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Apprehending cultivation of coffee *(Coffea sp)* of karo community and the effect on production

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Abstract
Research on the portrait of coffee cultivation *(Coffea sp)* of Karo people and their impact on production had completed well. The study did in Tambak Bawang, Tanjung Purba Villages, and Suka Mbayak, Tiga Panah Sub-district, Karo Regency in 2020. It used the interview method with 60 well-known coffee farmers in three villages in the two sub-districts. The data were processed using the validity test, reliability, regression test, F-test, and t-test. The results showed a 92.8% effect of technical culture on coffee plant production. Differences in the application of culture (seed treatment, land cultivations, plantings, shades, maintenances, and harvesting factors) by traditional coffee farmers, semi-modern (hybrid), and up-to-date coffee farmers significantly affect their production. The very significant influence of technical culture on the production of coffee plants in traditional, semi-modern, and modern systems. Modern farmers who apply practical culture well produce up to 1757.5 kg/ha, semi-modern system are 763.5 kg/ha, and the traditional system are only 519.8 kg/ha

Keywords: coffee plants, technical culture, production

Introduction: Background

Coffee is one of the significant commodities traded around the world after oil [10] because it is used generally by the extensive community [36]. Nearly 92% of coffee production was by small farmers and cooperatives [14], and in Indonesia, 96.07% of coffee land is smallholder plantations that produce 95.78% of all national coffee production. Rofi [33] and Lizawati *et al*. [25] stated that the coffee productivity of the farmers was low because they did not apply decent agriculture practices. However, they had not explained in detail the association between attired agriculture practices and coffee production. This study aims to prove the statement of Rofi [33] and Lizawati *et al*. [25] regarding the relationship between technical culture practices that were usually carried out by farmers and the production of the coffee. The research was lead in Tanah Karo, North Sumatra Province, in 2020.

Tanah Karo was a vegetable, fruit, and coffee-producing center in North Sumatra. There are numerous kinds of agricultural products from the area supplied to local markets or major cities in Sumatra and Java include Bandung, Jakarta, Semarang, Surabaya, Pekanbaru, and others [1]. Not only achieving local demand, but Tanah Karo been also exported agricultural products to foreign countries, Japan, Singapore, South Korea, and Malaysia [1]. One of the superior products for decades in Tanah Karo was orange.

However, the trend of citrus fruit production in Tanah Karo in recent years had reduced drastically, and on the other hand, coffee plantations have been augmented significantly [12]. The development of coffee plants had good prospects for improving the economy and community welfare [4]. The Karo Regency Agriculture Office noted that the total area of oranges in 2017 was 8,530 ha where 5,099 hectares of production areas which produced 245,213 tons. The following year in 2018, the orange area was 7,044 hectares, the harvest area was 4,153 hectares, the production was 212,374 tons. The decline in citrus production in Karo District reached 32,839 tons. The farmers who originally planted oranges then switched to coffee plants, so that the coffee plantation area had increased. The Karo District Agriculture Office [1, 3] noted that the increase in coffee land in 2017 was 8,374 hectares, with a harvested area of 5,755 hectares that produced 8,777 tons of coffee. The extent of coffee land in 2008 increased by 804 ha compared to 2007, namely 9178 ha that the producing area was 13280 tonnes or an increase of 4503 tonnes [3]. There were several reasons for farmers to switch to coffee, the lack of pests and diseases, relatively low production costs, and a better selling price. Recently, Tanah Karo Coffee had been in great demand, both at the local, regional, and even global levels [3]. Moreover, the area of Karo Regency is at an altitude of 120–1420 M asl [2] that allows coffee plants to grow and develop fit to produce high-quality coffee.

In general, there were three categories of technical coffee plant culture developed by the Karo people, traditional coffee practical culture, based on knowledge and cultivation practices from hereditary habits. The characteristics of out-dated coffee cultivation the use of local types of coffee, use of sweeping seeds, no treatment of seeds and seedlings, irregular spacing, no shade, no regular maintenance (fertilization, irrigation, pruning, and weeding), and harvesting. Post-harvest handling that was not well planned. Sometimes farmers harvested the coffee still raw or just mixed with ripe ones. Post-harvest coffee was sold raw or had very high moisture content without drying it first, so the price was very low-priced. The modern coffee technical culture was the use of grander seeds from the coffee plant seed center, systematic seeding, planting at regular breaks, using leguminous shade plants, taking care, harvesting, and post-harvesting. Modern coffee farmers only harvest completely ripe coffee, the red fruits. Post-harvest, coffee was ground and dried until its moisture content was by applicable regulations, then sold. Meanwhile, the technical culture of semi-modern coffee (hybrid) is a blend of

traditional systems with modern systems. Some farmers who applied a semi-modern scheme used grander coffee brands, yet they didn't do the treatment or those who use local kinds of coffee but did treatment as in modern coffee technical culture.

