weeds mechanically and manually, because it requires high costs and is less effective, the grass grows back quickly, and the control time is longer, and requires a lot of labor.

Based on [7], the frequency of use of pesticides (i.e. herbicides) of respondents to Pagaralam coffee farmers is quite high (1 to 3 times a year). Only 20% of respondents do not use herbicides. The dependence of farmers on the use of pesticides is quite high (63%), although the awareness of farmers is quite high (53%) towards organic land management. In addition, the willingness of farmers to intercrop farming is quite low (29%). If the land has a high potential for overgrown weeds, it will require extra care and high costs for weed control. Herbicide applications are often mixed with fertilizers (by 53%). Respondents understood that the use of herbicides could result in a decrease in production (43%) and coffee spoilage (48%). Some coffee fields, the land is damaged and the coffee plants become less or even not producing. Based on [8], using bivariate analysis, frequency of fertilization and use of pesticides are two variables that are related to land productivity.

In this study, Pagaralam coffee farmers who are considered a population are defined as farmers who own and operate their own coffee farming in Pagaralam, starting from land and plant maintenance to post-harvest process to green bean production. In land maintenance, sometimes farmers involve workers both from within their families and workers outside the family. Likewise, during the harvest process, farmers sometimes also involve workers, both men and women. The majority of farmers involve their family members in post-harvest processing of coffee.

Herbicide reductant is a product made from organic as herbicide reducer, so it can reduce herbicide residue in agricultural areas as well as more economical because it can reduce herbicide costs. A mixture of reductants in pesticides can save agricultural or plantation maintenance costs by at least 10 percent to 40 percent [9]. Based on information from herbicide distributors and field assistant of private companies in Pagaralam on early year 2021, there were around 600 – 1,000 users of herbicide reductants during the last 3 years. However, there are around 500 farmers who are loyal to using reductants for more than 1 year. In this study, coffee farmers in Pagaralam were divided into 2 categories, namely reductant users (who were loyal to using more than 1 year) and non-users (i. e. farmers who had just started as users and also farmers who had never used herbicides). Coffee fields of reductant users are spread over 4 sub-districts in Pagaralam.

Hypothesis is a temporary answer to a research problem that is theoretically considered the highest and most likely level of truth. According to [10], the hypothesis is based on the existence of a relationship between variables where there are assumptions or temporary conclusions that need to be proven true. A statistical hypothesis is a statement or conjecture about one or more populations [11]. Hypothesis testing is a procedure based on samples and probability theory to determine whether the hypothesis is reasonable and verifiable [12]. The F test can be used to determine whether two populations have different variations or not. While the Z test can be used to test the mean of two independent populations on a large sample. The chi squares test is a test for data on a nominal scale and does not require assumptions about the normal distribution of the population.

The introduction of the reductant requires an educational process for farmers to be wise, in the right way, on target, and on time in weed control. The farming culture (behavior) of coffee farmers who use reductants is farmers who are willing to learn, willing to accept new innovations in plant care, discussing issues related to fertilization and the use of pesticides, so that their coffee plants can produce optimally. In this case, it is necessary to examine the hypothesis that farmers who use herbicide reductants have different characteristics from farmers who do not use reductants.

The purpose of this study was to analyze the comparison of characteristics between farmers who used herbicide reductants and those who did not, using the mean test, variance test, and chi squares test. The mean test was carried out on a large sample and the samples taken were assumed to come from two independent populations. The variance test was carried out on a large sample and the sample taken was assumed to come from a normally distribution population. The research variables tested were the characteristics of the farmers including the identity of the farmers, the state of the land, and the farming culture of the Pagaralam coffee farmers. Furthermore, the results of this study can be a reference for related institutions regarding the state of Pagaralam coffee farming, so that it can be input regarding sustainable agriculture.

Research methods

This research is a case study, which the object of research is Pagaralam coffee farmers who own and did a coffee farming. Respondents were selected as research samples using purposive sampling technique. If it uses α= 5% and the allowable error margin is 7% (i.e. the percentage of the estimate is likely to make an error in determining the sample size), then the number of samples taken is $n \geq pq\left(\frac{Z\frac{\alpha}{2}}{E}\right)^2$ (Widarjono, 2021). It is found $n \geq (\frac{500}{6914})(1-\frac{500}{6914})\left(\frac{1{,}96}{7\%}\right)^2$, so that $n > 52$. In this study, 125 respondents were taken. After the respondents were classified, 55 respondents were reductant users and 70 respondents were not reductant users.

Questionnaire questions filled out by respondents include the identity of the respondent, the identity of the land, the culture of coffee land management, the production and income of the respondent, as well as the state of the respondent's perception of sustainable agriculture. The observed characteristics of the population elements are called variables. In this paper, not all questionnaire questions become research variables. Previously, the questionnaire questions were modified through validity and reliability tests.

The steps in this research are:

1. Develop a data matrix from the recapitulation of the answers to several questions on the questionnaire.
2. Performing descriptive statistics on variables from several questionnaire questions whose variable measurement scales are ratio scales.
3. Calculating the percentage of answers to questionnaire questions whose variable measurement scales are nominal and ordinal.
4. Conduct descriptive statistics from Step 2 based on 2 categories of respondents, namely farmers who use herbicide reductants and non-users (including farmers who are just starting to use). In this step, a description of the variables with histograms or boxplots is carried out in each category of respondents. In this case, it is assumed that there are two samples obtained from two populations.
5. Perform mean test on several variables with a ratio scale by using the Z test, namely the equation $Z = \frac{\overline{x_1}-\overline{x_2}}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}}$; where $\overline{x_1}$ = mean of sample taken from population 1; $\overline{x_2}$ = mean of samples taken from

population 2; s_1^2 = variance of sample 1; s_2^2 = variance of sample 2; n_1 = number of samples taken from population 1; dan n_2 = number of samples taken from population 2.

