Analysis on correlation of cultivation practices on production of Arabica coffee

Y Musa¹, H Iswoyo¹, L Sarif¹ and M V I Herdijono²

¹Department of Agronomy, Universitas Hasanuddin, Makassar, Indonesia
²Faculty of Economic, Universitas Masamus, Merauke, Indonesia

Email: iswoyo@yahoo.com

Abstract. This paper presents the results of a study which was conducted to analyze the effects of maintenance practices of Arabica coffee on production. The location of the study was in a coffee production center of Tompobulu Subdistrict, Gowa Regency, Province of South Sulawesi, Indonesia. The research was in the form of a survey supported by literature study, observation, and interviews. Sample selection was purposive sampling and analyzed by multiple linear regression data. The results show that coffee productivity in Cikoro Village, Tompobulu Subdistrict, Gowa Regency is still low at 0.53 kg per tree. The multiple linear regression equation of Arabica coffee productivity obtained is Y = 351,487 + 53,331X1 + 5,324X2 + 7,108X3 + 1,967X4 + 5,080X5 + 3,889X6 + 5,407X7 + 9,420X8 + 5,307X9. Fertilizer dose and rejuvenation trimming variables had very significant effects. Other variables, namely fertilization frequency, fertilization method, fertilization time, shape trimming, production pruning, sanitation, and pest control, did not significantly affect the productivity of arabica coffee plants. Maintenance practices could increase the production and productivity of Arabica coffee plants in study location, especially on fertilizer dosage aspects and rejuvenation trimming.

1. Introduction
Currently, Indonesia has become the fourth largest coffee producer in the world after Brazil, Colombia, and Vietnam. Coffee produced in Indonesia is good quality Arabica and Robusta for export to some coffee consumer countries, including America, Japan, the Netherlands, Germany, and Italy [1,2].

The area of Arabica coffee plantations in Indonesia in 2017 was 330,498 ha and the number of productions in the same year was 173,765 tons. Productivity and land area are still extendable, considering that Indonesia is a tropical country that is suitable for Arabica coffee. South Sulawesi Province as one of the coffee plantation areas that contribute to coffee production in Indonesia. This province in average produces 12.29% of Indonesian Arabica coffee, equivalent to 20,309 tons per year [3].

Tompobulu Subdistrict of Gowa Regency, South Sulawesi has Arabica coffee plantation area of 2,331 ha and total production of 1,588.15 tons [4]. Cikoro Village is one centre where Arabica coffee is one of its superior commodities. The village is 900 meters above sea level with a highland topography making this area potential for the development of Arabica coffee plants due to the suitable environmental and climatological conditions.
One important aspect that affects the production and productivity of arabica coffee is the maintenance technique [5]. The implementation of improper maintenance techniques could result in low production due to less optimal growth and susceptibility to pests and diseases. Directorate General of Indonesian Agriculture ministry [6] emphasized the aspects of good cultivation system. The aspects consist of: land selection, land suitability, land preparation, shade planting, superior seedlings, nursery, planting, and maintenance techniques including fertilization (dosage, method, frequency, and application time), pruning, sanitation, and pest and disease control. Therefore, this paper presented the results of an investigation to see the effect of maintenance techniques on the production and productivity of arabica coffee in Cikoro Village, Tompobulu Subdistrict of Gowa Regency.

2. Methodology
This research was a survey through direct observations in the field to ensure the data obtained from the farmers could be justified. Determination of surveyed location was purposive by considering the area as the production centre of Arabika coffee and become the centers of coffee development in Gowa Regency.

2.1. Data collection method
This study combined several methods as follows:

2.1.1. Area survey. This stage helped in obtaining preliminary information regarding the population of samples and other variables. The sampling was done purposively by several filters such as: plants’ age of more than ten years; a minimum land area of 0.5 hectares; and a minimum five years of farming experience.

2.1.2. Farm observation. The purpose was to get information regarding the conditions of the coffee farms, maintenance activities and techniques. Included in observation was fertilization techniques of coffee plants including the dosage of fertilizers, application methods, application frequency, application time, sanitation, pruning and control of coffee plants’ pests and diseases. Also included other essential matters relating to maintenance techniques and information which was disclosed during or after interviews.