Limited technology and knowledge cause farmers to apply traditional or semi-modern technical cultures that are very simple so that they did not produce optimal production [6]. Although coffee continues to develop, it cannot be relied on as the foremost source of income for the community, even when compared to horticultural crops. Statements of Rofi [33] and Lizawati *et al.* [25], low coffee production is closely related to the cultivation patterns they apply. Therefore, interventions to improve coffee cultivation are needed to increase the quantity and quality of coffee, which in turn improves the welfare of farmers.

This study did to capture the activities of traditional, semi-modern, and modern coffee farmers and their relationship with coffee production that could support the statements of Rofi [33] and Lizawati *et al.* [25] The results of this study used as input for various stakeholders in providing interventions to coffee farmers. Intervention could be in the form of lessons and training, as well as assisting in the arrangement of superior seeds, types of shade plants, soil cultivation, monitoring of pests and diseases, and harvesting and post-harvest required. The intervention was carried out by first knowing the habits of the farmers in cultivating coffee. Until now, the configuration of coffee cultivation by Karo Community is not well documented. Hence, research on the portrait of traditional coffee (Coffea sp) cultivation of the Karo community and its impact on production being significant and needs to be done.

Methods

1. Location and Time of Research

This research did in three villages, Tambak Bawang, Tanjung Purba, and Suka Mbayak Village, Tigapanah District, Karo Regency, from January to December 2020. The research location is about 80 km from Medan, the capital of North Sumatra Province, and could be reached by vehicle in about 2 hours. There were 97 coffee farmers that members of the three farmer groups, the numbers of samples used in this study were 60 farmers from the total population with a distribution of 20 tasters per farmer group. The data used in this study consisted of 1) secondary data obtained from related agencies, especially about the area of coffee plantations in Karo Regency, the amount of production, marketing, and marketing channels; and 2) primary data obtained from interviews with farmers covering types of coffee, seed sources, seed and nursery treatment, land cultivation, planting, shade plants, weed control, pest and disease eradication, coffee and shade crop pruning, harvesting, and post-harvest. From a preliminary survey conducted by researchers, it found out that a well-known coffee processing company was working with one of the three farmer groups. The company has empowered a small group of farmers to develop Arabica coffee with modern cultivation patterns. This study aims to compare the traditional systems practiced by most people with up-to-date and hybrid shapes practiced by farmers and their impact on production.

Researchers conducted interviews directly with farmers by visiting them in the villages. Apart from obtaining quantitative information, the interview did obtain qualitative evidence about their level of knowledge, what they did, the obstacles they faced, and others. All of this was necessary to get a beneficial portrait of the coffee cultivation that had been functional. The data and evidence collected from traditional farmers then compared with those obtained from farmers who had applied modern and semi-modern (hybrid) shapes. Furthermore, the results of this study were elaborated with previous research results from relevant sources, both those related to data and other supporting statements.

2. Data Collection Techniques

The study did use purposive sampling based on the concentration of the distribution of coffee farmers in three locations, Tambak Bawang, Tanjung Purba, and Suka Mbayak villages, Tigapanah sub-district, Karo district. Observations were made directly in the field regarding the condition of coffee plants and farmer activities related to seed procurement, land management, planting, maintenance, shade, and harvesting.

- Interviews did to 60 farmers which were conducted face to face and also using the telephone regarding farmers' habits in cultivating coffee plants. Interviewing is a technique of collecting data that is structured or unstructured and did face-to-face or in person or using a telephone network [46].
- The questionnaire, in this study, was closed where the respondent only gives short answers to the questions the researcher poses. There were six items asked, the factors of seed treatment, land cultivation, planting, shade, maintenance, and harvesting and post-harvest.
- Population and sample in this study the number of coffee farmers who constitute the population was 97 people, so to obtain the sample size, the Slovin formula used to calculate the minimum sample size if the behavior of them was uncertain.

Slovin formula:

$$n = \frac{N}{1 + Ne^2}$$

Where:
n. sample size
N. population
e. Error tolerance limit (sig; 10%)

Based on calculations of this formula, the number of samples in this study was 60 farmers with 20 farmers using traditional coffee farming systems, 20 semi-moderns (hybrid), and 20 others were tasters of farmers who applied modern one.

