BUKTI KORESPONDENSI ARTIKEL

Factors Determining Income and Product Type of Robusta Coffee Farming in Central Java, Indonesia

An. Edy Prasetyo

No.	Tanggal	Aktivitas Korespondensi
1.	3 Februari 2021	*Submit the Original Article* dengan Judul "*Factors Determining Income and Product Type of Robusta Coffee Farming in Central Java, Indonesia*" ke ISSJ.
2.	3 Februari 2021	Tanggapan dari Reviewer.
3.	14 Maret 2021	Jawaban *succesfully submitted* dari ISSJ, dan *authorship confirmation* (permohonan kepada seluruh author untuk dapat menyetujui tulisan tersebut).
4.	8 Agustus 2021	Surat *Substantial Review.*
5.	6 Oktober 2021	Pemberitahuan dari ISSJ, bahwa article sedang di pertimbangkan.
6.	6 Oktober 2021	Pemberitahuan dari ISSJ, bahwa article yang telah di submit perlu ditambahkan data (*revision required*).
7.	17 Oktober 2021	*Submit the 1st revision.*
	17 Oktober 2021	*Pemberitahuan.*
8.	3 Februari 2022	*Revision required 2nd Review.*
9.	24 Februari 2022	*Submit the 2nd Review by Author.*
10.	20 Juni 2022	*Accepted.*
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International Social Science Journal - Decision on ISSJ-OF-2021-082.R1

Sebastian Ille <onbehalfof@manuscriptcentral.com>
Thu 03/02/2022 21:46
To: Edy Prasetyo <edyprasetyo@lecturer.undip.ac.id>

03-Feb-2022

Dear Dr. Prasetyo:

Thank you for your recent submission to the International Social Science Journal on "Factors Determining Income and Product Type of Robusta Coffee Farming in Central Java, Indonesia" (ISSJ-OF-2021-082.R1). This manuscript has now been reviewed and the reviewer comments are included at the bottom of this letter.

As you will see from their comments, the reviewers are satisfied with the significant changes you have made to your manuscript, which they believe makes its contribution much stronger. One of the reviewers is suggestion that you make a few minor updates to the recommendations for policymakers so that they are organized in a more step-by-step manner. If you feel this is appropriate, we invite you to add a few lines to the conclusion that will make this clearer. Once you've done that we can move forward toward publication.

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Once again, thank you for submitting your manuscript to International Social Science Journal and I look forward to receiving your revision.

Sincerely,
Dr. Sebastian Ille
International Social Science Journal
sebastian.ille@nchlondon.ac.uk

Reviewer(s)' Comments to Author:

Reviewer: 1

Comments to the Author
This is a revised version of the manuscript. The revision was comprehensive. Many new relevant references were added to replace the old ones. The discussion was also supported by previous relevant studies. The analysis was also renewed with a more robust analytical model than before, by adding factors affecting the decision to adopt the improved products or processed beans to get the added value. With such analysis, it will be more adequate to provide policy recommendations. However, the paper still can be improved ad more useful for policymakers if the recommendation can be practically stated in a step-by-step manner. This will help the local governments formulate appropriate actions.

Reviewer: 2

Comments to the Author
Review of the revised version
The revised paper tries to analyse smallholder coffee farming as the potential source of income for Indonesian rural communities. The income resulting from smallholder coffee farming is potentially enhanced by shortening the supply chain by conducting an additional process to take an added value as the extra income for farmers. The added value came from further post-harvest handling before selling the product to the market. The idea coincides with the concept of commercialization where farmers should utilise the potential market. Such an introduction is the important revised part. Another imperative revision is the methodology that put additional analysis to study the determinants affecting farmers to conduct further process. With such analysis, the important factors can be scientifically determined. The model used to analyse, to a large extent, is adequately powerful to address the objectives of the study. There is also a correction related to the comparison between farmers who conduct post-harvest handling and their counterpart. The presentation of the results is clear and concise, and the discussion is also comprehensive. Many relevant references have been added to support the introduction, literature review, methodology and discussion of the results. The conclusion was drawn from t the analysis as the basis of recommendation or policy implication. Thus,

compared to the previous version, this revised one is much better. From my side, the paper is now acceptable to be published, as the author(s) made very substantial revisions in all parts of the manuscript to address the reviewer's comments and suggestions.

International Social Science Journal - Manuscript ID ISSJ-OF-2021-082.R1 [email ref: SE-8-a]

Mohana Mummoorthi <onbehalfof@manuscriptcentral.com>

Wed 06/10/2021 17:29

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06-Oct-2021

Dear Dr. Prasetyo:

Your revised manuscript entitled "Factors Determining Income and Product Type of Robusta Coffee Farming in Central Java, Indonesia" by Prasetyo, Edy; Listiyaningsih, Dini; Setiadi, Agus; Mukson, Mukson; Roessali, Wiludjeng, has been successfully submitted online and is presently being given full consideration for publication in International Social Science Journal.

Co-authors: Please contact the Editor-in-Chief Office as soon as possible if you disagree with being listed as a co-author for this manuscript.

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For your reference: the manuscript number of the PREVIOUS manuscript version is: ISSJ-OF-2021-082.

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Thank you for submitting your manuscript to International Social Science Journal.

Sincerely,
International Social Science Journal Editorial Office

Determinants of Income Generated from Robusta Coffee Farming in Central Java, Indonesia

Abstract

Coffee farmers in Central Java have widely cultivated Robusta variety. During the last decade, the demand for coffee increases substantially. The coffee commodity is cultivated because of the higher price, which makes the commodity more competitive in the market. The study was conducted to analyze the comparison of farmers' income from Robusta coffee farming which is based on the form of the post-harvest processing, and to analyze the factors that affect the income of Robusta coffee farmers in Temanggung Regency. Primary data were obtained from direct interviews with 98 farmers running the Robusta coffee farming business; secondary data were obtained from the relevant institutions. The results show that the income of Robusta coffee farmers by selling their product in the form of coffee grain was higher than those who directly sold the coffee as raw material. The factors influencing the income were the farm size, the age of coffee plantations, raw coffee production, the variable cost, and the form of Robusta coffee product sold by farmers. These factors partially influenced the income of Robusta coffee farmers. However, the fixed cost did not influence the income of Robusta coffee farmers.

Keywords: coffee farming, economic aspects, Java province, product differentiation, smallholder

Introduction

The coffee production is one of the businesses that is currently growing over the globe. Studies on the coffee business have been carried out by researchers such as Geibler et al. (2016) and Mishra (2013) that show promising prospect. The success of the coffee business starts with a good business model that pays attention to the value chain (Mishra, 2013). Ferreira et al. (2021) stated that going to a coffee shop is a lifestyle for people in urban areas. A good coffee business with respect to the value chain will generate high profits. Lee and Bateman (2021) states that organic coffee is now gaining more attention in the international coffee business than conventional ones. Currently, both robusta and arabica coffee are developed organically for high profit.

Indonesia is one of the potential coffee producers in the world and have contribute significant market share. At a national level, the farm size of coffee plantations in Indonesia in 2015 has reached up to 1,230,001 ha. Smallholder farmers dominate the coffee plantation, with a total of up to 1.9 million farmers.

Based on the farm size, around 1.2 million ha (96.16%) is owned by farmers in rural areas, and 22.59 ha (1.8%) is managed by the government and, 25.54 ha (2.04%) is owned by private companies (Directorate General of Plantation, 2016).

The coffee plantation has roles as the source of income and job opportunities for people, and one of the sources of foreign exchange since to some extents of the product is exported. The export of coffee plantations in Indonesia is the fourth largest export value, following rubber, palm oil, and cacao (Secretary General of Ministry of Trade, 2018).

In the last decade, the domestic demand for coffee has been rapidly increasing, especially as the raw material for beverage. Coffee consumption has been seen as part of a lifestyle in people's social existence. According to Ministry of Agriculture (2016), coffee consumption in Indonesia in 2016 was 249,824 ton, and in 2021 it will be projected to increase by 48.06%, which account for about 369,886 ton. The coffee price in Indonesia from 2014 to 2017 showed an increasing trend with an average of 4.80% per year.

Temanggung Regency is the center of coffee production and coffee processing in Central Java, especially Robusta coffee. Based on the Decree of the Ministry of agriculture No. 830 of 2016 about developing a center of coffee plantation, Temanggung Regency is predicted to be one of the centers of Indonesian coffee production. There are eight sub-districts in the area that have potentials to become centers for coffee production.

Temanggung Regency is supported by the large size of land and highly favorable in agro climate, especially for Robusta coffee plantation. The farm size and Robusta coffee production in Temanggung Regency have the highest coffee production in Central Java Province. An estimated total of 4,583 tons of Robusta coffee was produced as well, as there was 9,338 ha of coffee planted in Temanggung Regency. In comparison, the production of Robusta coffee in Central Java was 14,921 tons. It means that Temanggung Regency contributes 30.72 percent of Robusta coffee production in Central Java (Office of Agriculture and Plantation of Central Java Province, 2016).

Based on post-harvest handling was carried out by the farmers, Robusta coffee products in Temanggung Regency could be categorized into raw coffee fruit (cherries) and green beans. The processing into green beans is the first stage process carried out by farmers. According to Listyaningsih et al. (2019), there would be value-added obtained by the farmers by selling their coffee into green beans compared to farmers selling their coffee in the form of cherries. Farmers not only get benefits from their increasing income; meanwhile, they can also have maximized added value by using waste from coffee plantations for fertilizer. Farmers also utilize residue from post-harvest processing as animal feed. Improving the value-

added of Robusta coffee in different products theoretically would influence the price and farmers' income. Moreover, increasing farmers' income will motivate the farmer to focus and sustain their coffee plantations.

This research was conducted to analyze the comparison of Robusta coffee farmers' income based on post-harvest processing and to analyze the factors influencing Robusta coffee farmers' income in Temanggung Regency, Central Java. Meanwhile, research benefits were expected to be the recommended material for the policymakers to move toward a more outstanding market orientation of the coffee industry. It is expected to be a piece of scientific information or reference for further research, especially in developing the Robusta coffee industry strategy.

Research Methodology

The research was conducted in Temanggung Regency. Temanggung Regency has been purposively selected based on consideration as a center of production and processing of Robusta coffee in Central Java Province. Research locations were purposively determined in three sub-districts, Gemawang, Candiroto, and Kandangan Sub-districts. The research was carried from November 2018 to January 2019.

A survey method was used in this research. The research was conducted by taking the sample from a population and developed a questionnaire as the primary data collecting instrument (Singarimbun and effendi, 1989). The respondents of Robusta coffee farmers were determined by a three-stage cluster random sampling method: (i) Determining sub-districts. It was based on the biggest Robusta coffee production in Temanggung Regency, namely: Gemawang, Candiroto, and Kandangan Sub-districts; (ii) Determining sample of villages. Two villages were selected from each sub-district with the largest Robusta coffee production, namely: Gemawang and Kemiriombo village, Muneng and Plosogaden village, and Blimbing and Gesing village; (iii) Determining the number of Robusta coffee farmers. Respondent was calculated based on the solving formula of determining the number of samples. There were 98 sampled farmers obtained from a 4,653 population of Robusta coffee farmers in Temanggung Regency. The 98 farmers were distributed in six regions of Gemawang village (36 farmers), Kemiriombo village (21 farmers), Muneng village (8 farmers), Plosogaden village (11 farmers), Blimbing village (4 farmers), and Gesing village (18 farmers).

The data used in this research were taken from primary and secondary data. Primary data were collected from Robusta coffee farmers, and secondary data were obtained through scientific literature and data relevant to this research. The primary data included cost analysis, price of production input, as well as the price of output production based on the post-harvesting product (cherries and green bean). Primary data collection was conducted by observation, and direct interview to Robusta coffee farmers based on the

questionnaire prepare beforehand. The data analysis method was a quantitative descriptive method including income analysis, independent sample t-test analysis, and multiple linear regression.