2.1.3. Interview or questionnaire. It is a way of collecting data in the form of structured questions given to respondents (farmers) following research problems.

2.2. Data analysis
The analysis was performed using multiple linear regression. This analysis could help to identify maintenance practices that affect coffee productivity. The form of multiple linear type production functions is:

\[ Y = a + bX_1 + cX_2 + dX_3 + eX_4 + fX_5 + gX_6 + hX_7 + iX_8 + jX_9 \]  

(1)

Where:
- \( Y \) = Crop Productivity (output quantity)
- \( X_1 \) = Fertilizer Dosage
- \( X_2 \) = Frequency of fertilizer application
- \( X_3 \) = Fertilizer application method
- \( X_4 \) = Fertilizer application time
- \( X_5 \) = Shape trimming
- \( X_6 \) = Production trimming
- \( X_7 \) = Rejuvenation trimming
3. Results and discussion

3.1. Effect of Maintenance practices on productivity
Arabica coffee production and productivity in study location were analyzed using multiple linear regression on nine maintenance practices as variables. Table 1 shows the result.

| Regression model                  | Coefficient of Regression Direction | Probability | Remarks          |
|-----------------------------------|-------------------------------------|-------------|------------------|
| Constant                          | 351.487                             | 0.000       |                  |
| Doses of Fertilizer (X1)          | 53.331                              | 0.034       | Significant effect |
| Frequency of Fertilizer application (X2) | 5.324                               | 0.734       | Not significant effect |
| Method of fertilizer application (X3) | 7.108                               | 0.292       | Not significant effect |
| Time of fertilizer application (X4) | 1.967                               | 0.881       | Not significant effect |
| Shape trimming (X5)               | 5.080                               | 0.513       | Not significant effect |
| Production trimming (X6)          | 3.889                               | 0.342       | Not significant effect |
| Rejuvenation trimming (X7)        | 5.407                               | 0.028       | Significant effect |
| Sanitation (X8)                   | 9.420                               | 0.080       | Not significant effect |
| Pest and disease controlling (X9) | 5.307                               | 0.393       | Not significant effect |

Table 1 above shows that the multiple linear regression equation between all maintenance practices variable on productivity (Y), obtained equations, namely:

\[ Y = 351.487 + 53.331X_1 + 5.324X_2 + 7.108X_3 + 1,967X_4 + 5,080X_5 + 3,889X_6 + 5,407X_7 + 9,420X_8 + 5,307X_9 \]

The equation above means:
• The value of 351,487 is the value of plant productivity if all nine independent variables are considered constant.
• The value of 53,331 is a value that indicates productivity will increase by 53,331% if there is a 1 level increase in the fertilizer dose.
• The value of 5,324 is a value indicating that productivity will increase by 5,324% if there is a 1 level increase in the frequency of fertilization.
• Value 7.108 is a value that indicates that productivity will increase by 7.108% if there is a 1 level increase in the fertilization method.
• Value 1.967 is a value that indicates productivity will increase by 1.967% if there is a 1 level increase at the time of fertilization.
• Value of 5.080 is a value that shows productivity will increase by 5.080% if there is a 1 level increase in form cutting activities.
• Value of 3.889 is a value that indicates productivity will increase by 3.889% if there is a 1 level increase in production pruning activities.
• Value of 5.407 is a value indicating that productivity will increase by 5.407% if there is a 1 level increase in rejuvenation pruning activities.
• Value 9.420 is a value that shows that productivity will increase by 9.420% if there is a 1 level increase in sanitation activities.
• Value 5,307 is a value that shows productivity will increase by 5,307% if there is a 1 level increase in pest and disease control activities.

3.2. Coefficient of determination (R$^2$).
Results of data analysis with multiple linear regression, the R square (R2) value is 0.961. It means the percentage of the influence of independent variables (fertilizer dosage, fertilization frequency, fertilization method, fertilization time, shape cutting, production pruning, rejuvenation pruning, sanitation and pest control) on the dependent variable (productivity) is 96.1%. The rest (3.9%) is influenced or explained by other variables outside the variables used.