3. Data Analysis

a. Validity Test

A validation test did determine the level of validity of the instrument (questionnaire) used in data collection. This validity did determine whether the items presented in the questionnaire were able to reveal with certainty what will be studied. The validity test was obtained by correlating each indicator score with the total score variable cane then the correlation results being compared with the critical value at a significant level of 0.05. An instrument was supposed to be valid if it was able to measure what was preferred and the equal of instrument cogency shown that the collected data

did not deviate from the description of the variable in question. The method used was to compare the correlation value or r count from the research variable with r table. Validity and reliability testing in this study used the SPSS (Statistical Package for the Social Science) 23 software from windows.

The criteria for determining the validity of a questionnaire were as follows:

If r count > r table, the statement was declared valid.

If r count < r table, the statement was declared invalid.

b. Reliability Test

The reliability test intended to determine the consistency of measuring instruments in use or other words, the measuring instruments had consistent results when used repetition at different times. Statements that had been declared valid in the validity test would be determined their reliability with the following criteria:

(a) If r alpha is positive or > from r-table, the statement was reliable.

(b) If r alpha is negative or < from r table, the report not reliable.

c. Multiple Linear Regression Analysis

To determine the impact of cultivation patterns on coffee production Linear Regression Analysis by Harlan [15] and Gomez [13] was used to predict how the state (rise and fall) of the dependent variable if two or more independent variables fluctuate in value. The results of the regression tests had been presenting in graphs and tables.

Formula: Y = a+b1x1+b2x2+b3x3+b4x4+b5x5+b6x6+e

Where: Y = coffee production, a: Constanta, b1 b2 b3 b4 b5 b6: regression coefficient, x1: seed treatment factor, x2: tillage factor, x3: planting factor, x4: shade factor, x5: maintenance factor, x6: harvesting factor, e: standard error

d. Determination Coefficient Test (R2)

The coefficient of determination (R2) test was castoff to measure the ability of the model to explain the variation in the dependent variable. R2 value that was getting closer to 1 means that the independent variables provide almost all the information needed to predict the independent variable [15].

e. T-Test

A sample t-test was an analysis technique to compare one independent variable. This technique was castoff to test whether a confident value was significantly different from the average of a sample. The t-test as a descriptive hypothesis testing technique had three criteria, the right, left, and two-side tests.

Result

After analysing the data, the following results were obtained:

a. The results of the validity and reliability tests were presented in Tables 1 and 2 below:

Table 1: Validity Test Results of Variables That Had Correlation ® with Total

Correlations							
		X1	X2	X3	X4	X5	X6
X1	Pearson Correlation	1	.874**	.850**	.939**	.800**	.733**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	60	60	60	60	60	60
X2	Pearson Correlation	.874**	1	.839**	.849**	.702**	.651**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	60	60	60	60	60	60
X3	Pearson Correlation	.850**	.839**	1	.824**	.694**	.685**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	60	60	60	60	60	60
X4	Pearson Correlation	.939**	.849**	.824**	1	.836**	.710**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	60	60	60	60	60	60
X5	Pearson Correlation	.800**	.702**	.694**	.836**	1	.749**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	60	60	60	60	60	60
X6	Pearson Correlation	.733**	.651**	.685**	.710**	.749**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	60	60	60	60	60	60
**. Correlation is significant at the 0.01 level (2-tailed).							

Table 1 show that all pieces of stuff forming a variable correlated (r) with a total score of each variable ≥ 0.25, then all items were valid. Thus, there was accuracy in the interpretation carried out in this study with the results of field observations. Furthermore, the results of the normality test had been presenting in Fig. 1 below.

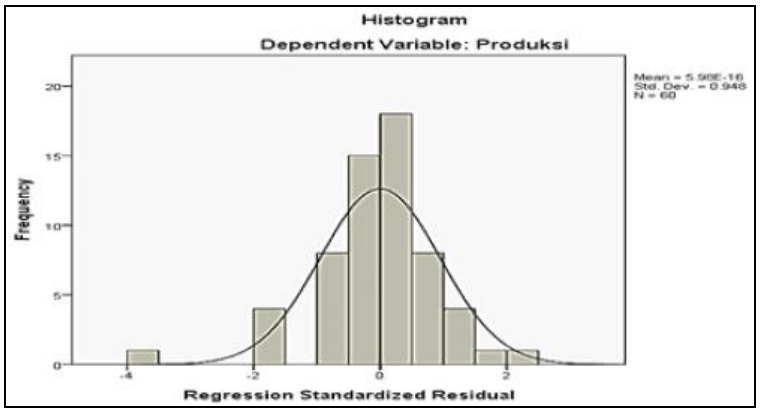


Fig 1: Multiple Linear Regression Normality Test the Effect of Cultivation Techniques on Coffee Plant Production.