Folowing Ekowati *et al.* (2014) income analysis was calculated by deducting total production cost of farming from the total revenue. The income can be amathematically formulated as follows.

$\Pi i = TRi - TCi$

where, Πi = Profit (IDR/year)
TRi = Total Revenue (IDR/year)
TCi = Total Cost (IDR/year)
$i = g$ = coffee produced in the form of coffee cherries
$i = b$ = coffee produced in the form of green bean

The independent sample t-test was used to analyze the comparison between Robusta coffee farmers' income with the post-harvest product of coffee cherries and green beans. The hypothesis of this research was: it was assumed that Robusta Coffee farmers' income who sell their product in the form of coffee cherries is significantly different from the farmers who sell the product in the form of green beans.

Following Soekartawi (2003), the factors influencing Robusta coffee farmers were analyzed using multiple linear regression, with the following mathematic formulation as follows.

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7D + e \quad (1)$$

where:
Y = Income of Robusta Coffee farmers (IDR/year)
a = Constant
$b_1 \_ b_7$ = Regression coefficient
X_1 = The farm size (ha)
X_2 = The number of Robusta coffee trees planted by farmers (number of the unit of tree)
X_3 = The coffee lifespan (year)
X_4 = The number of coffee cherries productions (kg/year)
X_5 = Fixed cost (IDR/year)
X_6 = Variable cost (IDR/year)
D = Dummy variable, in this case, the form of coffee had been sold by the farmer
D = 1, if the coffee was sold in the form of green bean
D = 0, if the coffee was sold in the form of coffee cherries
e = Disturbance term

Moreover, statistic test applied was F test, coefficient determination (R^2),and t-test. The research hypothesis was: it was assumed that independent variables, which include the farm size, number of coffee trees planted by farmers, coffee lifespan, the production quantity of coffee cherries, fixed cost, the variable cost, and the form of coffee had been sold by the farmer significantly influences the dependent variable, which is farmers' income generated from Robusta coffee farming.

Results and Discussion

Robusta coffee farmers in Temanggung Regency usually harvest coffee cherries from July to August every year. The standard measure for robusta coffee maturity is marked by a change in the color of

the coffee fruit skin to red or reddish yellow. However, there are some robusta coffee farmers who harvest their coffee when the coffee is not completely ripe. This is caused by several things, but the main thing is due to the consideration of the urgent economic needs of the family. Robusta coffee is harvested when it is ripe. This harvest has the following advantages: (i) Coffee is easy to process because the skin is easy to peel off; (ii) The ratio of the weight of coffee beans to the weight of fresh coffee is higher; (iii) The coffee beans are pithier so that the bean size is bigger; (iv) Faster coffee drying time; (v) Better physical quality and flavor. Harvesting unripe robusta coffee where the fruit is still green or yellow, and harvesting robusta coffee whose fruit is too ripe (black fruit), or harvesting the fruit in an unhealthy condition will cause low physical quality of the Robusta coffee beans, and the taste is unfavourable.

The robusta coffee marketed by farmers based on post-harvest handling (shape) can be classified into two types, namely cherries and green beans. Marketing in the form of coffee logs if the robusta coffee fruit is not subject to post-harvest handling, or in other words, after harvesting, it can be directly marketed to buyers, who are generally collector traders. Meanwhile, the marketing of robusta coffee in the form of coffee beans is carried out by farmers when there is post-harvest processing. Processing of robusta coffee from coffee cherries into coffee beans is done by dry processing.

Coffee farmers mostly carry out the dry processing process, and this is because, in general, the capacity of the coffee farmers to do is small, and it is easy to do even though it only uses simple equipment. In dry processing, after the Robusta coffee fruit is harvested, it is dried immediately. Robusta coffee fruit must be dried immediately to avoid undergoing chemical processes that can reduce product quality. Peeling the flesh of the fruit, peeling the horn skin, and peeling the epidermis are done after the coffee becomes dry. Peeling the dry coffee fruit skin aims to separate the coffee beans from the fruit skin, horn skin and epidermis. Peeling the horn skin using a pulper and stripping the epidermis using a huller.

This condition is in accordance with the opinion of Najiyati and Danarti (2004), which states that the difference between dry processing and wet processing is the treatmet using water. Wet processing uses water for peeling and washing the coffee cherries, while dry processing after the coffee cherries are harvested immediately dried and then stripped.

The different forms of Robusta coffee marketed by farmers have different consequences for post-harvest processing costs. Farmers who market in the form of coffee beans have a higher variable cost than farmers who market in the form of coffee logs. The gap is IDR 12,444,523/ha/yr compared to IDR 10,320,436/ha/year. The high difference is due to post-harvest processing costs for Robusta coffee which is marketed in the form of coffee beans. Post-harvest processing costs referred to are costs for drying and milling or stripping the coffee skin. The production input value in the form of fertilizer (mainly manure) in

Robusta coffee farming in Temanggung Regency is absolutely lower than the cost of labor. This is because the robusta coffee farmers have not done fertilization optimally according to the recommendations recommended by the related technical agencies.

According to the recommendation of related technical agencies, the dosage of manure use for mature coffee plants is 14,000 kg/ha/year, but coffee farmers in Temanggung Regency only use manure for an average of 587.95 kg/ha/year. This is due to the lack of manure availability in the coffee farming area and the relative lack of understanding of farmers about the benefits of organic fertilizers for the coffee production process.

The total revenue of coffee farmers who market their coffee products in the form of coffee cherries is IDR 22,174,146/year/5,091 m^2, while the total revenue of coffee farmers who market their coffee in the form of coffee beans is IDR 29,462,276/year/5,386 m^2. The revenue component comes from the production output multiplied by the selling price per unit weight. This is in accordance with the opinion of Suratiyah (2006), which states that gross income or income is all income obtained from farming during one period calculated from sales. The revenue value of robusta coffee farmers in Temanggung Regency is influenced by the amount of production, the form of the product being marketed, and the selling price of the coffee weight unit.

The production of Robusta coffee for each farmer is different. This is partly due to the different scales of coffee farming and the age of the coffee plants and the varying care of coffee plants. Coffee prices may vary due to the different forms of coffee marketed, the quality of the coffee, and the different marketing channels chosen by farmers. Farmers who market their coffee products in the form of beans get a higher average price than farmers who market their coffee in the form of logs (IDR 25,688.60/kg of coffee beans is greater than IDR 5,443.90/kg of logs). Robusta coffee farmers in Temanggung Regency market coffee in the form of beans to collectors, wholesalers, and coffee producers. Coffee logs are marketed only to coffee collectors and artisans because large traders generally only accept coffee in the form of coffee beans.

The quality of coffee also affects the marketing price of Robusta coffee. For example, Coffee beans with a moisture content above 12% are slightly lower than coffee beans with a moisture content of 12%, where the price difference is around IDR 500/kg. Based on the results of Listyati's research (2017), farmers sell robusta coffee to collectors and wholesalers, and if the price in the market is not much different, farmers usually choose to sell to collector traders.

The income of coffee farmers who market their products in the form of coffee logs with an average business scale of 0.51 ha for one year is IDR 13,917,364.63 or equivalent to IDR 27,337,192.35/ha/year. The ability of capital in coffee farming to generate income (profitability) is 168.56%. This profitability value is

compared with the small business loan interest at the farmer level, for example, Food and Energy Security Credit (KKPE), People's Business Credit (KUR) with interest rates ranging from 6-7 percent, then robusta coffee farming whose products are marketed in the form of coffee logs. is worth the effort. The value of production costs, revenues, and farming income for robusta coffee whose products are marketed in the form of logs in detail are presented in Table 1.

Table 1. Econmic aspects of coffee logs on an average land area of 0.51 ha.

No.	Items	Value (IDR)	Number IDR
1.	Fix cost		
	▪ Building and land Tax	46,042	
	▪ Land rent	2,163,675	
	▪ Depreciation	792,929	
	Number		3,002,647
2.	Variable cost:		
	▪ Livestock fertilizer (404.95 kg)	171,707	
	▪ NPK fertilizer (167.39 kg)	399,804	
	▪ SP-36 fertilizer (99.10 kg)	210,512	
	▪ Urea fertilizer (193.61 kg)	376,987	
	▪ fertilization labor(6.35 mwd)	407,317	
	▪ weeding labor (9.46 mwd)	610,731	
	▪ pruning labor (15.56 mwd)	1,006,829	
	▪ harvesting labor (31.96 mwd)	2,070,243	
	Number		5,254,134
	Production cost		8,256,781
3.	Revenue		
	▪ logs coffee (4,073.17 kg)	22,174,146	
	Income		22,174,146
4.	Farm profit		13,917,364

Explanation: Men's Working Days (MWD)

Meanwhile, the income of Robusta coffee farmers who market their products in the form of green beans with an average business scale of 0.54 ha for one year is IDR 19,582,492 or equivalent to IDR 36,358,136/ha/year, with a profitability value of 198.21%. This profitability value reflects that coffee farming carried out by coffee farmers in the Regency is very feasible to be cultivated. The value of production costs, revenues, and farming income for Robusta coffee, whose products are marketed in the form of bean coffee, are presented in detail in Table 2.

Table 2. Economic aspects of coffee beans on an average land area of 0.54 ha.

No.	Items	Number (IDR)	Number (IDR)
1.	Fix cost		
	▪ Building and land Tax	48,982	
	▪ Land rent	2,289,050	
	▪ Depreciation	839,131	
	Number		3,177,163
2.	Variable cost:		
	▪ Livestock fertilizer (404,95 kg)	107,543	
	▪ NPK fertilizer (167,39 kg)	437,684	

	▪ SP-36 fertilizer (99,10 kg)	222,526	
	▪ Urea fertilizer (193,61 kg)	383,500	
	▪ fertilization labor (6,35 mwd)	430,877	
	▪ weeding labor (9,46 mwd)	640,701	
	▪ pruning labor (15,56 mwd)	1,069,473	
	▪ harvesting labor (31,96 mwd)	2,349,386	
	▪ Ose Processing labor (16.58 mwd)	1,060,927	
	Number		6,702,620
	Cost Production		9,879,783
3.	Revenue:		
	▪ Ose Coffee (1,191 kg)	29,462,276	
	Number of Revenue		29,462,276
4.	Farm Income		19,582,492
5.	Farm income of Robusta coffee/ha		

Explanation: Men's Working Days (MWD)

The income of robusta coffee farmers who sell their products in the form of coffee beans (green beans) is higher than the income of robusta coffee farmers who market their products in the form of coffee logs. This is in line with the results of Saragih's research (2019), that farmers who carry out primary processing (processing red logs into unhulled coffee) get higher income and are significantly different from farmers who sell red logs. For this reason, efforts are needed so that robusta coffee farmers have the motivation to process their products into coffee beans in order to increase the added value of their farming.

Hariyati (2014) states that the highest driving factor in developing processed coffee products in Sidomulyo Village, Silo District, Jember Regency is the high motivation of farmers. This is also supported by statistical analysis using the Independent Sample t-test. It can be seen that the income of robusta coffee farmers who market their products in the form of bean coffee has a significantly different value from the income of robusta coffee farmers who market their products in the form of log coffee ($P < 0.05$). The income of robusta coffee farmers who market their products in the form of coffee beans has a greater value than the income of Robusta coffee farmers who market their products in the form of coffee logs (IDR 36,358,136/ha/year, higher than IDR 27,337,192/ha/yr). The significant statistical test results illustrate that the role of post-harvest processing of robusta coffee products can actually increase the added value of robusta coffee farming.