3.3. Simultaneous significance testing (F test)
The F-test is known as simultaneous test or model test or ANOVA test which is used to see how the influence of all independent variables together on the dependent variable. Based on the F-test, it can be concluded that H0 (maintenance practices factors do not affect productivity) is rejected and H1 (maintenance practices factors have an effect on productivity) is accepted.

3.4. Significant testing of individual parameters (T-test)
The t-test is also known as a partial test, which is useful in testing the influence of each independent variable individually to the dependent variable. Based on this test, the independent variables which significantly affected the dependent variable are fertilizer dose and rejuvenation pruning. Whereas, the other independent variables did not significantly affect the dependent variables.

3.5. Affecting variables
Fertilizer dose was one practice which had a significant effect on coffee productivity. Application of the right dose will increase soil fertility, which resulted in more stable plant's productivity and increasing plant's resistance to disease as well as to improve plant conditions and resistance to extreme environmental changes [6].

The optimal and efficient fertilizer dosage for the growth leading to the generative phase is the one containing Phosphors [7]. While for improving yields and seeds quality, the optimal fertilizer is one with Potassium content [8].

Based on the results of the multiple regression analysis, the rejuvenation pruning by farmers in the research location significantly affected the productivity of Arabica coffee plants. Implementation of rejuvenation pruning was conducted by trimming all branches on one side and leaving the opposite
side intact. Trimming one side later will encourage the growth of shoots on the trimmed side. This rejuvenation pruning greatly affects the productivity level of Arabica coffee plants, especially for older plants. Rejuvenation pruning works on less productive old plants with still sturdy roots [9]. Implementation of proper rejuvenation is just before the rainy season after the harvesting period. Rejuvenation is essential to restore the potential of aging coffee plants or ones that have been damaged by severe diseases [10].

4. Conclusion
The multiple linear regression equation obtained for Arabica coffee productivity: \( Y = 351,487 + 53,331X_1 + 5,324X_2 + 7,108X_3 + 1,967X_4 + 5,080X_5 + 889X_6 + 5,407X_7 + 9,420X_8 + 5,307X_9 \). Variable dose of fertilizer \((X_1)\) and rejuvenation pruning \((X_7)\) had a very significant effect, while variable frequency of fertilization \((X_2)\), fertilization method \((X_3)\), fertilization time \((X_4)\), pruning form \((X_5)\), pruning production \((X_6)\), sanitation \((X_2)\) \((X_8)\) and pest control \((X_9)\) did not significantly affect the productivity of Arabica coffee plants. It means the factors of maintenance practices especially in the aspects of fertilizer dosage and rejuvenation pruning were able to increase the productivity of Arabica coffee plants in Cikoro Village, Tompobulu District, Gowa Regency of South Sulawesi Province.

References
[1] Saragih J R 2013 Socioeconomic and ecological dimension of certified and conventional arabica coffee production in North Sumatra, Indonesia *Asian J. Agric. Rural Dev.* 3 93–107
[2] Suprobo H Y 2018 Nice, Indonesia Peringkat ke-4 Produsen Kopi Dunia *War. Ekon.*
[3] Pusat Data dan Sistem Informasi Pertanian 2017 Outlook Komoditi Kopi
[4] Badan Pusat Statistik (BPS) Kabupaten Gowa 2017 Data Statistik Kabupaten Gowa
[5] Nchare A 2007 Analysis of factors affecting technical efficiency of arabica coffee producers in Cameroon
[6] Direktorat Jenderal Perkebunan 2014 *Pedoman Teknis Budidaya Kopi Yang Baik* vol 60
[7] Hidayat N 2008 Pertumbuhan dan Produksi Kacang Tanah (Arachis hypogea L.) Varietas Lokal Madura Pada Berbagai Jarak Tanam Dan Dosis Pupuk Fosfor *Agrovigor J. Agroekoteknologi* 1 55–64
[8] DaMatta F M, Ronchi C P, Maestri M and Barros R S 2007 Ecophysiology of coffee growth and production *Brazilian J. plant Physiol.* 19 485–510
[9] Goto Y B and Fukunaga E T 1986 *Coffee: rejuvenating the abandoned orchard* (Hawaii Agricultural Experiment Station, University of Hawaii)
[10] Rahardjo P 2012 *Berkebun Kopi* (Penebar Swadaya)