Fig. 1 Show that the resulting curve forms a normal bent curve, then the residual was stated normal and the normality assumption is met.

Table 2: Results of the Validity Test on Sample and Independent Research Factors.

A. Case Processing Summary			Reliability Statistics	
	Sample (N)	%	Cronbach's Alpha	N of Items
Cases Valid	60	100.0	.932	6
Excluded [a]	0	.0		
Total	60	100.0		

A. Listwise deletion based on all variables in the procedure.

B. Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
X1	13.650	13.282	.948	.906
X2	13.233	17.775	.879	.913
X3	13.183	17.305	.865	.913
X4	13.950	13.336	.934	.909
X5	12.633	20.372	.828	.933
X6	12.767	19.877	.752	.932

Table 2A shows, the value of α was 0.932, which means that the reliability of the study was very high. The degree of consistency of research data could be trusted and was by predetermined criteria. Thus, the coffee technical culture data was reliable and giving the same results when tested on coffee in other areas. All items in this study were reliable, where all tests were internally consistent because they had such strong reliability. Table 2B shows the value of α the seed treatment factor (X1) 0.906, land cultivation factor (X2) 0.913, planting factor (X3) 0.913, shade factor (X4) 0.909, maintenance factor (X5) 0.933, and harvesting factor (X6) 0.932. The data shows that X1-X6 has high reliability and was 100% valid.

The results of the practical culture regression test for coffee plants and their effects on production had shown in Table 3 below.

Table 3: Coefficient of Determination of Coffee Cultivation Factors on Production

Model Summary[b]				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.963[a]	.928	.920	156.9
a. Predictors: (Constant), X6, X2, X5, X3, X4, X1				
b. Dependent Variable: Production				

Table 3 shows the coefficient of determination (R2) was 0.928, so there was a 92.8% contribution of the effect given by coffee plant cultivation/ independent variables (X1-X6) to coffee production (Y). The rest had influenced by other variables not included in this study. Thus the seed treatment factor (X1), land cultivation factor (X2), planting factor (X3), shade factor (X4), maintenance factor (X5), and harvesting factor (X6) simultaneously (collectively) affect coffee production (Y).

To determine the effect of cultivation techniques on production, the F test was carried out which was presented in Table 4 below.

Table 4: F test results of the effect of cultivation techniques on coffee plant production

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	16808602.2	6	2801433.7	113.8	.000[b]
	Residual	1304713.3	53	24617.2		
	Total	18113315.5	59			
a. Dependent Variable: production						
b. Predictors: (Constant), X6, X2, X5, X3, X4, X1						

Table 4 shows that technical culture had a very significant effect on coffee plant production with a significant value (sig.) of 0.000 < 0.05. Thus the seed treatment factor (X1), land cultivation factor (X2), planting factor (X3), shade factor (X4), maintenance factor (X5), and harvesting factor (X6) simultaneously (together) affect coffee production (Y). These results could be interpreted that the coefficient of determination in multiple linear regression in this study had been fulfilled.

a. Overall T Test Results.

The results of the T test for the entire study sample were presented in Table 5 below.

Table 5: Overall Sample T-Test Results

One-Sample Test						
	Test Value = 0					
	T	**df**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
					Lower	**Upper**
T. Cultivation	14.170	59	.000	1013.6	870.5	1156.7

Table 5 shows Sig 0.00 < 0.05, which means that the overall variation of the data in this study was not the same or heterogeneous, thus it means that H0 was rejected, Ha was accepted. However, after being grouped into three, traditional, semi-modern, and modern, it was known that the data for semi-modern and modern cultivation techniques were using Sig. 0.287 > 0.05 then it was relatively homogeneous (Table 6 A. B. and C).

Table 6A: Traditional vs Modern Cultivation T Test

Independent Samples Test										
		Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
									Lower	**Upper**
T. Cultivation	Equal variances assumed	11.7	.002	-31.2	38	.000	-1238	39.7	-1318.0	-1157.4
	Equal variances not assumed			-31.2	25	.000	-1238	39.7	-1319.4	-1155.9

Table 6A had Sig 0.02 < 0.05 means that traditional and modern data variations were not the same or heterogeneous. Sig 2-tailed 0.00 < 0.05 means that H0 was rejected, Ha was accepted.