The results of research by Suhendar et al. (2012) that most farmers sell their produce in the form of ground coffee (bean coffee) to collector traders who have collaborated for a long time, while a small proportion of farmers sell in the form of coffee cherries. Soekartawi (2005) states that the level of technology

application in agriculture is one of the factors that determines the level of production and income of agricultural businesses.

Theoretically, there are many factors that influence the high and low income of Robusta coffee farmers in Temanggung Regency. These factors have a direct or indirect effect on farmers' income. Some of the factors include the farm area, the age of the plant, the amount of production, fixed production costs, variable production costs, and the shape of the robusta coffee product that is marketed. Based on Table 3, the factors of farm area, age of coffee plants, production of coffee logs, fixed production costs, variable production costs, and the form of coffee being marketed simultaneously has a very significant effect on the income of coffee farmers in Temanggung Regency (F sign <0.05). At the same time, the coefficient of determination (adjusted R2) is 0.531, which means that the variation in independent factors (X_1 to X_6) of 53.10% can explain the variations that occur in the dependent variable, namely the income of robusta coffee farmers, while 40.90% explained by other factors that were not included in the regression equation model.

Table 3. Analysis of variance Factors that affect the farm income

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	74232.64	6	12372.106	19.338	0.000[b]
	Residual	58219.81	91	639.778		
	Total	132452.45	97			

Note: Dependent Variable: Y; Predictors: Constant, D, X_1, X_2, X_3 X_4, X_5

Table 4. Estimated coefficients of factors affecting income

Model	Unstandardized Coef.		Standardized Coef.	t	Sig.
	B	Std. Error	Beta		
Constant	225,453	11,236		20.065	0.000
X_1	- 0.059	0.009	-3.606	-6.781	0.000
X_2	1.531	0.365	0.309	4.192	0.000
X_3	0.100	0.013	4.947	7.437	0.000
X_4	1.186E-006	0.000	0.047	0.640	0.524
X_5	-1.883E-005	0.000	-1.427	-2.616	0.010
D	27,997	9.002	0.376	3.110	0.002

As the anova shows a significant effect of factors, the analysis proceeds with investigating individual effect, as presented in Table 4. Based on Table 4, a regression equation can be formed as an estimator of the influence of the factors of agricultural land area, plant age, total production of coffee logs, fixed production

costs, variable production costs, and shape of coffee products that are marketed on the income of robusta coffee farmers can expressed in term of equation as follows.

Y = - 3,606X1 + 0,309X2 + 4,947X3 + 0,047X4 - 1,427X5 + 0,376D + e

The regression coefficient in this equation is the coefficient for the independent variable that has been standardized, so the regression equation does not have a constant because the regression line crosses the original point. Standardization (standardized beta) is applied to eliminate differences in the unit of measure applied to independent variables whose reality is not the same (heterogeneous). According to Ghozali (2007), if the size of the independent variables is not the same, then it is better if the regression equation interpretation uses the standardized beta. Further disclosed, the advantage of using standardized beta is that it is able to eliminate differences in the unit of measure in the independent variable. From the results of the regression equation, that the factors of production of farm area, age of coffee plants, production of coffee logs, variable production costs, and the form of robusta coffee products marketed by farmers partially significant effect on the income of robusta coffee farmers in Temanggung Regency (t sign <0.05). Only the fixed production cost factor has no significant effect on the income of robusta coffee farmers in Temanggung Regency (t sign> 0.05).

The land area factor for coffee farming has a significant effect and has a negative correlation on the income of robusta coffee farmers, which means that if the land factor as a medium for coffee farming is increased, the area is greater (greater than 0.53 ha of average land area) and assuming the other factors are considered constant, in fact, it will reduce the income value of Robusta coffee farmers, and *vice versa*. This happens because the land area factor as a factor of production has reached its optimal point (diminishing returns), so that if the additional land area is done, it will result in a more significant increase in production costs compared to the increase in revenue, and in turn, it will actually reduce the value of coffee farmers' income. Robusta. According to Soekartawi (1994), that the law of diminishing returns can illustrate the relationship between production and one production factor with the assumption that other production factors are considered constant.

Age of coffee plants has a significant effect and has a positive correlation to the income of robusta coffee farmers, which means that if the age of the coffee plant is longer than the average plant age (more than 21.64 years) and assuming other factors hold it constant, it will increase the income value of Robusta coffee farmers. This condition implies that the longer the age of the coffee plant, the more it has a positive role in increasing production so that it will also affect the increase in the income of robusta coffee farmers in Temanggung Regency. This condition reflects that the average age of robusta coffee plants in Temanggung Regency is still in a productive condition or it is not yet time for replanting.

The production of log coffee has a significant effect and has a positive correlation to the income of robusta coffee farmers, which means that the production of coffee logs is greater than the average production (greater than 4,267.86 kg/yr/0.53 ha) and with the assumption of other factors is considered constant, it will increase the income value of Robusta coffee farmers. This means that by increasing the production of coffee logs, it will increase the value of revenue greater than the cost of production so that the income of coffee farmers increases significantly.

Fixed production costs have no significant effect on the income of robusta coffee farmers, which means that regardless of the amount of fixed production costs, it does not affect the income of robusta coffee farmers. This is in accordance with the theory of production costs, that the amount of production costs remains independent of the amount of product produced so that the production costs do not affect the income of robusta coffee farmers.

Variable production costs have a significant effect and have a negative correlation to the income of robusta coffee farmers, which means that if the variable production costs are greater than the average (greater than 6,096,620.92/yr) and assuming different factors. Others are considered constant, it will reduce the income value of Robusta coffee farmers. This condition occurs because the variable production costs positively correlate to the scale of farming or the amount of robusta coffee production. However, if the increase in variable production costs is more significant than the increase in farm income, then the variable production costs negatively correlate with the income of robusta coffee farmers.

The form of coffee marketed has a significant effect and has a positive correlation to the income of robusta coffee farmers, which means that if the coffee marketed is in the form of green beans, in other words, it is not in the form of cherries. Furthermore, assuming other factors are considered constant, it will increase the income value of Robusta coffee farmers.

Conclusions

Coffee farming has been widely grown in Indonesia. This crop is one of the commodities that has been internationally traded. At a household level, coffee farming is an income source for smallholder estate crops in Java, Indonesia. This study concludes that the factors that influence income are the area of farming land, age of coffee plants, production of coffee logs, variable production costs, and the form of coffee products marketed by farmers partially have a significant effect on the income of robusta coffee farmers. Meanwhile, the factor of fixed production costs has no significant effect on the income of robusta coffee farmers.

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Pertanian, Vol. 6 No. 3, pp. 43-52.

International Social Science Journal - Manuscript ID ISSJ-OF-2021-082 [email ref: SE-6-a]

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To: Edy Prasetyo <edyprasetyo@lecturer.undip.ac.id>

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13-Mar-2021

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As you will see from their comments, the reviewers are satisfied with the significant changes you have made to your manuscript, which they believe makes its contribution much stronger. One of the reviewers is suggestion that you make a few minor updates to the recommendations for policymakers so that they are organized in a more step-by-step manner. If you feel this is appropriate, we invite you to add a few lines to the conclusion that will make this clearer. Once you've done that we can move forward toward publication.

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Sincerely,
Dr. Sebastian Ille

International Social Science Journal
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Reviewer(s)' Comments to Author:

Reviewer: 1

Comments to the Author
This is a revised version of the manuscript. The revision was comprehensive. Many new relevant references were added to replace the old ones. The discussion was also supported by previous relevant studies. The analysis was also renewed with a more robust analytical model than before, by adding factors affecting the decision to adopt the improved products or processed beans to get the added value. With such analysis, it will be more adequate to provide policy recommendations.
However, the paper still can be improved ad more useful for policymakers if the recommendation can be practically stated in a step-by-step manner. This will help the local governments formulate appropriate actions.

Reviewer: 2

Comments to the Author
Review of the revised version
The revised paper tries to analyse smallholder coffee farming as the potential source of income for Indonesian rural communities. The income resulting from smallholder coffee farming is potentially enhanced by shortening the supply chain by conducting an additional process to take an added value as the extra income for farmers. The added value came from further post-harvest handling before selling the product to the market. The idea coincides with the concept of commercialization where farmers should utilise the potential market. Such an introduction is the important revised part. Another imperative revision is the methodology that put additional analysis to study the determinants affecting farmers to conduct further process. With such analysis, the important factors can be scientifically determined. The model used to analyse, to a large extent, is adequately powerful to address the objectives of the study. There is also a correction related to the comparison between farmers who conduct post-harvest handling and their counterpart. The presentation of the results is clear and concise, and the discussion is also comprehensive. Many relevant references have been added to support the introduction, literature review, methodology and discussion of the results. The conclusion was drawn from t the analysis as the basis of recommendation or policy implication. Thus, compared to the previous version, this revised one is much better. From my side, the paper is now acceptable to be published, as the author(s) made very substantial revisions in all parts of the manuscript to address the reviewer's comments and suggestions.

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17-Oct-2021

Dear Dr. Prasetyo:

Your revised manuscript entitled "Factors Determining Income and Product Type of Robusta Coffee Farming in Central Java, Indonesia" by Prasetyo, Edy; Listiyaningsih, Dini; Setiadi, Agus; Mukson, Mukson; Roessali, Wiludjeng; Ekowati, Titik, has been successfully submitted online and is presently being given full consideration for publication in International Social Science Journal.

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Determinants ofFactors Determining Income Generated fromand Product Type of Robusta Coffee Farming in Central Java, Indonesia

Abstract

Coffee farmers in Central Java have widely cultivated Robusta varietycultivars. During the last decade, the demand for coffee increases substantially. The coffee commodity is cultivated because of the higherhigh price, which makes the commodity more competitive in the market. The study was conducted to analyze the comparison of farmers'potentially generates income from Robusta coffee farming which is based on the form of for the farmers. The study aimed to analyse the farmers' income associated with the post-harvest processing, and to analyzeanalyse the factors that affect the income of Robustapost-harvest processing from coffee farmers infarming Temanggung Regency. Primary data were obtained from direct interviews with 98 farmers running the Robusta coffee farming business; secondary data were obtained from the relevant institutions.. The results show that the income of Robusta coffee farmers by selling their product in the form of coffee grain was higher than those who directly sold the coffee as raw material. Theprocessed in green bean coffee boosted the farmers' income, and the socio-economic characteristics, extension service and plan density influenced product processing. The confounding factors influencing the income were the farm size, the age of coffee plantations, raw coffee production, level, and the variable cost, and the form of Robusta coffee product sold by farmers. These factors partially influenced the income of Robusta coffee farmers. However, the fixed cost did not influence the income of Robusta coffee farmers.. It is recommended that farmers sell green bean coffee by intensifying extension services and increasing plant density.

Keywords: coffee farming, economic aspects, Java province, product differentiation, smallholder

Introduction

The coffee production is one of the businesses that is currently growing over the globe. Studies on the coffee business have been carried out by researchers such as Geibler et al. (2016) and Mishra (2013) that show promising prospect. The success of the coffee business starts with a good business model that pays attention to the value chain (Mishra, 2013). Ferreira et al. (2021) stated that going to a coffee shop is a lifestyle for people in urban areas. A good coffee business with respect to the value chain will generate high profits. Lee and Bateman (2021) states that organic coffee is now gaining more attention in the international

~~coffee business than conventional ones. Currently, both robusta and arabica coffee are developed organically for high profit.~~

Indonesia is one of the potential coffee producers in the world and ~~have contribute~~has contributed significant market share. At a national level, the farm size of coffee plantations in Indonesia in 2015 has reached ~~up to~~ 1,230,001 ha. Smallholder farmers dominate the coffee plantation, with a total of up to 1.9 million farmers. Based on the farm size, around 1.2 million ha (96.16%) is owned by farmers in rural areas, and ~~22.59 ha (1.8%) is managed by~~ the government manages 22.59 ha (1.8%), and~~,~~ 25.54 ha (2.04%) is owned by private companies (Directorate General of Plantation, ~~2016~~2016a; 2016b).