6. Perform variance test on several variables with a ratio scale, using the *F* test, namely the equation $F = \frac{s_1^2}{s_2^2}$; where s_1^2 and s_2^2 respectively represent the variances of sample 1 and sample 2. The large sample variance is placed in the numerator, while the small sample variance is placed in the denominator.
7. Compile a two-way contingency table on several variables with nominal and ordinal scales, or categorizable ratio-scale variables. Each of these variables is divided into categories to become row variables. While the column variables are categories of reductant users and non-reductant users.
8. Perform the chi squares test (χ^2) on the relationship of each row and column variables in Step 7.
9. Interpretation of results.

Stages of data processing with the help of Minitab 19 and SPSS 24 software.

3. Results and discussion

The assumption in this study is that Pagaralam coffee farmers have homogeneous characteristics. This was based on literature from BPS and field surveys. In this study, the number of samples taken is about 10% of the population (Pagaralam coffee farmers), namely 55 reductant -using farmers and 70 non-reductant-using farmers (including those who had just started using it).

Several questionnaire questions are in the form of open-ended questions and there are also multiple choice. Recapitulation of answers to open-ended questions can be seen in Table 1. While the answers to multiple-choice questions can be expressed as categories and on an ordinal scale. The recapitulation of the percentage of answers can be seen in Table 2.

Based on Table 1, the average age of the respondents is 43.8 years, the average length of schooling is 10 years (graduated from junior high school), for the number of children who are dependents 1 to 2 people, the number of family members who help 1 to 2 people, farming since the age of 21 years, long time in coffee farming for 22 years, has a land area of 1.3 ha, the number of trees is 3,930 stems, the average spacing is 2,3 m, the planting area per 1 tree is 3.4 m^2, the age of the tree is 19 years, yield of 10 quintals, frequency of herbicide use in 1 year 2 times, distance of herbicide use every 5 to 6 months, frequency of use of chemical fertilizers < 1 time (0.8 times), frequency of use of organic fertilizers 0.4 times, distance of fertilizer use 8 month, the production of green beans at harvest is 9.9 quintals, the production of green beans outside the harvest period is 1.7 quintals, the total production of green beans at harvest is 10.97 quintals, the average selling price is Rp 18,626,-. Land maintenance costs Rp 2,726,976, gross income is Rp 19,258,000, net income is Rp 15,993,184,-, the number of workers in the family is 2 people with an average of 1 male and 1 female, respectively, the number of workers outside the family is 6 people with an average number of male workers equal to or more than women, and an average harvest period of 2.4 months.

Table 1. Descriptive statistics of several variables in the form of open questions

No.	**Variable**	**N**	**Mean**	**Min**	**Q1**	**Median**	**Q3**	**Max**
1	Age	125	43.82	23.00	35.00	44.00	50.00	76.00
2	Education	125	10.29	4.00	6.00	12.00	12.00	17.00
3	Number of dependent children	125	1.35	0.00	0.00	1.00	2.00	6.00
4	Number of family members helping	125	1.58	0.00	1.00	1.00	2.00	6.00
5	age to start coffee farming	125	21.70	11.00	19.00	20.00	25.00	40.00
6	Long time in coffee farming	125	22.29	2.00	12.00	23.00	30.00	56.00
7	Land area (in hectares)	125	1.28	0.25	1.00	1.00	2.00	5.00
8	Number of trees	125	3930	800	2500	3500	5750	15000
9	Average planting distance (in *m*)	125	2.3	1.00	2.25	2.25	2.25	6.25
10	Planted area (m^2)/1 tree	125	3.5	1.25	2.78	3.33	3.45	12.50
11	Total harvest	125	11.0	1	6	10	13	80.1
12	Average production outside the harvest period	86	1.7	0.1	1	1.3	2	5
13	Age of tree (in years)	124	19.2	3	12	20	24.5	50
14	Estimated yield of green bean	125	10.1	1	5	9	10	100
15	Frequency of herbicide use	125	2.2	1	2	2	3	4
16	Herbicide use interval	125	5.5	3	4	6	6	12
17	Frequency of chemical fertilizer use	122	0.9	0	0	1	2	4
18	Frequency of using Organic fertilizer	118	0.4	0	0	0	1	2
19	Fertilizer usage time interval	79	7.9	1	6	6	12	12
20	Production of green beans (in quintal) Net income (in 1 year)	124	9.9	2	5	9	10	80
21	Minimum selling price of green beans	125	17682	15000	17000	18000	18000	20009
22	The maximum selling price of green beans	125	19759	17000	19000	20000	20000	25500
23	Average price of green beans	125	18626	8000	18250	19000	19000	20150
24	Land maintenance costs	125	2726976	250000	1000000	2000000	4000000	10900000
25	Gross income (in 1 year)	125	19258000	3800000	10000000	17200000	20000000	195000000
26	Net income (in 1 year)	125	15993184	2300000	8962500	14000000	17000000	151400000
27	Number of workers in the family (TD)	121	2.1	0	2	2	2	5
28	Male (TDL)	121	1.2	0	1	1	2	5
29	Female (TDW)	120	0.9	0	1	1	1	2
30	Number of Workers outside the family (TL)	76	5.8	0	3	5	8	20
31	Male (TLL)	76	3.3	0	2	3	4.75	10
32	Female (TLP)	76	2.5	0	0	2	4	10
33	Harvest time (in months)	108	2.5	2	2	2	3	3

Notes:
Education is calculated based on the length of education (in years), namely elementary school: 6 years, junior high school: 9 years, high school: 12 years, and undergraduate: 17 years.
Average for the number of dependent children = 1 to 2 people.
Average number of family members who help = 1 to 2 people.