Table 6B: Traditional vs Semi Modern Cultivation T Test

Independent Samples Test										
		Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
									Lower	**Upper**
T. Cultivation	Equal variances assumed	6.3	.016	-7.5	38	.000	-243.7	32.5	-309.6	-177.8
	Equal variances not assumed			-7.5	28.2	.000	-243.7	32.5	-310.3	-177.02

Table 6B had same as Table 6A Sig 0.02 < 0.05 means that traditional and modern data variations were not the same or heterogeneous. Sig 2-tailed 0.00 < 0.05 means that H0 was rejected, Ha was accepted.

Table 6C: Semi Modern with Modern T Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
T. Cultivation	Equal variances assumed	1.16	.287	-21.2	38	.000	-994	46.9	-1089	-899
	Equal variances not assumed			-21.2	36	.000	-994	46.9	-1089	-899

Sig 0.287> 0.05 means that the semi-modern and modern data were relatively homogeneous, 2-tailed sig 0.00 <0.05, very significant.

The average coffee production for each cultivation technique was presented in Table 7 below.

Table 7: Traditional, Semi Modern, and Modern Production

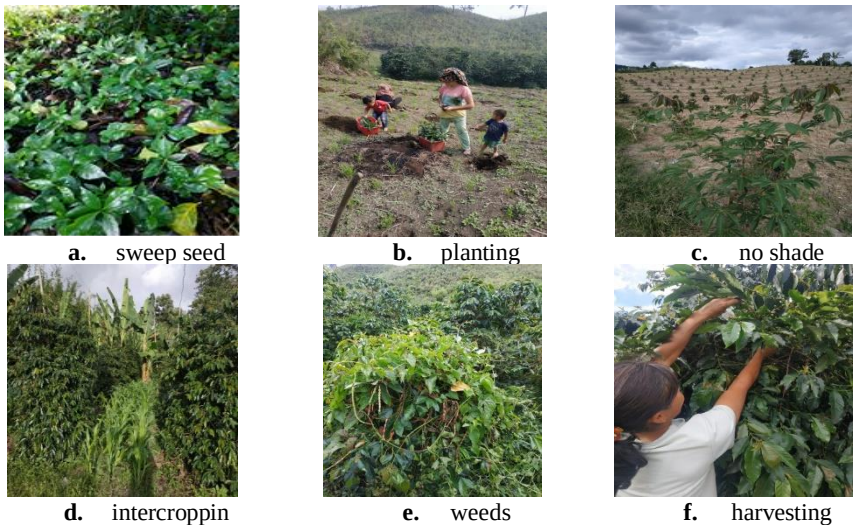
Group Statistics					
	Production	N	Mean	Std. Deviation	Std. Error Mean
T. Cultivation	1.Traditional	20	519.8	66.0	14.8
	2. Modern	20	1757.5	164.7	36.8
	3. Semi Modern	20	763.5	129.7	29.0

Table 7 shows the average coffee production in traditional cultivation techniques was 519.8 kg/ha, semi-modern 763.5 kg/ha, and modern 1757.5 kg/ha.

Discussion

Gumulya & Helmi [14] stated that 92% of global coffee production comes from small farmers and cooperatives. Then, the coffee productivity of the farmers was confidential as low because they did not apply worthy agricultural practices [33, 25]. Righteous agricultural practices mentioned by Rofi [33] and Lizawati *et al.* [25] were not explained and further elaborated based on research data, particularly the relationship between agricultural practices and coffee production. The results of this study indicate the coefficient of determination (R2) was 0.928, which means that there was a 92.8% effect of technical culture on coffee plant production. The remaining 7.2% influenced by other variables not included in this study.

The effects of practical culture were simultaneous. The results of this study indicate that the F count was 113,8 (Table 4) and the value of sig. ≤ 0.01, then the technical culture of coffee had a very significant effect on production. The average coffee production using modern practical cultures was 1,757.5 kg/ha, semi-modern 763,5kg/ha, and traditional agriculture produces 520 kg/ha. Therefore, improvement of technical cultures such as a selection of grander seeds and proper seed treatment, land cultivation, planting techniques, use of shade plants, maintenance (weeding, eradication of pests and diseases, and pruning), and harvesting techniques, significantly determine the quality of coffee production. There were very prominent differences between the traditional, semi-modern, and modern coffee technical cultures (Fig.1, 2, 3) below.



a. sweep seed **b.** planting **c.** no shade

d. intercroppin **e.** weeds **f.** harvesting

Fig 2: Portrait of the practical culture of traditional coffee

Fig. 2 shows, traditional coffee farmers use local coffee seeds obtained from local community gardens. A small number of them carry out seeding (nurseries and use of polybags). Most of them only use bush seeds that grow wild around the coffee staple and not from high-yielding seeds. The selection of superior planting material was a significant step in good coffee cultivation practice [22]. In selecting grander planting material, it was necessary to consider the

suitability of the environment in which the coffee planted to obtain maximum flavor quality and productivity, the seeds obtained from producers who based the Decree of the Minister of Agriculture as producers. The pits of coffee and seedlings must be certified so that their quality being certain. Treatment during storage, transportation, and maintenance of seedlings was necessary to avoid failure when planted in the field [30].