The coffee plantation has roles as the source of income and job opportunities for people, and one of the sources of foreign exchange since ~~to some extents of the product is exported. The export of coffee plantations in Indonesia is the fourth largest export value, following rubber, palm oil, and cacao (Secretary General of Ministry of Trade, 2018).~~

~~In the last decade, the domestic demand for coffee has been rapidly increasing, especially as the raw material for beverage.~~ exported to some extent. According to Directorate General of PlantationCoffee consumption has been seen as part of a lifestyle in people's social existence. ~~According to Ministry of Agriculture~~ (2016), coffee consumption in Indonesia in 2016 was 249,824 ton, and in 2021 it will be projected to increase by 48.06%, which account for about 369,886 ton. The export of coffee plantations in Indonesia is the fourth largest export value, following rubber, palm oil, and cacao (Directorate General of Plantation, 2017). In the last decade, the domestic demand for coffee has rapidly increased, especially as the raw material for a beverage. Coffee consumption has been seen as part of a lifestyle in people's social existence. The coffee price in Indonesia from 2014 to 2017 showed an increasing trend with an average of 4.80% per year.

Temanggung ~~Regency~~district is one of the ~~center~~centres of coffee ~~production~~productions and coffee processing in Central Java, especially Robusta coffee. Based on the Decree of the Ministry of agriculture No. 830 of 2016 about developing a ~~center~~centre of coffee plantation, Temanggung ~~Regency~~ is predicted to be one of the ~~centers~~centres of Indonesian coffee production. There are eight sub-districts in the area that have the potentials to become ~~centers~~centres for coffee production.

Temanggung ~~Regency~~ is supported by the large land size ~~of land~~ and is highly ~~favorable~~favourable in agro~~-~~climate, especially for Robusta coffee ~~plantation~~plantations. The farm size and ~~Robusta~~ coffee production in ~~Temanggung Regency have~~the region has the highest coffee production in Central Java Province. An estimated total of 4,583 tons of Robusta coffee was produced ~~as well~~, as there was 9,338 ha of coffee planted in ~~Temanggung Regency.~~the region. In comparison, the production of Robusta coffee in

Central Java was 14,921 tons. It means that ~~Temanggung Regency~~the region contributes around 30~~.72 percent~~ % of Robusta coffee production in Central Java (Office of Agriculture and Plantation of Central Java Province, 2016).

Based on post-harvest handling ~~was~~ carried out by the farmers, ~~Robusta~~ coffee products in Temanggung ~~Regency~~ could be ~~categorized~~categorised into raw coffee fruit (~~cherries~~cherry coffee) and green ~~beans~~bean coffee. The processing into green beans is the first stage process carried out by farmers. According to ~~Listyaningsih~~Listiyaningsih et al. (2019), there would be value-added obtained by the farmers by selling their coffee into green beans compared to farmers selling their coffee in the form of cherries. Farmers not only get benefits from their increasing income~~; meanwhile,~~,, but they can also have ~~maximized~~maximised added value by using waste from coffee plantations for ~~fertilizer.~~organic fertiliser. Farmers also ~~utilize~~utilise residue from post-harvest processing as animal feed. Improving the value-added of~~ Robusta~~ coffee in different products theoretically would influence the price and farmers' income. Moreover, increasing farmers' income will motivate the farmer to focus and sustain their coffee plantations.

This research was conducted to ~~analyze~~analyse the ~~comparison of Robusta coffee farmers'~~ income ~~based on~~effect of post-harvest processing ~~and to analyze~~from freshly harvested coffee into green bean coffee and analyse the factors influencing ~~Robusta coffee farmers' income~~farmers' intention to conduct the post-harvest handling in Temanggung Regency, Central Java~~. Meanwhile, research~~, Indonesia. This study is expected to give benefits ~~were expected to be the recommended material~~ for farmers in increasing the income, the policymakers to ~~move toward a more outstanding~~formulate appropriate and practical actions related to the market orientation of the coffee industry~~. It is expected~~, and researchers to ~~be a piece of~~explore scientific information or reference for further ~~research~~studies, especially in developing a strategy for the development of Robusta coffee industry.

Literature Review

Coffee is one of the commodities globally traded. At a global level, Richards and Smith (2015) reveal that the coffee industry undergoes booming and escalates more in the upcoming time because of its enormous popularity and consumption. ICO (2020) reports that the international export and the total consumption worldwide increased from 83.8 million gunnies in October 2019 to 168.5 million gunnies in May 2020 (a gunny is equivalent to 60 kg). It has become one of the foremost consumed products in the fashionable life and has become the second most popular beverage (Bae et al., 2014; Esquivel and Jimenez, 2012; Farah, 2012). It has flourished and prospered worldwide since it the discovered initially in Ethiopia, absconding the people who hanker for the product (Flamen, 1989; Smith, 1985). The high demand for coffee makes the coffee-based business profit-making (Hameed et al., 2018).

Coffee production is one of the businesses that is currently growing over the globe. Studies on the coffee business have been carried out by researchers such as Geibler et al. (2016) and Mishra (2013) that show promising prospects. Farming based on the coffee plantation is also a vital economic production in many developing countries (Daviron and Ponte, 2005). In Colombia, the commodity is the most important exported agricultural product for the country's economy, in which Colombian coffee production in 2019 generated approximately 2.7 billion USD (OEC, 2020).

The commercialisation of agriculture is the key to success in economic development. Commercialisation can be conducted by intensifying the farm. In vegetable production, for example, changing from subsistence to profit-oriented farming is because of the adoption of technology in the farm intensification (Mariyono, 2019a), and the result is the improvement of rural prosperity (Mariyono, 2019b; Weatherspoon et al., 2021). In general, growing smallholder coffee commercialisation becomes a viable pathway for agricultural economic development in coffee-growing areas (Gebreselassie and Ludi, 2006).

The success of the coffee agribusiness starts with a good business model that pays attention to the value chain (Mishra, 2013). Ferreira et al. (2021) stated that going to a coffee shop is a lifestyle for people in urban areas. A good coffee business with respect to the value chain will generate high profits. ~~strategy~~Lee and Bateman (2021) state that organic coffee is now gaining more attention in the international coffee business than conventional ones. Currently, both Robusta and Arabica coffee are developed organically for high profit.

At the farm level, the primary constraint of coffee-based agribusiness is the long marketing channel of coffee. There are many players in the value chains of coffee that reduce profit gained by farmers. Ahmad et al. (2019) show that farmers in East Java Indonesia gained the lowest profit share in the marketing channel. Ntimbaa and Akyoob (2017) show broad variations of farmgate prices among farmers selling in different market channels. Three factors significantly influenced the farmer's marketing channel choice: the price of coffee, farmer's age, and distance to the selling centre from the farmstead. This condition is almost similar to commercial vegetable farming, where farmers get a small fraction of their profit (Mariyono et al., 2020). Restructuring farmer cooperatives, providing formal credit facilities to provide favourable credit to farmers, and establishing more rural primary cooperative and private coffee buying centres in remote villages to reduce transportation costs will benefit the farmers.

Smallholders produce around 90% of coffee in some countries (Velez-Vallejo, 2018). This condition makes the farmers are sensitive to economic shocks. For instance, coffee bean prices sharply dropped during the coffee crisis of the late 1990s, which sank from around US$1.50 per pound in 1997, about one-third that amount in 2001 (Taylor, 2007) because of oversupply (Ponte, 2001). Another shock comes from a natural

situation. Harvey et al. (2018) report that climate change is already causing significant adverse impacts on smallholder coffee farmers across the Central American region.

Consequently, most small-scale coffee farmers have difficulties making a decent living due to low coffee prices, high production costs, and climate variability, among other factors (Berdegué and Fuentealba, 2014). Therefore, estimation of coffee profitability is essential for sustainable farming systems and the wider coffee industry. Furthermore, estimating profitability continues to be a research challenge due to a lack of adequate tools adapted to specific characteristics of small-scale crop production in developing countries. Small-scale coffee farms in developing countries do not have information systems with accurate data on their agricultural micro-economic activities (Poole. 2017). Furthermore, the omission of relevant information in estimating profitability results in values far from reality (Giovannucci and Koekoek, 2007; Kilian et al., 2006). This current paper is expected to fill the gap.

Research Methodology

The ~~research~~study was conducted in Temanggung Regency. Temanggung Regency has been purposively selected ~~based on consideration as a center~~; the region is one the largest centres of production and processing of Robusta coffee in Central Java Province. ~~Research locations~~Study sites wer purposively determined in three main sub-districts~~,~~: Gemawang, Candiroto, and Kandangan ~~Sub-districts.~~. The ~~research~~study was carried from November 2018 to January 2019.

A survey method was used in this research. The research was conducted by taking the sample from a population and developed a questionnaire as the primary data collecting instrument ~~(Singarimbun and effendi, 1989).~~. The respondents of Robusta coffee farmers were determined by a three-stage cluster random sampling method: (i) Determining sub-districts. It was based on the ~~biggest~~largest Robusta coffee production in Temanggung Regency, namely: Gemawang, Candiroto, and Kandangan Sub-districts; (ii) Determining sample of villages. Two villages were selected from each sub-district with the largest Robusta coffee production~~, namely~~: Gemawang and Kemiriombo village, Muneng and Plosogaden village, and Blimbing and Gesing village; (iii) Determining the number of Robusta coffee farmers. Respondent was calculated based on ~~the solving~~Slovin's formula of determining the number of samples. There were 98 sampled farmers obtained from a 4,653 population of Robusta coffee farmers in Temanggung Regency. The 98 farmers were distributed in six regions of Gemawang village (36 farmers), Kemiriombo village (21 farmers), Muneng village (8 farmers), Plosogaden village (11 farmers), Blimbing village (4 farmers), and Gesing village (18 farmers).

The primary data used in this research were ~~taken from primary and secondary data. Primary data were~~ collected from Robusta coffee farmers~~, and secondary data were obtained through scientific literature and~~

~~data relevant to this research. The primary data~~ by interviewing selected farmers based on the questionnaire. The information included cost analysis, price of production input, ~~as well as~~and the price of output production based on the post-harvesting product (~~cherries~~cherry coffee and green bean~~). Primary data collection was conducted by observation, and direct interview to Robusta coffee farmers based on the questionnaire prepare beforehand. The~~ coffee). This study employed a data analysis method ~~was a~~of quantitative ~~descriptive method including income analysis, independent sample t-test analysis,~~comparison and ~~multiple linear regression.~~

~~Folowing Ekowati *et al.* (2014) income~~causality approaches. The comparison analysis was ~~calculated by deducting total production cost of farming from~~conducted to compare the ~~total revenue. The income can be amathematically formulated as follows.~~

~~$\Pi i = TRi - TCi$~~

~~where, Πi = Profit (IDR/year)~~

~~TRi = Total Revenue (IDR/year)~~

~~TCi = Total Cost (IDR/year)~~

~~$i = g$ = coffee produced in the form~~financial aspects of coffee ~~cherries~~

~~$i = b$ = coffee produced in the form of green bean~~

~~The independent sample t-test was used to analyze the comparison between Robusta coffee farmers' income with the post harvest product of coffee cherries and green beans. The hypothesis of this research was: it was assumed that Robusta Coffee farmers' income who sell their product in the form of coffee cherries is significantly~~farming of two different ~~from the farmers who sell the product in the form of green beans.~~

product types. Following ~~Soekartawi (2003), the factors influencing Robusta coffee farmers were analyzed~~a standard procedure of statistical mean comparison, the mean of each financial aspect was tested using ~~multiple linear regression, with the following mathematic formulation as follows.~~

~~$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7D + e$ (1)~~

~~where:~~

~~Y = Income of Robusta Coffee farmers (IDR/year)~~

~~a = Constant~~

~~b_1…b_7 = Regression coefficient~~

~~X_1 = The farm size (ha)~~

~~X_2 = The number of Robusta coffee trees planted by farmers (number of the unit of tree)~~

~~X_3 = The coffee lifespan (year)~~

~~X_4 = The number of coffee cherries productions (kg/year)~~

~~X_5 = Fixed cost (IDR/year)~~

~~X_6 = Variable cost (IDR/year)~~

~~D = Dummy variable, in this case, the form of coffee had been sold by the farmer~~

~~$D = 1$, if the coffee was sold in the form of green bean~~

~~$D = 0$, if the coffee was sold in the form of coffee cherries~~

~~e = Disturbance term~~

~~Moreover, statistic test applied was F test, coefficient determination (R^2),and t-test. The research hypothesis was: it was assumed that independent variables,~~ independent sample t-test analysis, which ~~include the farm size, number of coffee trees planted by farmers, coffee lifespan, the production quantity of coffee cherries, fixed cost, the variable cost, and the form of coffee had been sold by the farmer significantly influences the dependent variable, which is farmers' income generated from Robusta coffee farming~~was hypothesised as follows.