Several variables from the questionnaire question points, the answers are in the form of categories. The percentage of answers to the questionnaire questions can be seen in Table 2.

Table 2. Percentage of respondents' answers to several selected questions on the questionnaire

No	Variable Items (Question Items)	Categories	Percentage
1	Education	Graduated/Not passed SD (Elementary School)	32
		SMP (Junior High School)	13
		SMA (Senior High School)	**43**
		Undergraduate	12
2	Side job	There is	24
		None	**76**
3	The role of the wife in coffee farming	Not helpful	18
		Sometimes helpful	17
		Very helpful	**65**
4	Land condition	Sloping (hilly)	28
		Flat	**73**
5	Coffee land condition	Not good	4
		Moderate	**83**
		Good	13
6	Coffee plant condition	Not good	5
		Moderate	**84**
		Good	11
7	Perception of harvest	Low	35
		Moderate	**63**
		High	2
8	Frequency of herbicide use in 1 year	1 time	14
		2 times	**53**
		3 times	30
		4 times	3
9	Herbicide use interval (in months)	3	7
		4	34
		5	2
		6	**49**
		12	7
10	Identifying reductants	Not yet	16
		Already	**84**
11	Reductant users	No	3
		Just tried	**49**
		Yes	**48**
12	Use of reductant (times)	**1**	**33**
		2	**28**
		3	15
		4	17
		5	7
13	Frequency of using chemical fertilizers in 1 year	**Never**	**40**
		1	**34**
		2	24
		3	2
		4	1
14	Frequency of using organic fertilizer in 1 year	**Never**	**65**

		1	27
		2	8
15	Time interval of fertilizer application (in months)	1, 3, 4, 5	13
		6	**49**
		8	1
		12	37
16	Herbicide and fertilization applications	Mixed	32
		Separated	**68**
17	Effects of chemical fertilization	None	28
		Starting to look	22
		Exist	**54**
18	Impact of chemical fertilization	**Exist and the impact is positive**	**88**
		Exist and the impact is negative	12
19	Impact of chemical herbicides (without reductants) on **coffee plants**	None	8
		Starting to look	**43**
		Exist	**49**
20	The impact of chemical herbicides (without reductants) on **coffee plants**	**Bad (negative)**	**91**
		Good (Positive)	9
21	Impact of chemical herbicides (without reductants) on **coffee production**	Nothing	27
		Starting to look	**36**
		Exist	**38**
22	The impact of chemical herbicides (without reductants) on coffee production	**Bad (negative)**	**93**
		Good (Positive)	7
23	Yield of the farmer's economic condition	Not enough	41
		Enough	**58**
		Very enough	2
24	Grading of coffee (post-harvest): pick red	**No**	**85**
		Sometimes	9
		Yes	6
25	If Yes*, is there a premium coffee market link (price of red picks)?	**No (sell to collectors)**	**89**
		Yes (joined a farmer group)	11
26	Drying treatment on the para-para	**No**	**92**
		Yes	8
27	Length of harvest period (in months)	**2**	**52**
		3	**48**

Based on Table 2, the highest percentage of answers on the question items are respondents with high school education (43%) and elementary school (32%), no side job (76%), wife's role is very helpful (65%), flat land condition (73%), condition of coffee land is moderate (83%), condition of coffee plants is moderate (63%), frequency of herbicide use 2 times (53%) with a distance of use of 6 months (49%), and so on.

The coffee harvest period ranges from 2 to 3 months, with varying times. The majority of respondents' harvest period is May-June, June-July, and June-August. There are some farmers who do red-picking, good land care, and have a longer harvest period.

Furthermore, the respondents were divided into 2 categories, namely reductant users and non-users (including those who had just started trying to use). For reductant users, on average, they have used 2.3 times in 1 year, which ranges from 1 to 3 times. The number of respondents who are not users are 70 people. While the respondents who are users are 55 people. Comparison of the characteristics of the categories of respondents can be seen in Table 3.

Comparison of the characteristics of the two categories of respondents does not include variables related to the production and income of respondents. The variables in question are estimated yields, land maintenance costs, gross income (in 1 year), net income (in 1 year), harvested production in the form of green beans (in quintals), and total production (in quintals).

Comparison of the characteristics of the two categories of respondents was carried out using the mean test to test the significance of the difference in the mean scores and the test of the difference between the two variances (with the *F* test). The *F* distribution provides a tool for testing the variance of two normally distributed populations. In other words, the *F* test can be used to determine whether two populations have different variations or not. The characteristics of respondents in testing this hypothesis are based on continuous variables. Table 4 shows the mean and variance tests of the two categories of respondents.

