Analysis of effect of production factors on the production and income of coffee farmers using Beauveria bassiana in Siborongborong Subdistrict

T M H Siahaan, T Supriana* and Iskandarini

Master of Agribusiness, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Indonesia.

E-mail: *tavi@usu.ac.id or toga.siahaan@gmail.com

Abstract. Arabica coffee is a type of coffee that is widely grown in the highlands of North Sumatra. Siborongborong District is the largest Arabica coffee producing. However, the productivity of Siborongborong is lower than the potential of Sigararutang variety. This study aims to analyse the effect of fertilizer, Beauveria bassiana (Bb) and labour use on coffee production and to compare the income of coffee farmers who use Bb intensively, non-intensively and do not use Bb. The method used to analyse are the multiple linear regression and compare means analysis (Independent Sample Test). The results show that simultaneously, fertilizer, Bb, and labour have a significant effect on coffee production. Partially, only fertilizer and Bb have a significant and positive effect, meanwhile labour has no significant effect on the coffee production. There is a significant difference between the income of coffee farmers who use Bb intensively and those who use Bb not intensively and who do not use Bb. However, no significant differences between the income of coffee farmers who used non-intensive and those who did not use Bb. The income of farmers who use Bb intensively is higher than farmers who use Bb not intensively and who do not use Bb.

1. Introduction

Siborongborong District is the largest Arabica coffee producing district in North Tapanuli Regency. The contribution of Arabica coffee production in Siborongborong reached 1,975.07 tons in 2013 with a planted area of 1,713.50 kg. The productivity of Siborongborong coffee of 1,152.64 kg / hectare / year is still above the productivity of Arabica coffee in North Tapanuli Regency of 1,055.85 tons / hectare / year. However, the productivity of Siborongborong coffee is lower than the potential of the Sigararutang variety, 1.8 tonnes / hectare / year or more.

The low productivity of coffee compared to its potential is caused by many factors, including farm management, pests and diseases. The main pests that cause decreased coffee production and quality performance are the coffee fruit borer, Hypothenemus hampei (Ferr.) or H. hampei [1]. This pest bores young fruit and hard coffee beans from around of the coffee fruit. As a result, the fruit does not develop, changes colour to reddish yellow, and falls [2]. The coffee fruit borer is the main pest of the coffee plant that attacks the fruit which is a direct product to be marketed, so it is categorized as a direct pest [3].

In the case of North Tapanuli Province in the 2015 period, the first quarter was recorded that 2,525.80 hectares of coffee were attacked with a classification of 1,445.80 experiencing mild attacks.
and 1,080.00 hectares were severely affected. In the second quarter, it was recorded that 1,621.70 hectares of coffee plants were attacked by this pest, with details of 721.05 hectares experiencing mild attacks and 900.65 hectares of severe attacks. In the third quarter, a total of 2,559.02 hectares of land were affected, classified as 1,555.14 hectares, which had a minor attack and 1,003.88 hectares were severely attacked. In the fourth quarter, there were 1,435.53 hectares affected, respectively 824.78 hectares and 610.75 hectares with severe attacks.

Based on the behaviour of H. hampei, the control that is considered the most potential to overcome it is biological control or the use of biopesticides. Development of this natural pesticide is being increased in Indonesia. This environmentally friendly control method is also supported by an increase of demand for organic coffee (bio-coffee), which is coffee produced through natural methods without using agricultural chemicals such as inorganic fertilizers, pesticides, growth regulators in market. Agricultural production factors can be divided into four groups, namely land (natural), capital, labour and entrepreneurial expertise (technology) [4].

This study aims to obtain empirical evidence regarding the effect of fertilizers, Beauveria bassiana and labour on coffee production and to compare the differences in income of coffee farmers who use Beauveria bassiana intensively, coffee farmers who use not intensively and do not use the Beauveria bassiana.

2. Data and methods

The population in the study were all Arabica coffee farmers in Siborongborong Subdistrict. The total number of Arabica coffee farmers is 335 farmers. The samples of this research were taken from three villages in Siborongborong Subdistrict, namely Parik Sabungan Village, Siaro Village, and Siborongborong I Village, where the majority of the population are coffee farmers. In these three villages, they often receive training in coffee cultivation, pest control, including the coffee fruit borer pests with the Beauveria bassiana application by government and private institutions. The unit of fertilizer variable and Beauveria bassiana variable is kg/hectare/year. The unit of labour variable is HOK (workers’ day)/hectare/year.