H_0: $\mu E_{GB} = \mu E_{CC} \equiv 0$

H_1: $\mu E_{GB} = \mu E_{CC} \neq 0$

where μ represents mean, E_{CG} represents the financial aspects of green bean coffee, and E_{CC} represents the coffee cherry.

The quantitative causality was approached using recursive path linear regression, as explained in Figure 1. The model explains that farmers' income is mainly affected by product type, and farmers' characteristics influence the product type. Other technical and economic factors are considered as confounding variables controlling the robustness of the effect.

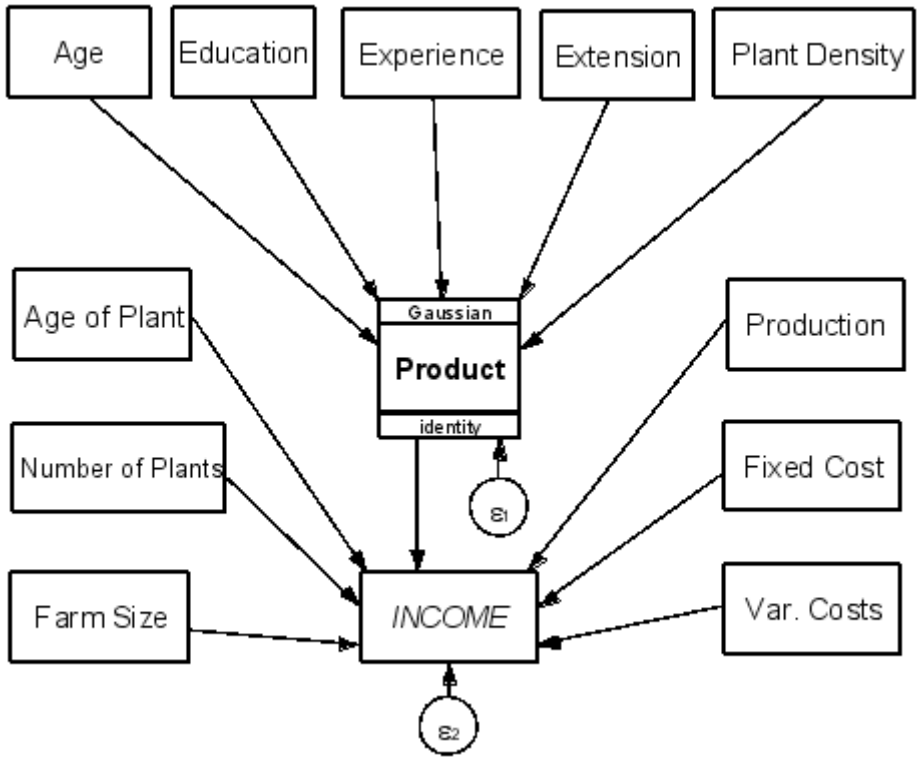


Figure 1. Analytical model of farmer income in coffee farming

In mathematical terms, the analytical model can be simultaneously expressed as follows.

$$Y_2 = \alpha_0 \pm \sum_{i=1}^{6} \alpha_i X_i \pm \alpha_7 Y_1 \pm \varepsilon_2 \quad (1)$$

$$Y_1 \begin{cases} 1 \\ 0 \end{cases} = \beta_0 \pm \sum_{j=1}^{5} \beta_j Z_j \pm \varepsilon_1 \quad (2)$$

where Y_2 is farmers income (IDR/year); X_i for i=1…6 is age of plant (year), number plants (unit), farm size (ha), production (kg/year), fixed cost (IDR/year) and variable cost (IDR/year); Y_1 is product type (1: green bean coffee, 0: otherwise); Z_j for j=1…5 is farmer age (year), farmer education (year), farmer experience (year), extension (times); plant density (tee/ha); α_i and β_j are coefficients to be estimated; ε_1 and ε_2 are error terms. Equation (1) represents the linear multiple regression model, and Equation (2) represents the logit regression model.

Hypotheses of the analytical model to be tested can be expressed as follows.

H_0: $\alpha_i \equiv \beta_j \equiv 0$

H_1: H_0 is not true

The analytical model was estimated using generalised structural equation modelling (GSEM) provided in STATA ver. 13 (StataCorp,2013). The use of GSEM can eliminate heteroskedasticity due to binary dependent variables (Verbeek, 2003). All hypotheses were tested at least a 90% confidence interval. The goodness of fit measures associated with the estimation was provided to show the robustness.

Results and Discussion

~~Robusta~~***Harvesting*** coffee ~~farmers~~

Farmers usually in Temanggung ~~Regency usually~~ harvest Robusta coffee ~~cherries~~in terms of cherry coffee from July to August every year. The standard measure for ~~robusta~~ coffee maturity is marked by a change in the ~~color~~colour of the coffee fruit skin from green to red or reddish yellow. However, ~~there are~~ some ~~robusta~~ coffee farmers ~~who~~ harvest their coffee when ~~the coffee~~it is not ~~completely~~entirely ripe~~. This is caused by~~ because of several ~~things, but the~~ factors. The main ~~thing is due to the consideration of~~factor is the urgent economic needs of the family. ~~Robusta~~

Harvesting mature coffee ~~is harvested when it is ripe. This harvest~~ has the following advantages: (i) ~~Coffee~~coffee is easy to process because the skin is easy to peel off; (ii) ~~The~~the ratio of the weight of coffee beans to the weight of fresh coffee is higher; (iii) ~~The~~the coffee beans are pithier so that the bean size is ~~bigger~~big; (iv) ~~Faster~~fast coffee drying time; (v) ~~Better~~good physical quality and ~~flavor~~flavour. Harvesting unripe ~~robusta coffee where the fruit is still green or yellow, and harvesting robusta~~ coffee ~~whose fruit is too ripe (yellow), overripe coffee~~ (black fruit), ~~or harvesting the fruit in an~~ unhealthy ~~condition~~conditions ~~will cause~~ the coffee beans' ~~low physical quality of the Robusta coffee beans, and the taste is unfavourable.~~

The ~~robusta~~ coffee marketed by farmers based on post-harvest handling (shape) can be classified into two types, namely cherries and green beans. Marketing in the form of coffee logs if the ~~robusta~~ coffee fruit is not subject to post-harvest handling, or in other words, after harvesting, it can be directly marketed to buyers, who are generally collector traders. Meanwhile, the marketing of ~~robusta~~ coffee in the form of coffee beans

is carried out by farmers when there is post-harvest processing. Processing of ~~robusta~~ coffee from coffee cherries into green bean coffee ~~beans~~ is ~~done~~conducted by dry processing.

Coffee farmers mostly carry out the dry processing process~~, and this is~~ because~~, in general,~~ the farmer capacity ~~of the coffee farmers to do~~ is small~~, and it~~. It is easy to do even though it only uss simple equipment. In dry processing, after the ~~Robusta~~ coffee fruit is harvested, it is dried immediately. ~~Robusta~~The coffee fruit must be dried immediately to avoid undergoing chemical processes that can reduce product quality. Peeling the fruit's flesh ~~of the fruit~~, peeling the horn skin, and peeling the epidermis are ~~done~~carried out after the coffee becomes dry. Peeling the dry coffee fruit skin aims to separate the coffee beans from the fruit skin, horn skin and epidermis. Peeling the horn skin ~~using~~uses a pulper and ~~stripping~~strips the epidermis using a huller.

This condition is in ~~accordance~~line with ~~the opinion of~~ Najiyati and Danarti (2004~~), which states~~) opinion that the difference between dry processing and wet processing is the ~~treatmet~~treatment using water. Wet processing uses water ~~for peeling~~to peel and ~~washing~~wash the coffee cherries, while dry processing after the coffee cherries are harvested immediately dried and then stripped.

Financial aspects

The different forms of ~~Robusta~~ coffee marketed by farmers have different consequences for post-harvest processing costs. Farmers who market in the form of coffee beans have a higher variable cost than farmers who market in the form of ~~coffee logs. The gap is IDR 12,444,523/ha/yr compared to IDR 10,320,436/ha/year. The high difference is due to post-harvest processing costs for Robusta coffee which is marketed in the form of coffee beans. Post-harvest processing costs referred to are costs for drying and milling or stripping the coffee skin. The production input value in the form of fertilizer (mainly manure) in Robusta coffee farming in Temanggung Regency is absolutely lower than the cost of labor. This is because the robusta coffee farmers have not done fertilization optimally according to the recommendations recommended by the related technical agencies.~~ the coffee cherry. The financial aspects of coffee farming per one hectare basis are presented in Table 1.

~~According to the recommendation of~~Table 1 compares the financial aspects between cherry coffee and green bean coffee management. Mostly, there are no significant differences in general aspects of farm management. The significant aspects related to harvesting and post-harvest handling where farmers conducting bean processing spent extra labour costs. Post-harvest processing costs refer to labour costs for drying and milling or stripping the coffee skin. However, the post-harvest handling resulted in higher revenue than the counterparts and improved net revenue significantly. The farmers producing green bean coffee enjoyed about 33 % higher than those who sold cherry coffee.

Table 1. Average values of financial coffee farming aspects

Items	IDR/ha		
	Cherry coffee	Green coffee	Gap
Fixed cost:			
▪ Building Tax	90,278	90,707	429
▪ Land rent	4,242,500	4,238,981	- 3,519
▪ Depreciation	1,554,763	1,553,946	- 816
Sub total	5,887,543	5,883,635	- 3,908
Variable cost:			
▪ Manure	336,680	199,154	- 137,527*
▪ NPK fertiliser	783,929	810,526	26,597
▪ SP-36 fertiliser	412,769	412,085	- 683
▪ Urea fertiliser	739,190	710,185	- 29,005
▪ Fertilisation labour	798,661	797,920	- 740
▪ Weeding labour	1,197,512	1,186,483	- 11,028
▪ Pruning labour	1,974,175	1,980,506	6,331
▪ Harvesting labour	4,059,300	4,350,715	291,415*
▪ Bean processing labour	0	1,964,680	1,964,680*
Sub total	10,302,224	12,412,259	2,110,036*
Total cost	16,189,767	18,295,894	2,106,128*
Revenue	43,478,718	54,559,770	11,081,053*
Net revenue	27,288,949	36,263,874	8,974,925*

Source: authors' analysis; Note: *) denotes significant difference at 0.05

Another significant gap is the cost of manure, where farmers producing green bean coffee applied less manure than their counterparts. This is because the farmers have not done fertilisation optimally according to the recommendations. Based on the recommendation from related technical agencies, the dosage of manre use for mature coffee plants is 14,000 kg/ha/year, but coffee farmers in ~~Temanggung Regency~~the regions only ~~use~~applied manure for an average of 587~~.95~~ kg/ha/year. This is due to the lack of manure availability in the coffee farming area and the relative lack of understanding of farmers about the benefits of organic ~~fertilizers~~fertilisers for the coffee production process.