Suppose the respondents are defined as non-reductant users as in sample-1 and respondents using reductant as in sample-2. The values of $Z_{count} = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$, $F_{count} = \frac{s_1^2}{s_2^2}$, and $\alpha = 1\%$. For the value of F_{count}, the larger sample variance is placed in the numerator, while the smaller sample variance is placed in the denominator. Table 3 presents the results of the mean and variance tests for the other variables in the two categories of respondents. The value of the variable is on a ratio scale and there is also an interval.

Based on Table 3, the variable values of respondent identity, land identity, and culture on land care can be characteristics of both categories of reductant users and non-reductant users. The values of mean and standard deviation of several variables in reductant users were higher than non-users. The difference in the mean value and standard deviation between the two categories of respondents was tested with the *Z* test and the *F* test, so that it can be analyzed whether the difference in values is significant or not.

In the comparison of the mean values of variable, if the value of $Z_{count} < Z_{critical}$, then it fails to reject the null hypothesis (H_0). In this case, the sample (respondents) is not sufficient to provide evidence that the characteristics of users and non-users of reductants based on the mean of these variables are not the same. In the same thing for the results of the *F* test, if the value of $F_{count} < F_{critical}$, then it fails to reject H_0, so there is no evidence that the variable variation in respondents using reductants is more stable than variable variations in respondents not using reductants. In this case, there is no difference in variance between the two populations. So, there is no difference in the character of the two categories of respondents on the variable.

Based on Table 5, the comparison of almost every mean variable in the two categories of respondents resulted in $Z_{count} < Z_{critical}$, meaning that it failed to reject the null hypothesis. In this case, the sample (respondents) is not sufficient to provide evidence that the user and non-constructing reductant characters based on these variables are not the same. So, the two categories of respondents have the same mean on these variables. There are only six variables whose mean value test results in H_0 rejection, namely planting area per 1 tree, age of tree, maximum selling price of green beans, and 3 variables related to the labor used. This means that the average of planting area per 1 tree, age of tree, maximum selling price of green beans, TD, TDL, and TLW of the two categories of respondents are not the same.

Table 3. Descriptive statistics, *Z* test, and *F* test of several variables in both categories of respondents

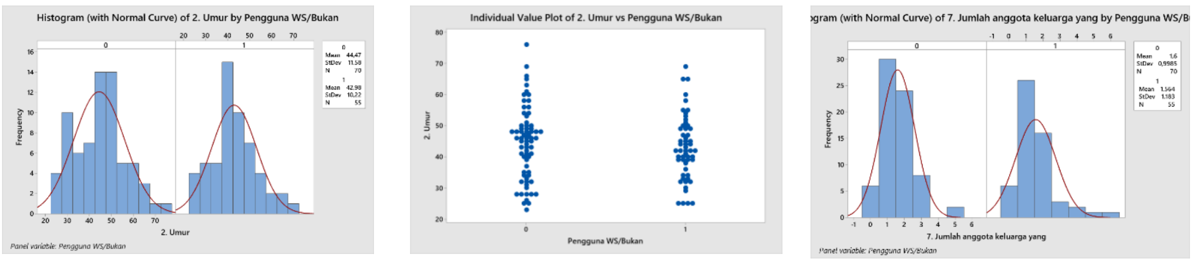
No.	Variables	Users/ Non users	Mean	StDev	Min	Median	Max	Z_{count}	F_{count}	De
1	Age	0	44.47	11.58	23	46	76	0.763	1.284	A
		1	42.98	10.22	25	42	69			
2	Education	0	10.871	3.358	4	12	17	2.015	1.326	A
		1	9.545	3.867	4	9	17			
3	Number of dependent children	0	1.343	1.238	0	1	6	-0.104	1.459	A
		1	1.364	1.025	0	1	4			
4	Number of family members helping	0	1.600	0.999	0	1	5	0.181	1.403	A
		1	1.564	1.183	0	1	6			
5	Long time in coffee farming	0	21.929	3.827	15	20	36	0.557	2.381	A
		1	21.418	5.903	11	20	40			
7	Land area (in hectares)	0	1.2000	0.6350	0	1	4	-1.372	1.721	A
		1	1.386	0.833	0	1	5			
8	Number of trees	0	3910	1868	800	3600	10000	-0.109	1.887	**
		1	3955	2567	1000	3500	15000			
9	Average planting distance (in *m*)	0	2.2306	0.7236	1	2	6	-1.534	1.660	A
		1	2.4069	0.5617	1	2	4			
10	Planted area (m^2)/1 tree	0	3.1179	0.8355	1	3	8	-3.208	3.436	F
		1	3.861	1.550	1	3	13			
13	Age of tree (in years)	0	15.943	0.864	15	4	40	-35.431	2.439	F
		1	23.41	1.35	20.5	3	50			
15	Frequency of herbicide use	0	2.1000	0.7450	1	2	4	-2.068	1.212	A
		1	2.3636	0.6767	1	2	4			
16	Herbicide use interval	0	5.714	2.221	3	6	12	1.285	1.319	A
		1	5.236	1.934	3	4	12			
17	Frequency of chemical fertilizer use	0	0.8406	0.7597	0	1	2	-0.727	1.795	A
		1	0.962	1.018	0	1	4			
18	Frequency of using Organic fertilizer	0	0.3382	0.5356	0	0	2	-1.648	1.880	A
		1	0.540	0.734	0	0	2			
19										
20	Minimum selling price of green beans	0	17824	987	15000	18000	20009	1.720	1.218	A
		1	17500	1089	15000	18000	19000			
21	The maximum selling price of green beans	0	20033	1077	17000	20000	25500	3.400	1.240	*
		1	19410	967	17000	20000	21000			
22	Average price of green beans	0	18758	1504	8000	19000	20150	1.382	2.726	**
		1	18457	911	16500	19000	20000			
23	Number of workers in the family (TD)***	0	2.2	0.786	0	2	4	2.569	1.224	*
		1	1.8	0.869	0	2	4			
24	Male (TDL) ***	0	1.4	0.723	0	1	3	3.536	1.300	*
		1	0.9	0.634	0	1	2			
25	Female (TDW) ***	0	0.9	0.427	0	1	2	-1.381	1.009	A
		1	1.0	0.429	0	1	2			
26	Number of Workers outside the family (TL) ***	0	2.4	2.328	0	2	6	-1.232	1.387	A
		1	2.9	2.741	0	3	6			
27	Male (TLL) ***	0	1.8	1.875	0	2	6	-0.716	1.263	A
		1	2.1	2.107	0	2	6			
28	Female (TLW)***	0	0.8	1.497	0	0	6	-3.129	2.632	**R**
		1	2.0	2.430	0	0	6			