The coffee seeds used by farmers in this study were in the form of sweep seeds that were pulled out and planted directly into the planting area during the rainy season. The planting area was cleared and the soil was cultivated, and then planted. There was no use of stakes, rorak, planting holes, shade plants, regular watering, and organic or inorganic fertilizers before planting. Ferry *et al.* [11] stated that planting holes should be done 6 months before planting. The size of the planting hole depends on the texture and structure of the soil, the heavier the soil, the bigger the planting hole. A good planting holes size was 60 cm x 60 cm at the surface and 40 cm x 40 cm at the bottom with a depth of 60 cm. For the contour terrace, the planting hole was made near the upper sloping side, the steeper the slope of the ground, the closer to the upper sloping side.

The topsoil had to unglue from the subsoil. The topsoil was in the west, while the lower soil was in the east so that the bottom layer of soil can be exposed to sunlight to kill microorganisms. The dug soil left for at least one month. Then, topsoil mixed with organic fertilizers. For gardens with less fertile soil and low levels of organic matter, organic fertilizers (green manure and manure) were added to the planting holes for 4–5 months before planting coffee at a dose of 5–10 kg per plant. The planting hole had to cover with topsoil three months before planting the coffee with the stake in the middle of the hole.

The coffee (Coffea sp.) was a plant that had low photosynthetic efficiency due to photorespiration. The low efficiency of photosynthesis causes the growth rate of coffee plants to be not optimal. The photorespiration process was when the sunlight intensity was high and also by the temperature around the plant increases. The growth and photosynthesis of Arabica coffee were significantly affected by the high and low levels of sunlight radiation [17]. Shade plants were needed to increase air and soil humidity in coffee plantations. Air humidity has a significant effect on coffee tree vegetation [7, 8]. The decrease in the quantity and quality of habitat caused 70% of the 103 coffee species to become threatened to extinction [9]. In order for coffee plants to grow and produce optimally, therefore, these plants need to be given shade plants. The benefits of shade plants for coffee plants include reducing the intensity of sunlight so that it was not too hot, reducing the temperature difference between day and night, keeping the microclimate more stable, sources of organic matter, windbreaks, and erosion, extending the life of the plant/ coffee production period (over 20 years), reduce overproduction (overbearing) and dead branches, as well as improve coffee quality [11].

In addition, traditional coffee farmers in this study also did not fully take proper plant care measures including not doing weeding (eradicating weeds), not doing fertilization, not doing eradication of pests and diseases, and not doing pruning and cleaning weeds (Figure 2). Yussa *et al.* [55] stated that the presence of weeds around coffee plants could be reducing seed production by 35%. Therefore, in order to obtain high production coffee plants, maintenance measures such as pruning and weed control were needed [52].

Applying the right fertilizer could increase the production and quality of coffee beans. The ratio of nitrogen (N) to potassium (K) was significant in the production of specialty coffee because the relative amounts of N and K could suppress the formation or increase the concentration of compounds that were beneficial for the establishment of specialty coffee flavors and aromas [5, 6]. Sari, R.R *et al.* [37] stated that NPK fertilizer had a very significant effect on the parameters of the height of coffee seeds at 30 DAS, wet Stover weight, and dry Stover weight. Jessy [20] stated that the uptake of potassium in coffee plants increases sharply during the fruit formation period and then continues to an extent until the highest reached at the time of fruit ripening. The same thing was stated by Martins *et al.* [26] the components potassium had fundamental implications for increasing coffee bean production, especially in regulating water loss, replenishing food reserves, and in the process of seed ripening. Furthermore, the research results of Silva *et al.* [40] showed that potassium had a significant effect on improving the quality of coffee seeds. According to Clemente *et al.* [6], it is also vital to increase the yield of the coffee seeds and also improve the quality of the chemical composition.