The ~~total revenue of coffee farmers who market their coffee products in the form of coffee cherries is IDR 22,174,146/year/5,091 m^2, while the total revenue of coffee farmers who market their coffee in the form of coffee beans is IDR 29,462,276/year/5,386 m^2. The revenue component comes from the~~ production ~~output multiplied by the selling price per unit weight. This is in accordance with the opinion of Suratiyah (2006), which states that gross income or income is all income obtained from farming during one period calculated from sales. The revenue value of robusta coffee farmers in Temanggung Regency is influenced by the amount of production, the form of the product being marketed, and the selling price of the coffee weight unit.~~

~~The production of Robusta coffee~~ of coffee for each farmer ~~is~~was different. This is due partly ~~due~~ to the different scales of coffee farming ~~and~~, the coffee plants' age ~~of the coffee plants~~, and the varying care of coffee plants. Coffee prices ~~may vary~~varied due to the different forms of coffee marketed, the quality of the

coffee, and the different marketing channels chosen by farmers. Farmers who ~~market~~marketed their coffee products in the form of green beans ~~get~~enjoyed a higher average price than farmers who ~~market~~marketed their coffee in the form of ~~logs (~~cherry coffee, which accounted for IDR 25,688.60/kg of ~~coffee~~green beans ~~is greater than~~ coffee and IDR 5,443.90/kg ~~of logs). Robusta~~for cherry coffee. The farmers in ~~Temanggung Regency market coffee in~~ the regions marketed coffee in the form of green beans to collectors, wholesalers, and coffee producers. ~~Coffee logs are~~Cherry coffee was marketed only to coffee collectors and artisans because large traders generally only ~~accept~~accepted coffee in the form of coffee beans.

The quality of coffee also affects the marketing price of Robusta coffee. For example, Coffee beans with a moisture content above 12% are slightly lower than coffee beans with a moisture content of 12%, where the price difference is around IDR 500/kg. Based on the results of Listyati's ~~research~~study (2017), farmers sell ~~robusta~~ coffee to collectors and wholesalers, and if the price in the market is not much different, farmers usually choose to sell to collector traders.

~~The income of coffee farmers who market their products in the form of coffee logs with an average~~Regarding business ~~scale of 0.51 ha for one year is IDR 13,917,364.63 or equivalent to IDR 27,337,192.35/ha/year. The~~investment feasibility, the ability of capital in coffee farming to generate income ~~(profitability)~~ is 168~~.56%.~~ % for cherry coffee and 198 % for green bean coffee. This profitability value is very high compared with the small business loan interest rate at the farmer level~~, for~~. For example, Food and Energy Security Credit (*Kredit Ketahanan Pangan dan Energi* = KKPE~~),~~) and People's Business Credit (*Kredit Usaha Rakyat* = KUR) ~~with~~pegged interest rates ranging from 6-% to 7 ~~percent, then robusta~~%. This means that agribusiness based on Robusta coffee ~~farming~~, whose products are marketed in ~~the form of~~cherry coffee ~~logs.~~, is worth the effort~~. The value~~

Despite farmer income is quite high, coffee farming is an estate crop that produces once or twice a year. This makes farmers wait for the harvest too long. Farmers need cash for daily life, and there is a risk of wasting money during the harvesting season. To guarantee sufficient cash for daily needs while waiting for coffee harvest, it needs to introduce seasonal cash crops in the community. Wijaya et al. (2021a; 2021b) show examples that vegetable cultivation helps farmer households increase income. Temanggung is hilly areas that fit for cultivating vegetables and other horticultural crops. This can fill the gap in the harvesting seasons of coffee. and very feasible to cultivate.

Factors determining income and products

Many factors influence the variation of income gained by farmers. Based on Figure 2, the farm size, age of coffee plants, production of coffee logs, fixed production costs, ~~revenues, and farming income for robusta coffee whose~~ variable production costs, and the form of product simultaneously provide significant

effects on the income of coffee farmers in the regions. At the sameime, the form of the product was determined by personal characteristics of farmers, extension and density of the plant. The significance shows $p \geq \chi^2 = 0.000$, with an overall R^2 of 0.5906, which means that explanatory factors explained about 60% variation in farmer income; the rest were explained by other factors not included in the simultaneous regression equation model (Gujarati, 2012).

In partial analysis, it can be seen that farmers selling green bean coffee products ~~are marketed in the form of logs in detail are presented in Table 1.~~

~~Table 1. Econmic aspects of coffee logs on an average land area of 0.51 ha.~~

~~No.~~	~~Items~~	~~Value (IDR)~~	~~Number IDR~~
~~1.~~	~~Fix cost~~		
	~~▪ Building and land Tax~~	~~46,042~~	
	~~▪ Land rent~~	~~2,163,675~~	
	~~▪ Depreciation~~	~~792,929~~	
	~~Number~~		~~3,002,647~~
~~2.~~	~~Variable cost:~~		
	~~▪ Livestock fertilizer (404.95 kg)~~	~~171,707~~	
	~~▪ NPK fertilizer (167.39 kg)~~	~~399,804~~	
	~~▪ SP-36 fertilizer (99.10 kg)~~	~~210,512~~	
	~~▪ Urea fertilizer (193.61 kg)~~	~~376,987~~	
	~~▪ fertilization labor(6.35 mwd)~~	~~407,317~~	
	~~▪ weeding labor (9.46 mwd)~~	~~610,731~~	
	~~▪ pruning labor (15.56 mwd)~~	~~1,006,829~~	
	~~▪ harvesting labor (31.96 mwd)~~	~~2,070,243~~	
	~~Number~~		~~5,254,134~~
	~~Production cost~~		~~8,256,781~~
~~3.~~	~~Revenue~~		
	~~▪ logs coffee (4,073.17 kg)~~	~~22,174,146~~	
	~~Income~~		~~22,174,146~~
~~4.~~	~~Farm profit~~		~~13,917,364~~

~~Explanation: Men's Working Days (MWD)~~

~~Meanwhile, the income of Robusta coffee farmers who market their~~ received significantly higher income than those selling un-processed products ~~in the form of green beans with an average business scale of 0.54 ha for one year is IDR 19,582,492 or equivalent to IDR 36,358,136/ha/year, with a profitability value of 198.21%. This profitability value reflects that coffee farming carried out by coffee farmers in the Regency is very feasible to be cultivated. The value of production costs, revenues, and farming income for Robusta coffee, whose products are marketed in the form of bean coffee, are presented in detail in Table 2.~~

. This advantage is robust since other confounding factors have controlled it. The high income from processed coffee Table 2. ~~Economic aspects of coffee beans on an average land area of 0.54 ha.~~

~~No.~~	~~Items~~	~~Number (IDR)~~	~~Number (IDR)~~
~~1.~~	~~Fix cost~~		
	~~▪ Building and land Tax~~	~~48,982~~	
	~~▪ Land rent~~	~~2,289,050~~	

	▪ Depreciation	839,131	
	Number		3,177,163
2.	Variable cost:		
	▪ Livestock fertilizer (404,95 kg)	107,543	
	▪ NPK fertilizer (167,39 kg)	437,684	
	▪ SP-36 fertilizer (99,10 kg)	222,526	
	▪ Urea fertilizer (193,61 kg)	383,500	
	▪ fertilization labor (6,35 mwd)	430,877	
	▪ weeding labor (9,46 mwd)	640,701	
	▪ pruning labor (15,56 mwd)	1,069,473	
	▪ harvesting labor (31,96 mwd)	2,349,386	
	▪ Ose Processing labor (16.58 mwd)	1,060,927	
	Number		6,702,620
	Cost Production		9,879,783
3.	Revenue:		
	▪ Ose Coffee (1,191 kg)	29,462,276	
	Number of Revenue		29,462,276
4.	Farm Income		19,582,492
5.	Farm income of Robusta coffee/ha		

Explanation: Men's Working Days (MWD)

The income of robusta coffee farmers who sell their products in the form of coffee beans (green beans) is higher than the income of robusta coffee farmers who market their products in the form of coffee logs. This is in line with theSaragih (2019) results of Saragih's research (2019), thatthose farmers who carry out primary processing (processing red logs into unhulledun-hulled coffee) get higher income and are significantly different from farmers who sell red logs. For this reason, efforts are needed so that robusta coffeeto motivate farmers have the motivation to process their products into coffee beans in order to increase the added value of their farming.

Other studies by Hariyati (2014) states that the highest driving factor in developing processed coffee products in Sidomulyo Village, Silo District, Jember Regency is the high motivation of farmers. This is also supported by statistical analysis using the Independent Sample t-test. It can be seen that the income of robusta coffee farmers who market their products in the form of bean coffee has a significantly different value from the income of robusta coffee farmers who market their products in the form of log coffee ($P < 0.05$). The income of robusta coffee farmers who market their products in the form of coffee beans has a greater value than the income of Robusta coffee farmers who market their products in the form of coffee logs (IDR 36,358,136/ha/year, higher than IDR 27,337,192/ha/yr). The significant statistical test rsults illustrate that the role of post-harvest processing of robusta coffee products can actually increase the added value of robusta coffee farming.

~~The results of research by Suhendar et al. (2012))~~, Saria and Fitria (2012) and Wahyu and Suwandari (2012) show that most farmers sell their produce in the form of ground coffee (bean coffee) to collector traders who have collaborated for a long time, while a small proportion of farmers sell in the form of coffee cherries. ~~Soekartawi (2005) states that the level of technology application in agriculture is one of the factors that determines the level of production and income of agricultural businesses.~~

~~Theoretically, there are many factors that influence the high and low income of Robusta coffee farmers in Temanggung Regency. These factors have a direct or indirect effect on farmers' income. Some of the factors include the farm area, the age of the plant, the amount of production, fixed production costs, variable production costs, and the shape of the robusta coffee product that is marketed. Based on Table 3, the factors of farm area, age of coffee plants, production of coffee logs, fixed production costs, variable production costs, and the form of coffee being marketed simultaneously has a very significant effect on the income of coffee farmers in Temanggung Regency (F sign <0.05). At the same time, the coefficient of determination (adjusted R2) is 0.531, which means that the variation in independent factors (X_1 to X_6) of 53.10% can explain the variations that occur in the dependent variable, namely the income of robusta coffee farmers, while 40.90% explained by other factors that were not included in the regression equation model.~~

~~Table 3. Analysis of variance Factors that affect the farm income~~

~~Model~~		~~Sum of Squares~~	~~Df~~	~~Mean Square~~	~~F~~	~~Sig.~~
~~4~~	~~Regression~~	~~74232.64~~	~~6~~	~~12372.106~~	~~19.338~~	~~0.000[b]~~
	~~Residual~~	~~58219.81~~	~~91~~	~~639.778~~		
	~~Total~~	~~132452.45~~	~~97~~			

~~Note: Dependent Variable: Y; Predictors: Constant, D, X_1, X_2, X_3 X_4, X_5~~

~~Table 4. Estimated coefficients of factors affecting income~~

~~Model~~	~~Unstandardized Coef.~~		~~Standardized Coef.~~	~~t~~	~~Sig.~~
	~~B~~	~~Std. Error~~	~~Beta~~		
~~Constant~~	~~225,453~~	~~11,236~~		~~20.065~~	~~0.000~~
~~X_1~~	~~-0.059~~	~~0.009~~	~~-3.606~~	~~-6.781~~	~~0.000~~
~~X_2~~	~~1.531~~	~~0.365~~	~~0.309~~	~~4.192~~	~~0.000~~
~~X_3~~	~~0.100~~	~~0.013~~	~~4.947~~	~~7.437~~	~~0.000~~
~~X_4~~	~~1.186E-006~~	~~0.000~~	~~0.047~~	~~0.640~~	~~0.524~~
~~X_5~~	~~-1.883E-005~~	~~0.000~~	~~-1.427~~	~~-2.616~~	~~0.010~~
~~D~~	~~27,997~~	~~9.002~~	~~0.376~~	~~3.110~~	~~0.002~~

As the anova shows a significant effect of factors, the analysis proceeds with investigating individual effect, as presented in Table 4. Based on Table 4, a regression equation can be formed as an estimator of the influence of the factors of agricultural land area, plant age, total production of coffee logs, fixed production costs, variable production costs, and shape of coffee products that are marketed on the income of robusta coffee farmers can expressed in term of equation as follows.