Description: Not a reductant user is denoted by 0.
The user of the reductant is denoted by 1. The critical Z for $\alpha/2$ is 2.33; the critical F value is for α = 1%. ***Mean and standard deviation (StDev) values in descriptive statistics are assumed not to be rounded off. Notation of * means that the mean test results reject H_0, but the variance test results accept H_0. Notation of ** means that the mean test result is accepted H0, but the variance test result rejects H0.

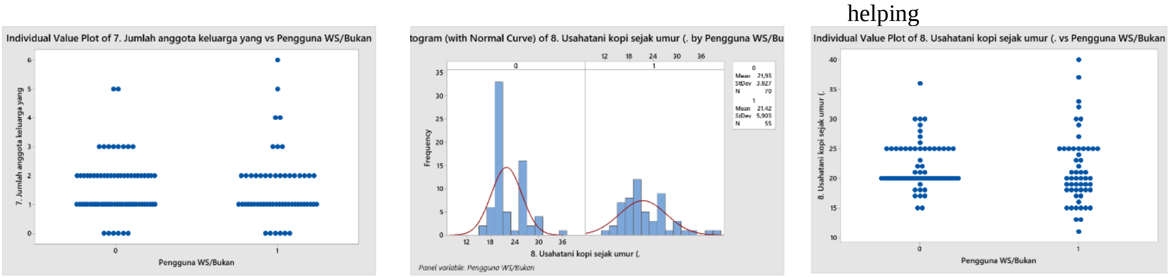
The category of non-user respondents had a lower average planting area per 1 tree and age of tree than respondents using reductants. However, the non-user respondents have a higher average maximum selling price of green beans. Especially for the variable of labor use, the category of non-user respondents has an average of worker in the family (TD) and also has male workers (TDL) which is higher than respondents using reductants. The opposite side for the average of female workers outside the family (TLW).

In the same case for the results of the F test, it fails to reject H_0, except for 5 variables. The test results accept H_0, meaning there is no evidence that the variable variation in respondents using reductants is more stable than variable variations in respondents not using reductants. So, there is no difference in variance between the two categories of respondents in the variance of the variables in Table 3, except for the number of trees, planted area per 1 tree, age of tree, average price of green beans, and the use of female worker outside the family. For example, in the variance test of the average price of green beans, the value of $F_{count} > F_{critical}$, which means that the variation in the average price of green beans for reductant users is more stable than the variation in non-reductant users. On the other hand, in the other four variables, variations in the number of trees, planting area per 1 tree, age of tree, and the use of female worker outside the family, non-reductant users were more stable (or lower) than the variation in reductant users.

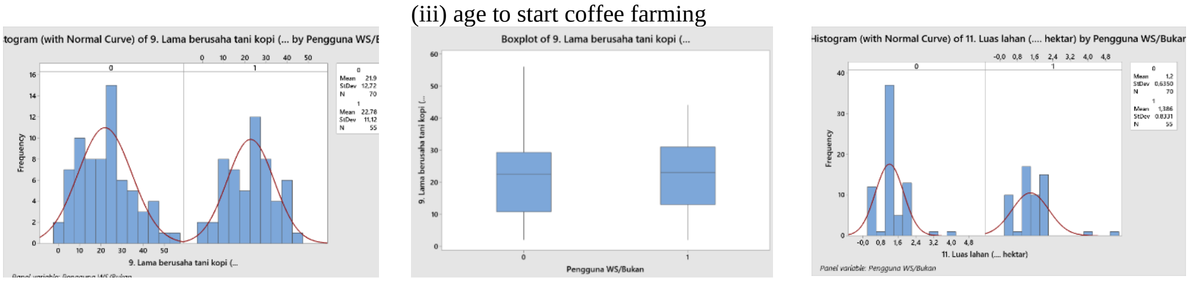
Figure 1 represents the histogram, value plot, and boxplot of several variables. In the figure for each of these variables, the plots of the two categories of respondents are distinguished.