Determination of the sample using proportional random sampling by comparing the total population of Arabica coffee farmers in the villages of Parik Sabungan, Siborongborong I and Siaro provides guidelines for determining the number of samples. Among them, in multivariate research (including multivariate regression analysis) the sample size must be at least 10 times the number of variables to be analysed. Thus, the sample taken and will be analysed is more than 30 sample farmers throughout the production period in 2015. To increase confidence, in this study 50 sample farmers were taken during the production period in 2015. Analysis of research data was carried out using multiple linear regression analysis with the equation:

\[ Y = a + b_1X_1 + b_2X_2 + b_3X_3 + e \]  

(1)

Where,

\( Y = \) Coffee production  
\( X_1 = \) Fertilizer  
\( X_2 = \) Beauveria bassiana  
\( X_3 = \) Labour

The Independent Sample T Test was used to test the mean difference between the two groups with formula [5]:

\[ \text{Independent Sample T Test} = \frac{|\bar{X}_1 - \bar{X}_2|}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \]
3. Results and discussion

3.1. Result of analytical factors which affect coffee production

Estimation of factors which affect coffee production is done with multiple regression. The results of the F-test show that simultaneously, the independent variable affect dependent variable. The t-test shows that the sign of each coefficient of dependent variable is positive. Table 1 shows that all independent variables have a significance level smaller than 0.05 except for labour variable and all independent variables have t-stat bigger than t-table of 1.6779 except for labour variable.

| Model         | Coefficient | t-table | t-stat | Sig. | F-table | F-stat | Sig. | R²    |
|---------------|-------------|---------|--------|------|---------|--------|------|-------|
| Constant      | -93.111     | 0.293   | .770   |      | 16.159  | .000   | .531 |       |
| X1 (Fertilizer)| .445        | 1.6779  | 3.667  | .001 |         |        |      |       |
| X2 (Beauveria bassiana) | .371        | 1.6779  | 3.071  | .004 |         |        |      |       |
| X3 (Labour)   | .122        | 1.6779  | 1.179  | .993 |         |        |      |       |

In Table 1, it can be seen that R² value of 0.513 shows that 51.3% of the variation in the dependent variable has been able to be explained by the variation of the independent variables, while the remaining 48.7% is explained by variations in other variables that have not been included in the model. Then, the F significance value of 0.000 and F-stat of 16.159 indicates that simultaneously the independent has a significant effect on the dependent variable. Then, partially, fertilizer variable has a significance value of 0.001 and t-stat of 3.667 shows that fertilizer variable has a significant effect on coffee production. Beauveria bassiana variable has a significance value of 0.004 and t-stat of 3.071 shows that Beauveria bassiana has a significant effect on the coffee production. Labour variable has a significance value of 0.224 and t-stat of 1.179 shows that labour has no significant effect on the coffee production. The results of this study support the results the other research which states that fertilization with urea, ZA, SP36, and KCl has a significant effect on the level of Arabica coffee production [6]. The results of this study support the results the other research which states that the use of organic matter and the effectiveness of using biological agents to increase coffee production and quality [7]. The results of this study support the results the other research which states that labour has no significant effect on coffee production [8].

Coefficient of fertilizer of 0.445 shows if fertilizer was added by 1 kg, production will increase by 0.445 kg. Coefficient of Beauveria bassiana of 0.371 shows if Beauveria bassiana was added by 1 kg, production will increase by 0.371 kg. Labour does not really affect the production, but still positive. This is in accordance with production theory which states that the use of fertilizer, use of Beauveria bassiana, and labour has a positive effect on coffee production [9]. From the Table 1 the equation model for this research is as follows:

\[ Y = -93.111 + 0.445X1 + 0.371X2 + 0.122X3 \]  

3.2. Result of analytical compare mean of farmers’ income (independent sample test)

Compare mean test is used to compare the mean of independent or paired samples by calculating t sample and displaying the two-way probability of a difference of two means [10]. The result of
independent sample test shows that there is a difference in income farmers between farmers which is intensively, not intensively and do not use Beauveria bassiana. The average farmers’ income presented in Table 2 and at a significant level represented in the Table 3.

In Table 2, it can be seen the average income of farmers using Beauveria bassiana intensively is IDR 20,108,714.3 per hectare per year, while the average income of farmers using Beauveria bassiana but not intensively is IDR 9,601,603.5 per hectare per year, and the average income of farmers who did not use Beauveria bassiana was IDR 8,060,285.7 per hectare per year. The average income of farmers using Beauveria bassiana intensively is much higher than using Beauveria bassiana not intensively and do not use Beauveria bassiana.

**Table 2. Average farmers income.**

| No   | Usage of B. bassiana | Average Income / Hectare / Year (in rupiah) |
|------|----------------------|---------------------------------------------|
| 1.   | Intensively          | 20,108,714.3                                |
| 2.   | Not Intensively      | 9,601,603.5                                 |
| 3.   | Do not use           | 8,060,285.7                                 |

**Table 3. Significance difference of farmers’ income.**

| No | Usage of Beauveria bassiana | Sig.(2-tailed) | Conclusion               |
|----|------------------------------|----------------|--------------------------|
| 1. | Intensively dan Non-Intensively | 0.000          | There is a significant difference |
| 2. | Non Intensively and Not Use  | 0.059          | There is no real difference |
| 3. | Intensively and Not use      | 0.000          | There is a significant difference |

Table 3 shows that significance 2-tailed is smaller than 0.005 except not intensively and not use. The results show that there is a significant difference in the income of coffee farmers between those who use Beauveria bassiana intensively and those who do not intensively. Likewise, there is a significant difference in the income of coffee farmers between those who use Beauveria bassiana intensively and those who do not use Beauveria bassiana. However, there was no real difference in the income of coffee farmers between those using Beauveria bassiana not intensively and those who did not use Beauveria bassiana. Beauveria bassiana is one of the biopesticides in pathogenic fungi in insects that has received great attention and has been used to control insect pests on various plant commodities [11].