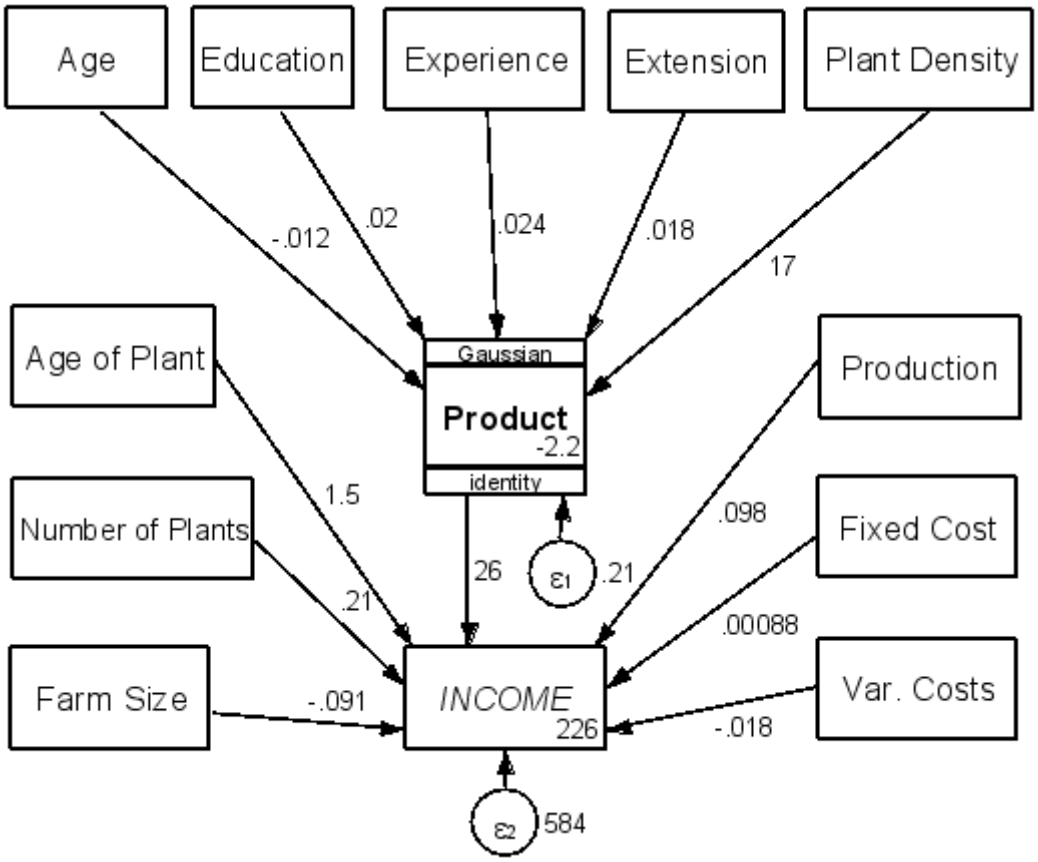
Y = - 3,606X1 + 0,309X2 + 4,947X3 + 0,047X4 - 1,427X5 + 0,376D + e

The regression coefficient in this equation is the coefficient for the independent variable that has been standardized, so the regression equation does not have a constant because the regression line crosses the original point. Standardization (standardized beta) is applied to eliminate differences in the unit of measure applied to independent variables whose reality is not the same (heterogeneous). According to Ghozali (2007), if the size of the independent variables is not the same, then it is better if the regression equation interpretation uses the standardized beta. Further disclosed, the advantage of using standardized beta is that it is able to eliminate differences in the unit of measure in the independent variable. From the results of the regression equation, that the factors of production of farm area, age of coffee plants, production of coffee logs, variable production costs, and the form of robusta coffee products marketed by farmers partially significant effect on the income of robusta coffee farmers in Temanggung Regency (t sign <0.05). Only the fixed production cost factor has no significant effect on the income of robusta coffee farmers in Temanggung Regency (t sign> 0.05).

The land area factor for coffee farming has a significant effect and has a negative correlation on the income of robusta coffee farmers, which means that if the land factor as a medium for coffee farming is increased, the area is greater (greater than 0.53 ha of average land area) and assuming the other factors are considered constant, in fact, it will reduce the income value of Robusta coffee farmers, and *vice versa*. This happens because the land area factor as a factor of production has reached its optimal point (diminishing returns), so that if the additional land area is done, it will result in a more significant increase in production costs compared to the increase in revenue, and in turn, it will actually reduce the value of coffee farmers' income. Robusta. According to Soekartawi (1994), that the law of diminishing returns can illustrate the relationship between production and one production factor with the assumption that other production factors are considered constant.

Age of coffee plants has a significant effect and has a positive correlation to the income of robusta coffee farmers, which means that if the age of the coffee plant is longer than the average plant age (more than

~~21.64 years) and assuming other factors hold it constant, it will increase the income value of Robusta coffee~~



~~farmers.~~

Source: authors' analysis

Figure 2. Estimated model of farmer income in coffee farming

The age of coffee plants has a significant effect on the income, which means that the more mature coffee plant, the higher the income received by farmers. This condition implies that the longer the age of the coffee plant, the more it has a positive role in increasing production so that it will also affect the increase in ~~the~~ income ~~of robusta coffee farmers in Temanggung Regency.~~. This condition reflects that the average age of ~~robusta~~ coffee plants in ~~Temanggung Regency is~~the regions was still ~~in a~~ productive ~~condition~~, or it ~~is~~has not ~~yet time for replanting~~been required to regenerate plants.

The ~~production of log coffee~~ farm size has a significant effect and has a ~~positive correlation to~~negative effect on the income ~~of robusta coffee farmers~~, which means that ~~the production of coffee logs is greater than the average production (greater than 4,267.86 kg/yr/0.53 ha) and with the assumption of other factors is considered constant, it will increase~~extended farm size of coffee farming reduced the income ~~value of Robusta coffee farmers.~~ . This ~~means~~phenomenon indicates that ~~by increasing~~the farmers have reached peak capacity in managing the farm. It would be drudgery when the limited resources operate a large farm. Normatively, farm size represents the ~~production of coffee logs, it will increase~~ scale of the ~~value of revenue greater than~~farm. It could also be the ~~cost of production so~~case that the ~~income of coffee farmers~~ density of plants is getting lower when the size of the farm increases ~~significantly.~~. Although the size of a farm is large,

the number of plants is almost the same. Another possible factor is that the plants in the extended farm were not in the productive stage; thus, the production was low, despite the large farm.

Table 2. Estimated coefficients and significance

Variables	Coefficients	Std. errors	z value	p>z
INCOME <-				
Constant	225.7	10.73	21.03	0.000
Product	26.40	8.685	3.04	0.002
Age of plant	1.548	0.349	4.44	0.000
Number of plants	0.207	0.121	1.72	0.088
Farm size	-0.091	0.026	-3.55	0.000
Production	0.098	0.013	7.59	0.000
Fixed cost	0.001	0.002	0.49	0.623
Var. costs	-0.018	0.007	-2.66	0.008
Product <-				
Constant	-2.246	1.255	-1.79	0.074
Age	-0.012	0.007	-1.70	0.090
Education	0.020	0.015	1.36	0.173
Experience	0.024	0.008	3.16	0.002
Extension	0.018	0.032	0.57	0.570
Plant density	16.78	7.888	2.13	0.033
# Observations	98			
Log-likelihood	-513.16			
LR test, χ^2 (23)	201.80	$p>\chi^2$=0.000		
Overall R2	0. 5906			

Source: authors' analysis

The number of plants shows a positive effect on the income. This indicates that the plants were in the production stages—this finding related to the fact that a large farm does not necessarily improve the income. The production level also has a significant effect on the income, which means that the production of coffee increases the income. This is also an obvious finding and co-inside with the number of plants that positively affect income. The higher the number of productive plants, the higher the production harvested by farmers. As the production significantly increases farmers' income, keeping the coffee in high productivity is necessary. The improvement of crop management can conduct it. The agronomic aspect and maintenance of coffee trees need to be conducted in a sustainable fashion to provide social benefits for both producers and consumers (Mariyono, 2009). Organic fertilisers can replace the inorganic ones, and botanical and biological pesticides can replace synthetic ones (Mariyono, 2020); crop protection can apply a concept of integrated pest management that can reduce chemical pesticides (Mariyono, 2008). Adoption of technology applicable to coffee farming has the potentials to improve income, and in this case, providing microfinance assistance to the farmers will catalyse the technology adoption (Mariyono, 2019a; 2019b). Soekartawi (2005) states that the level of technology application in agriculture is one factor that determines the level of production and income of agricultural businesses.

Fixed production costs have no significant effect on ~~the~~ income ~~of robusta coffee farmers, which~~. This means that regardless of the ~~amount~~quantity of fixed production ~~costs~~cost, it does not affect the income ~~of robusta coffee farmers. This is in accordance with~~, as explained by the theory of production costs, that the amount of production costs remains independent of the amount of product ~~produced so that the production costs do not affect the income of robusta coffee farmers.~~

. Variable production costs have a significant effect ~~and have~~on income with a negative correlation ~~to the income of robusta coffee farmers, which means that if the variable production costs are greater than the average (greater than 6,096,620.92/yr) and assuming different factors. Others are considered constant, it will reduce the income value of Robusta coffee farmers~~. This condition occurs because the variable production costs positively correlate to the scale of farming or the amount of ~~robusta~~ coffee production. However, if the increase in variable production costs is more significant than the increase in farm income, then the variable production costs negatively correlate with the income of ~~robusta~~ coffee farmers.

~~The form of coffee marketed has a significant effect and has a positive correlation to the income of robusta coffee farmers, which means that if the coffee marketed is in the form of green beans, in other words, it is not in the form of cherries. Furthermore, assuming other factors are considered constant, it will increase the income value of Robusta coffee farmers.~~

From Figure 2 and Table 2, it can be seen that the farmers' intention to create a valued product in the form of green bean coffee depends on several factors. The age of farmers significantly reduced the intention of farmers to process further the harvested coffee bean into green bean form. This finding is reasonable since the post-harvest handling of coffee is drudgery, and it is pretty difficult for old farmers to do so. Education and experience significantly increased the farmers' intention to process the harvested coffee into green bean form, and so did the extension service.

Education and experience represent human capital or capacity in coffee-based agribusiness, and the extension service enhances the capacity. Concerning education, sending back to formal education might be effective to enhance the capacity; however, it was too late in the stage. Providing training with special topics for coffee will be helpful, like one for vegetable and rice farmers through special training (Mariyono, 2019c; 2020). Note that human capital improvement can lead to high motivation of farmers. Hariyati (2014) states that the highest driving factor in developing processed coffee products in Jember Regency is the high motivation of farmers.