(i) Age (ii) Number of family members helping

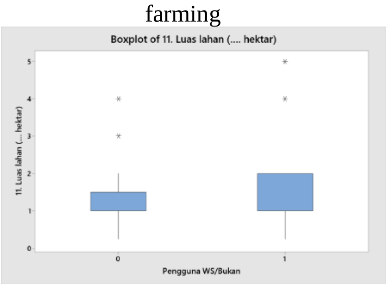


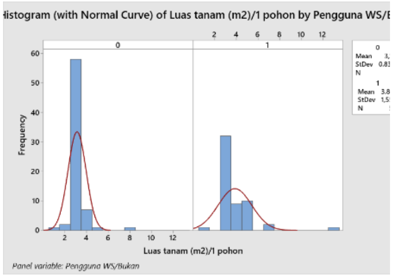
(iii) age to start coffee farming

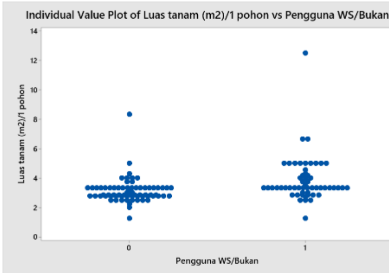


(iv) Long time in coffee farming

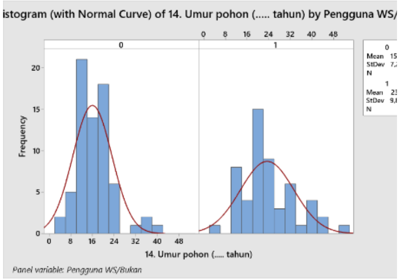
(v) Land area (in hectares)

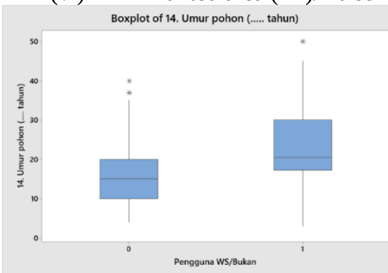


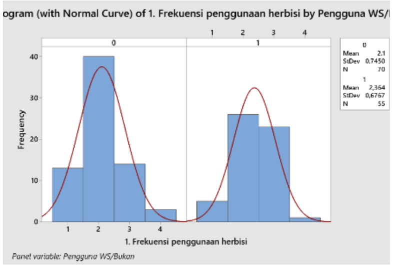




(vi) Planted area (m^2)/1 tree

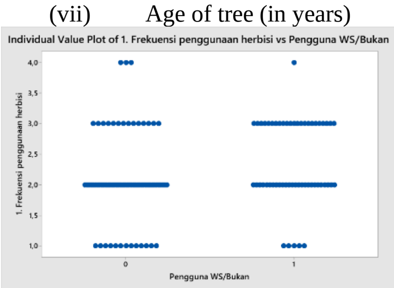


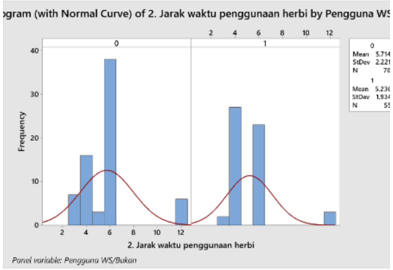


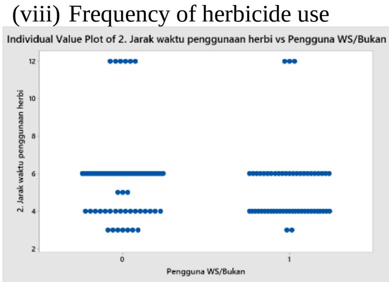


(vii) Age of tree (in years)

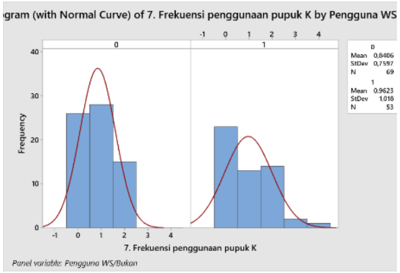
(viii) Frequency of herbicide use

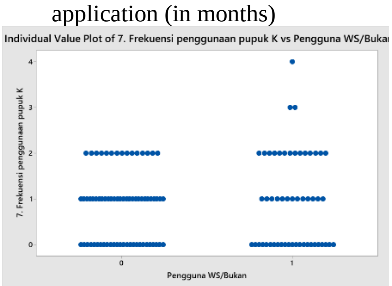


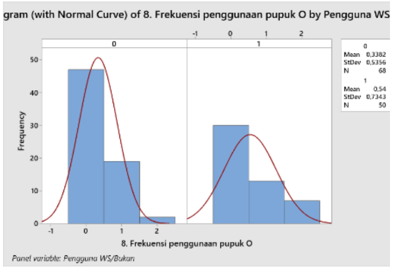




(ix) Time interval of herbicide application (in months)