Furthermore, the low productivity and quality of the coffee were caused by attacks by plant pest organisms. Pest attacks could cause economic losses in both quality and quantity. Pest attack was not only on mature plants in the field but also in nurseries, orchards, and storage. Pests in coffee plants include groups of pests and diseases. Pests on coffee plants are the coffee pod borer, red stem borer, branch and twig borer, green louse, and *Sanurus indecora*. Coffee plant diseases were divided into diseases caused by fungi include leaf rust, leaf spot, leaf fungus, root fungus, split cancer, fallen stem disease, and diseases caused by nematodes. Sianturi & Wachjar [39] stated that an important cultivation technique in increasing coffee production was pruning. Pruning was done to achieve optimal production. Besides, pruning was very useful to facilitate harvesting. The benefits and functions of pruning were generally so that the tree remains low so that it is easy to care for, forming new production branches, making it easier to control pests and diseases [31].

Most traditional coffee farmers in this study harvested not only ripe fruit (red) but also mixed with green and yellow fruit. Consequently, the weight of the coffee produced was shrinkage a lot, as was the quality. Sativa *et al.* [38], on his preliminary observation, found out that farmers had not implemented virtuous harvest procedures characterized by the presence of mixed green, yellow, and red fruit that causes the low quality of the rice coffee produced. At the farmer level, there was often little attention to matters concerning the level of fruit maturity. The red fruit was often mixed with green fruit and then dried immediately. For specialty coffee, this was undesirable because it could affect the final quality of the coffee, so it was necessary to separate the red and green fruit picking. There were three ways of processing coffee based on the use of water, namely wet, semi-wet, and dry. The dry method that often used was slow drying at low temperatures, be precise temperatures of 40-50oC were a better way [29]. The best result was natural drying by did in sunny weather, although drying had a problem, include uncontrollable weather conditions [38].

Traditional coffee production in this study was 519.8 kg/ha,

quite significant from the outdated Robusta coffee production found by Rofi [33] that was only 130 kg/ha. The results of this study support the statement Rofi [33] also by Lizawati *et al.* [25] stated that farmers' coffee productivity was low because they did not apply better agricultural practices. Agricultural practices that in this research were called practical cultures include the selection of superior seeds, land preparation, shade plants, fertilization, eradication of pests and diseases, eradication of weeds, pruning and harvesting as well as good post-harvest handling.