4. Conclusions

Based on the results of data analysis and discussion, it can be concluded that simultaneously, fertilizer, Beauveria bassiana, and labour simultaneously have a significant effect on coffee production partially, only fertilizer and Beauveria bassiana had a significant and positive effect on coffee production, meanwhile labour has no significant effect on the coffee production. There is a significant difference between the income of coffee farmers who use Beauveria bassiana intensively and those who use Beauveria bassiana not intensively and who do not use Beauveria bassiana. However, no significant differences between the income of coffee farmers who used non-intensive and those who did not use Beauveria bassiana. The income of coffee farmers who use Beauveria bassiana intensively is higher than coffee farmers who use Beauveria bassiana not intensively and who do not use Beauveria bassiana.

References

[1] Pinem S E 2014 Analisis Pengaruh Penggunaan Biopestisida dan Pengelolaan Kebun terhadap Produksi Petani Kopi di Kabupaten Simalungun [Analysis of the Effect of Biopesticide Use and
Plantation Management on Coffee Farmers' Production in Simalungun Regency

Master Thesis
(Medan, Indonesia: Universitas Sumatera Utara)

[2] Rahardjo P 2012 Kopi: Pedoman Budi Daya dan Pengolahan Kopi Arabika dan Robusta [Coffee: Guidelines for Arabica and Robusta Coffee Cultivation and Processing] (Jakarta, Indonesia: Penebar Swadaya)

[3] Siahaan I R T U 2015 Potensi Pemanfaatan Steinernema sp. Isolat Lokal terhadap Penggerek Buah Kopi Hypotenemus hampei (Coleoptera: Curculionidae) di Laboratorium dan Lapangan [Potential Utilization of Steinernema sp. Local Isolates against Coffee Fruit Borer Hypotenemus hampei (Coleoptera: Curculionidae) in Laboratory and Field] Master Thesis (Medan, Indonesia: Universitas Sumatera Utara)

[4] Sukirno S 2008 Mikroekonomi Teori Pengantar [Introductory Microeconomics Theory] 3rd Ed (Jakarta, Indonesia: PT RajaGrafindo Persada)

[5] Sugiyono 2008 Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif dan R&D [Educational Research Methods: Quantitative, Qualitative and R & D Approaches] (Bandung, Indonesia: Alfabeta)

[6] Thamrin S 2014 Faktor-Faktor yang Mempengaruhi Produksi Usahatani Kopi Arabika di Kabupaten Enrekang Sulawesi Selatan [Factors Affecting the Production of Arabica Coffee Farming in Enrekang South Sulawesi] AGRIC 26 1 pp 1-6

[7] Hartatie D and Fatimah T 2013 Toleransi Bahan Organik pada Efektivitas Pemakaian Agens Hayati untuk Meningkatkan Produksi dan Kualitas Kopi Robusta di Perkebunan Kalijompo Kecamatan Sukorambi Jember [Tolerance of Organic Ingredients on the Effectiveness of Using Biological Agents to Increase Production and Quality of Robusta Coffee in Kalijompo Plantation Sukorambi Subdistrict, Jember] Jurnal Ilmiah Inovasi 13 1 pp 56-65

[8] Istiana, Hastuti D and Prabowo R 2015 Faktor-Faktor yang Mempengaruhi Tingkat Pendapatan Petani Kopi (Coffee sp) (Studi Kasus di Kecamatan Jambu Kabupaten Semarang) [Factors Affecting the Income Level of Coffee Farmers (Coffeea sp) (Case Study in Jambu District, Semarang Regency)] MEDIAGRO 11 2 pp 46-9

[9] Mubyarto 1985 Pengantar Ekonomi Pertanian [Introduction to Agricultural Economics] (Jakarta, Indonesia: LP3ES)

[10] Ghozali I 2006 Aplikasi Analisis Multivariate dengan Program SPSS [Multivariate Analysis Application with SPSS Program] (Semarang, Indonesia: Badan Penerbit Universitas Diponegoro)

[11] Prayogo Y 2006 Upaya Mempertahankan Keefektifan Cendawan Entomopatogen untuk Mengendalikan Hama Tanaman Pangan [Efforts to Maintain the Effectiveness of Entomopathogenic Fungi to Control Food Plant Pests] Jurnal Litbang Pertanian 25 2 pp 47-54