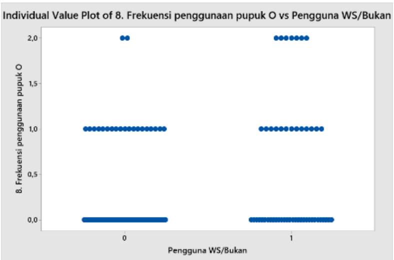


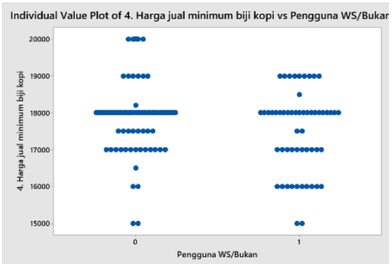


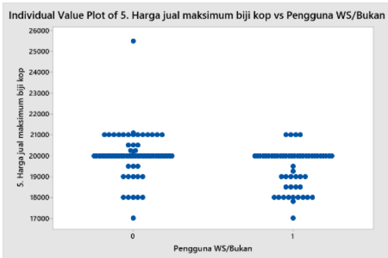


(x) Frequency of chemical fertilizer use

(xi) Frequency of using Organic fertilizer

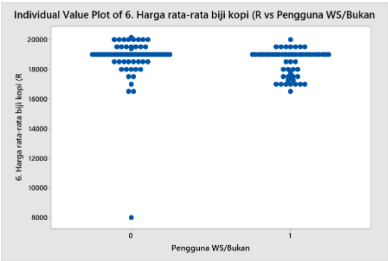




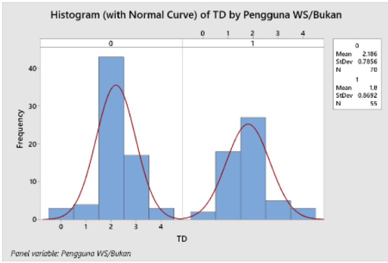


(xii) The minimum selling price of green beans

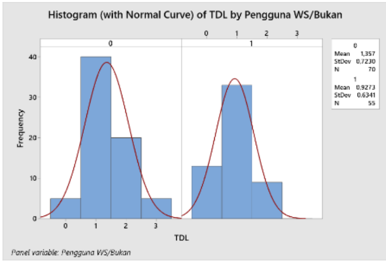
(xiii) The maximum selling price of green beans



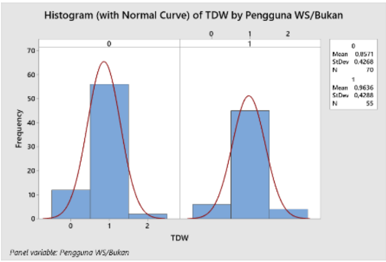
(xiv) Average price of green beans



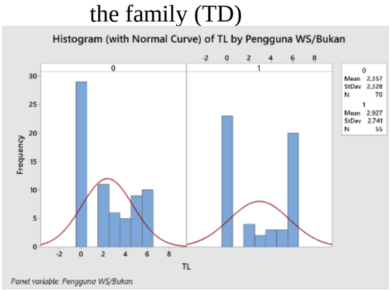
(xv) Number of Workers inside the family (TD)



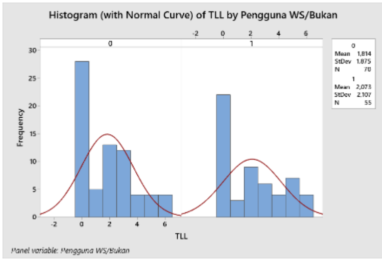
(xvi) TDL



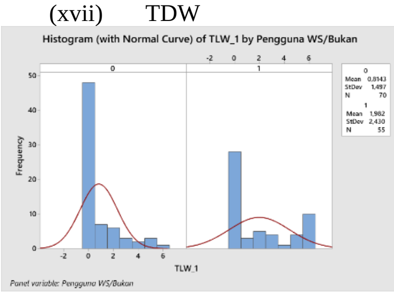
(xvii) TDW



(xviii) TL



(xix) TLL



(xx) TLW

Figure 1. Histogram, Plot of values, and Boxplot of several variables

If seen from Table 3 and Figure 1, it can be seen that the interpretation of the range of values for each variable in the two categories of respondents tends to differ not too much. In some variables, there are 1 to 3 respondent data that have a variable value that differs greatly from other respondents. This respondent's data has the potential to become outliers, such as the variables of land area, planted area per 1 tree, frequency of herbicide use, frequency of use of chemical and organic fertilizers, and selling price of coffee. There are data that have the potential as outliers only in the category of reductant users (i.e. frequency of herbicide use and frequency of use of chemical fertilizers) and some are only in the category of non-reductant users (i.e. frequency of use of organic fertilizers, maximum selling price of green beans, and average price of green beans), as well as in both categories of respondents (i.e. land area, planted area per 1 tree, and age of tree). In the histogram with normal curves and standard deviation values, each variable in the user category mostly has a higher variance than the non-user category.

Bivariate analysis on the relationship between the values of several variables on a nominal or ordinal scale with respondents' categories was carried out by using the chi squares test (χ^2). In some contingency tables, the relationship between row variables and column variables, there are cells that are less than 5, so the contingency table is rearranged by combining categories in row variables. Column variables consist of 2 categories of respondents. The Minitab output from the 2 tests on several variables with an ordinal scale can be seen in Figure 2. In the invalid test results, the initial step of the correspondence analysis is carried out. Table 4 is a recapitulation of Minitab's results from the 2 tests.

Education vs. Users and non-users

	0	1	All
SARJANA	8	7	15
SD	16	24	40
SMA	39	15	54
SMP	7	9	16
All	70	55	125

Cell Contents
Count

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	10,941	3	0,012
Likelihood Ratio	11,173	3	0,011

Side Job vs. Users and non-users

	0	1	All
Ada	16	14	30
Tidak ada	54	41	95
All	70	55	125

Cell Contents
Count

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	0,114	1	0,736
Likelihood Ratio	0,114	1	0,736

Coffee land condition vs. Users and non-users

	0	1	All
Good	6	10	16
Less good	3	2	5
Moderate	60	41	101
Missing	1	2	*
All	69	53	122

Cell Contents
Count

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	2,723	2	0,256
Likelihood Ratio	2,703	2	0,259

Coffee plant condition vs. Users and non-users

	0	1	All
Good	5	9	14
Less good	4	2	6
Moderate	61	42	103
All	70	53	123

Cell Contents
Count

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	3,023	2	0,221
Likelihood Ratio	3,006	2	0,222

2 cell(s) with expected counts less than 5.