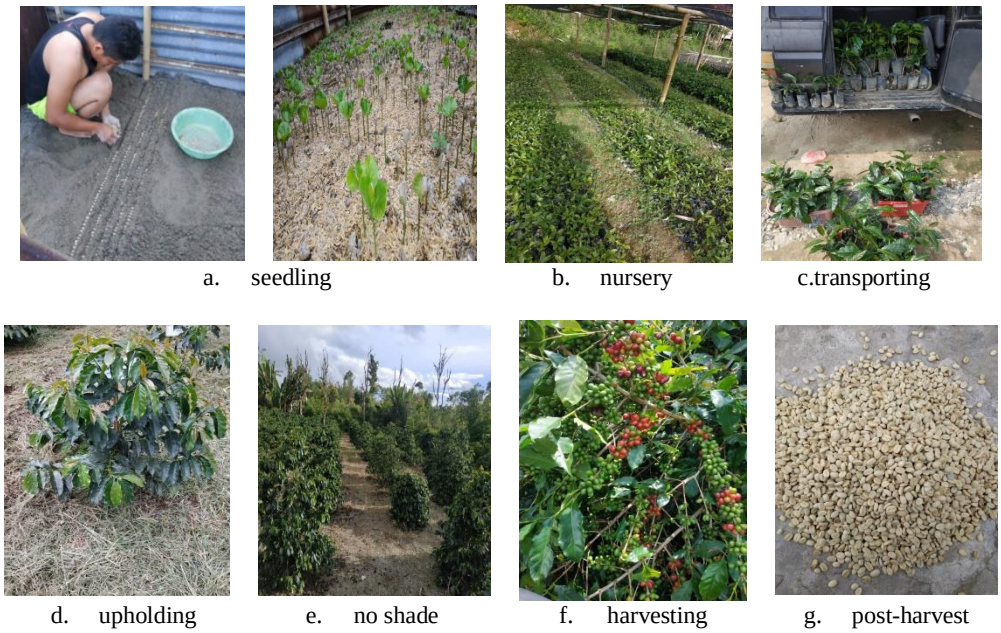


Fig 3: Portrait of a Coffee Plant Hybrid Technical Culture

The results of the observation of coffee hybrid cultivation (Fig. 3) show that farmers apply a better cultivation system, did seedling and nurseries, regular planting, fertilizing, weeding, and harvesting well. This justly good cultivation practice could increase production yield by 763.5 kg/ha, 243 kg/ha more than the traditional coffee production that was only 519.8 kg/ha. However, in this hybrid cultivation system, the coffee seeds used were mostly local types, did not use shade plants, no pruning, and irregular irrigation. The selection of superior planting material was a vital step in good coffee cultivation practice [22]. The growth and photosynthesis of Arabica coffee were significantly affected by the high and low levels of sunlight radiation [17]. Shade plants were needed to increase air and soil humidity in coffee plantations. Air humidity had a significant effect on coffee tree vegetation [7, 8]. For coffee plants to grow and produce optimally, therefore, these plants needed to give shade plants. The benefits of shade plants for coffee plants are: to reduce the intensity of sunlight, reduce the temperature difference between day and night, maintain microclimate stability, sources of organic matter, windbreak, and erosion, extend plant life/ coffee production period (over 20 years), reduce overbearing/ dead branches, and improving coffee quality [11].

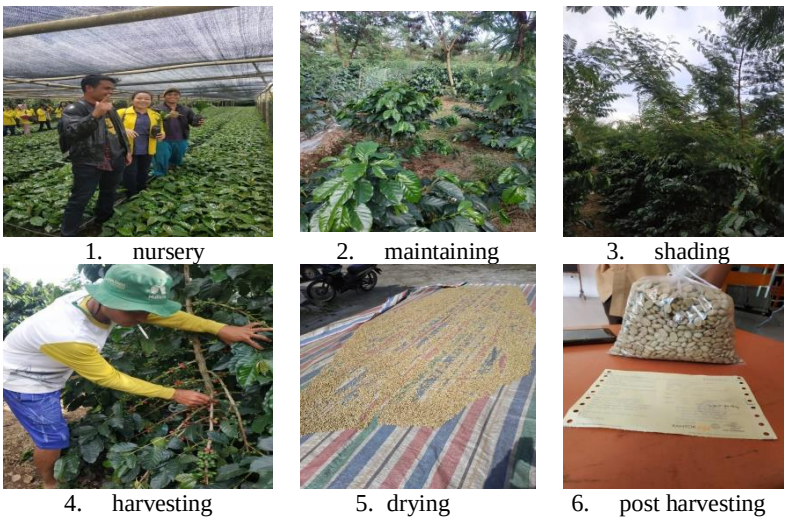


Fig 4: Portrait of the Technical Culture of Modern Coffee Plants

In contrast to traditional and semi-modern coffee farmers, observations of modern farmers found that they used superior seeds of the Arabica Komasti variety or Andung Sari Tiga which were resistant to leaf rust disease caused by the fungus Hemileia vastatrix. Farmers used these superior varieties of coffee imported directly from Jember, East Java. Besides, the farmers also applied modern technical culture including seeding (nurseries, used of screen houses, use of polybags and organic fertilizers, and regular maintenance such as watering and eradicating pests and diseases in seeds), preparing planting areas (cleaning, tilling, planting shade types of legume, making holes for planting three months before planting, providing compost/ organic as basic fertilizer), spacing, making *rorak*, regular and planned maintenance (eradicating weeds, eradicating pests and diseases, pruning), and harvesting and post-handling, and the harvest was also well planned.

The application of technical culture was so good that coffee production reaches 1757.5 kg/ ha. The amount of produce was more than the production of traditional and semi-modern coffee that was only 519,8 kg/ha and 763.5 kg/ha. There are 92.8% of the produced been determined by the application of technical culture. Mahyuda *et al.* [26] noted that there was 48,320 ha of Arabica coffee in Central Aceh Regency with a total production of 29,239 tons/year or 605.1 kg/ha, East Java coffee production in 2007 was 550 kg/ha [27], and West Sumatra 793,2 kg/ha [31]. The data of modern pattern coffee production results from this study were higher than the others indicates that the technical culture used by these farmers was fabulous as recommended in the Regulation of the Minister of Agriculture [22] and Ferry *et al.* [11]

Conclusion

Based on the results of the study, we then conclude that there was a 92.8% influence of cultivation techniques on coffee plant production. Differences in the application of cultivation techniques (seed treatment, land cultivation, planting, shade, maintenance, and harvesting) by traditional, semi-modern, and modern coffee farmers significantly affect coffee production. Modern farmers who applied good cultivation techniques produced coffee up to 1757.5 kg/ha, semi-modern 763.5 kg/ha, and traditional farmers only produced 519.8 kg/ha. To increase the coffee production of the farmers, therefore, it was absolutely necessary to make improvements to the habits of traditional and semi-modern farmers in cultivating coffee plants. Increasing knowledge and skills of traditional farmers' coffee cultivation could be done through the involvement of modern coffee farmers as facilitators in coffee cultivation training and extension.

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