Figure 2. Minitab output on the χ^2 test

The recapitulation of interpretation of Figure 2 is presented in Table 4. If the value of $\chi^2_{count} > \chi^2_{table\ (\alpha = 0,05;df)}$, then it will reject H_0, meaning that there is a relationship between row variables (i.e. variables that characterize the users and non-users of reductants) with categories respondents. The χ^2 test is only carried out on variables whose values are nominal and ordinal scales, or also variables whose values are ratio scale, but whose values can be divided into a small number of categories.

Table 4. Recapitulation of bivariate analysis results with the χ^2 test

Variables	χ^2_{count}	df	*p*-value	Test results
Education	10.941	3	0.012	**Reject H_0**
Side job	0.114	1	0.736	Accept H_0
The role of the wife in coffee farming	0.615	2	0.735	Accept H_0
Land condition	6.764	1	0.009	**Reject H_0**
Coffee land condition	1.920	2	0.383	Accept H_0
Coffee plant condition	3.023	2	0.221	Accept H_0
Frequency of herbicide use in 1 year	8.030	3	0.045	**Reject H_0**
Frequency of using chemical fertilizers in 1 year	3.763	2		Accept H_0
Frequency of using organic fertilizer in 1 year	5.027	2	0.081	Accept H_0
Herbicide and fertilization applications	1.460	1	0.227	Accept H_0
Impact of chemical fertilizers (without reductants) on coffee plant	0.782	2		Accept H_0

If 'Yes', the impact of chemical herbicides (without reductants) on **coffee plants**	0.557	1	0.456	Accept H_0
Impact of chemical herbicides (without reductants) on coffee production	14.962	2	0.001	**Reject H_0**
If 'Yes', The impact of chemical herbicides (without reductants) on **coffee production**	0.557	1	0.456	Accept H_0
General assessment of **herbicide reductants** in the long term	3.450	2		Accept H_0
* Positive (good) impact of herbicide reductants on coffee plants	12.737	2	0.002	**Reject H_0**
* Positive (good) impact of herbicide reductants on **coffee production**	1.920	2	0.383	Accept H_0
Grading of coffee (post-harvest): pick red	0.012	2	0.994	Accept H_0
Premium coffee market link (price of red picks)	2.383	1	0.123	Accept H_0
Drying treatment on the para-para	0.934	1	0.334	Accept H_0
The role of Relevant department	14.267	2	0.001	**Reject H_0**
The role of formulator	3.073	3		Accept H_0
The role of Field Assistant from PAI	5.446	3		Accept H_0
Mentoring/assistance in field	0.665	2	0.721	Accept H_0
The impact after using reductants on the amount of production	8.382	2		***Reject H_0**
Impact after using reductants on production costs (maintenance and harvest)	0.341	2	0.843	Accept H_0
Impact after using reductant on gross income	3.831	2		Accept H_0
Impact after using reductant on net income	7.557	1	0.006	**Reject H_0**
Number of workers in the family (TD)	17.768	4	0.001	**Reject H_0**
Male (TDL)	11.769	3	0.008	**Reject H_0**
Female (TDW)	2.095	2	0.351	Accept H_0
Number of Workers outside the family (TL)	11.153	5	0.048	**Reject H_0**
Male (TLL)	3.009	6	0.808	Accept H_0
Female (TLW)	13.329	6	0.038	**Reject H_0**
Length of harvest period (in months)	4.375	1	0.036	**Reject H_0**

Note: *The value of $\chi^2_{count} > \chi^2_{table}$. The test result is invalid, because there are cells whose frequencies are less than 5. But, if we use correspondence analysis, the test results are H_0 rejected.

Based on Table 4, rejecting H_0 means that the variables have a relationship with the categorization of respondents, or in this case the variables that characterize the two categories of respondents are different. These variables are education, land conditions, frequency of herbicide use, impact of chemical herbicides (no reductants) on coffee production, *positive (good) impact of reductants on coffee plants, role of relevant department, impact after using reductant on production amount, impact after using reductant to net income, number of workers in the family (TD), male (TDL), number of workers outside the family (TL), female (TDW), and length of harvest period (months). On the other hand, if it fails to reject H_0 (in this case, it accepts H_0), it means that there is no relationship between the variables that become characters of the two respondent categories.

4. Conclusion

Based on the mean test, only the variables of the average planting area per 1 tree, age of tree, maximum selling price of green beans, TD, TDL, and TLW were not the same between the two categories of respondents.

Based on the results of the *F* test, there is no difference in the variance of the variables studied between the two categories of respondents, except for the number of trees, planting area per 1 tree, age of tree, average price of green beans, and the use of female workers outside the family. In these five variables, variations in the number of trees, planting area per tree, age of trees, and the use of female workers outside the family, in non-reductant users were more stable (lower) than the variation in respondents using reductants.

Based on the chi squares test, the variables that have a relationship with the categorization of respondents (or in this case the variables that characterize the two categories of respondents are different) are education, land conditions, frequency of herbicide use, impact of chemical herbicides (No reductants) on coffee production, positive impact (good) reductant in coffee plants, the role of relevant department, the impact after using reductants on the amount of production, the impact after using reductants on net income, number of workers in the family (TD), male TD (TDL), number of outside workers family (TL), female TL (TDW), and length of harvest period (months).

Acknowledgement

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