Conclusions

Coffee farming has been widely grown in Indonesia. This crop is one of the commodities that has been internationally traded. ~~At~~The commercialisation of this crop leads to agricultural economic

development in rural areas where farmer households cultivate the crop. The commercialisation at a household level, coffee farming ~~is~~becomes an income source for smallholder estate crops in Java, Indonesia. Coffee products' value chains, starting from farm production to end-users at coffee shops, have distributed considerable income for the marketing channels. Farmers as producers can get more income when they take one step of the chains by processing the products. This study concludes that ~~the factors that influence~~shortsheeting one step of value chains by farmers improve farmers income ~~are the area of farming land,~~considerably. The step is to process coffee cherry became green bean coffee before selling to the market. Other factors determining the income were the age of coffee plants, ~~production of coffee logs, variable~~the number of plants, production quantity, operational costs, ~~and the form of coffee products marketed by farmers partially have a significant effect on the income of robusta coffee farmers. Meanwhile, the factor of fixed production costs has no significant effect~~farm size. However, not all farmers did not take the opportunity to get the value. Personal characteristics, extension programme and density of crops led to different actions. Old farmers were reluctant to take the opportunity. Trained and educated farmers were enthusiastic about getting the value-added in the supply chain. The density of crops highly affected farmers to utilise the chance. This study recommends that policymakers intensify the extension service, particularly to encourage farmers to increase crop density. This action has double impacts on ~~the~~ income ~~of robusta coffee farmers.~~and likelihood for farmers to process the coffee cherry to green bean coffee with high value in the market.

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1

Factors Determining Income and Product Type of Robusta Coffee Farming in Central Java, Indonesia

Abstract

Coffee farmers in Central Java have widely cultivated Robusta cultivars. During the last decade, the demand for coffee increases substantially. The coffee commodity is cultivated because of the high price, which potentially generates income for the farmers. The study aimed to analyse the farmers' income associated with the post-harvest processing and analyse the factors that affect the post-harvest processing from coffee farming Temanggung Regency. Primary data were obtained from direct interviews with 98 farmers running the coffee farming business. The results show that the product processed in green bean coffee boosted the farmers' income, and the socio-economic characteristics, extension service and plan density influenced product processing. The confounding factors influencing the income were the farm size, the age of coffee plantations, production level, and the variable cost. It is recommended that farmers sell green bean coffee by itensifying extension services and increasing plant density.

Keywords: coffee farming, economic aspects, Java province, product differentiation, smallholder

Introduction

Indonesia is one of the potential coffee producers in the world and has contributed significant market share. At a national level, the farm size of coffee plantations in Indonesia in 2015 has reached 1,230,001 ha. Smallholder farmers dominate the coffee plantation, with a total of up to 1.9 million farmers. Based on the farm size, around 1.2 million ha (96.16%) is owned by farmers in rural areas, and the government manages 22.59 ha (1.8%), and 25.54 ha (2.04%) is owned by private companies (Directorate General of Plantation, 2016a; 2016b).

The coffee plantation has roles as the source of income and job opportunities for people, and one of the sources of foreign exchange since exported to some extent. According to Directorate General of Plantation (2016), coffee consumption in Indonesia in 2016 was 249,824 ton, and in 2021 it will be projected to increase by 48.06%, which account for about 369,886 ton. The export of coffee plantations in Indonesia is the fourth largest export value, following rubber, palm oil, and cacao (Directorate General of Plantation, 2017). In the last decade, the domestic demand for coffee has rapidly increased, especially as the raw material for a beverage. Coffee consumption has been seen as part of a lifestyle in people's social existence.

The coffee price in Indonesia from 2014 to 2017 showed an increasing trend with an average of 4.80% per year.

Temanggung district is one of the centres of coffee productions and coffee processing in Central Java, especially Robusta coffee. Based on the Decree of the Ministry of agriculture No. 830 of 2016 about developing a centre of coffee plantation, Temanggung is predicted to be one of the centres of Indonesian coffee production. There are eight sub-districts in the area that have the potentials to become centres for coffee production.

Temanggung is supported by the large land size and is highly favourable in agro-climate, especially for Robusta coffee plantations. The farm size and coffee production in the region has the highest coffee production in Central Java Province. An estimated total of 4,583 tons of Robusta coffee was produced, as there was 9,338 ha of coffee planted in the region. In comparison, the production of Robusta coffee in Central Java was 14,921 tons. It means that the region contributes around 30 % of Robusta coffee production in Central Java (Office of Agriculture and Plantation of Central Java Province, 2016).

Based on post-harvest handling carried out by the farmers, coffee products in Temanggung could be categorised into raw coffee fruit (cherry coffee) and green bean coffee. The processing into green beans is the first stage process carried out by farmers. According to Listiyaningsih et al. (2019), there would be value-added obtained by the farmers by selling their coffee into green beans compared to farmers selling their coffee in the form of cherries. Farmers not only get benefits from their increasing income, but they can also have maximised added value by using waste from coffee plantations for organic fertiliser. Farmers also utilise residue from post-harvest processing as animal feed. Improving the value-added of coffee in different products theoretically would influence the price and farmers' income. Moreover, increasing farmers' income will motivate the farmer to focus and sustain their coffee plantations.

This research was conducted to analyse the income effect of post-harvest processing from freshly harvested coffee into green bean coffee and analyse the factors influencing farmers’ intention to conduct the post-harvest handling in Temanggung Regency, Central Java, Indonesia. This study is expected to give benefits for farmers in increasing the income, the policymakers to formulate appropriate and practical actions related to the market orientation of the coffee industry, and researchers to explore scientific information or reference for further studies, especially in developing a strategy for the development of Robusta coffee industry.

Literature Review

Coffee is one of the commodities globally traded. At a global level, Richards and Smith (2015) reveal that the coffee industry undergoes booming and escalates more in the upcoming time because of its

enormous popularity and consumption. ICO (2020) reports that the international export and the total consumption worldwide increased from 83.8 million gunnies in October 2019 to 168.5 million gunnies in May 2020 (a gunny is equivalent to 60 kg). It has become one of the foremost consumed products in the fashionable life and has become the second most popular beverage (Bae et al., 2014; Esquivel and Jimenez, 2012; Farah, 2012). It has flourished and prospered worldwide since it the discovered initially in Ethiopia, absconding the people who hanker for the product (Flamen, 1989; Smith, 1985). The high demand for coffee makes the coffee-based business profit-making (Hameed et al., 2018).

Coffee production is one of the businesses that is currently growing over the globe. Studies on the coffee business have been carried out by researchers such as Geibler et al. (2016) and Mishra (2013) that show promising prospects. Farming based on the coffee plantation is also a vital economic production in many developing countries (Daviron and Ponte, 2005). In Colombia, the commodity is the most important exported agricultural product for the country's economy, in which Colombian coffee production in 2019 generated approximately 2.7 billion USD (OEC, 2020).

The commercialisation of agriculture is the key to success in economic development. In the decentralised period (Sasana and Nugroho, 2018) it helps the local governments reduce the rural poverty. Commercialisation can be conducted by intensifying the farm. In vegetable production, for example, changing from subsistence to profit-oriented farming is because of the adoption of technology in the farm intensification (Mariyono, 2019a), and the result is the improvement of rural prosperity (Mariyono, 2019b; Weatherspoon et al., 2021). In general, growing smallholder coffee commercialisation becomes a viable pathway for agricultural economic development in coffee-growing areas (Gebreselassie and Ludi, 2006).

The success of the coffee agribusiness starts with a good business model that pays attention to the value chain (Mishra, 2013). Ferreira et al. (2021) stated that going to a coffee shop is a lifestyle for people in urban areas. A good coffee business with respect to the value chain will generate high profits. Lee and Bateman (2021) state that organic coffee is now gaining more attention in the international coffee business than conventional ones. Currently, both Robusta and Arabica coffee are developed organically for high profit.

At the farm level, the primary constraint of coffee-based agribusiness is the long marketing channel of coffee. There are many players in the value chains of coffee that reduce profit gained by farmers. Ahmad et al. (2019) show that farmers in East Java Indonesia gained the lowest profit share in the marketing channel. Ntimbaa and Akyoob (2017) show broad variations of farmgate prices among farmers selling in different market channels. Three factors significantly influenced the farmer's marketing channel choice: the price of coffee, farmer's age, and distance to the selling centre from the farmstead. This condition is almost similar to

commercial vegetable farming, where farmers get a small fraction of their profit (Mariyono et al., 2020). Restructuring farmer cooperatives, providing formal credit facilities to provide favourable credit to farmers, and establishing more rural primary cooperative and private coffee buying centres in remote villages to reduce transportation costs will benefit the farmers.

Smallholders produce around 90% of coffee in some countries (Velez-Vallejo, 2018). This condition makes the farmers are sensitive to economic shocks. For instance, coffee bean prices sharply dropped during the coffee crisis of the late 1990s, which sank from around US$1.50 per pound in 1997, about one-third that amount in 2001 (Taylor, 2007) because of oversupply (Ponte, 2001). Another shock comes from a natural situation. Harvey et al. (2018) report that climate change is already causing significant adverse impacts on smallholder coffee farmers across the Central American region.

Consequently, most small-scale coffee farmers have difficulties making a decent living due to low coffee prices, high production costs, and climate variability, among other factors (Berdegué and Fuentealba, 2014). Therefore, estimation of coffee profitability is essential for sustainable farming systems and the wider coffee industry. Furthermore, estimating profitability continues to be a research challenge due to a lack of adequate tools adapted to specific characteristics of small-scale crop production in developing countries. Small-scale coffee farms in developing countries do not have information systems with accurate data on their agricultural micro-economic activities (Poole. 2017). Furthermore, the omission of relevant information in estimating profitability results in values far from reality (Giovannucci and Koekoek, 2007; Kilian et al., 2006). This current paper is expected to fill the gap.

Research Methodology

The study was conducted in Temanggung Regency. Temanggung Regency has been purposively selected; the region is one the largest centres of production and processing of Robusta coffee in Central Java Province. Study sites were purposively determined in three main sub-districts: Gemawang, Candiroto, and Kandangan. The study was carried from November 2018 to January 2019.

A survey method was used in this research. The research was conducted by taking the sample from a population and developed a questionnaire as the primary data collecting instrument. The respondents of Robusta coffee farmers were determined by a three-stage cluster random sampling method: (i) Determining sub-districts. It was based on the largest Robusta coffee production in Temanggung Regency, namely: Gemawang, Candiroto, and Kandangan Sub-districts; (ii) Determining sample of villages. Two villages were selected from each sub-district with the largest Robusta coffee production: Gemawang and Kemiriombo village, Muneng and Plosogaden village, and Blimbing and Gesing village; (iii) Determining the number of Robusta coffee farmers. Respondent was calculated based on Slovin’s formula of determining the number of

samples. There were 98 sampled farmers obtained from a 4,653 population of Robusta coffee farmers in Temanggung Regency. The 98 farmers were distributed in six regions of Gemawang village (36 farmers), Kemiriombo village (21 farmers), Muneng village (8 farmers), Plosogaden village (11 farmers), Blimbing village (4 farmers), and Gesing village (18 farmers).

The primary data used in this research were collected from Robusta coffee farmers by interviewing selected farmers based on the questionnaire. The information included cost analysis, price of production input, and the price of output production based on the post-harvesting product (cherry coffee and green bean coffee). This study employed a data analysis method of quantitative comparison and causality approaches. The comparison analysis was conducted to compare the financial aspects of coffee farming of two different product types. Following a standard procedure of statistical mean comparison, the mean of each financial aspect was tested using independent sample t-test analysis, which was hypothesised as follows.

H_0: $\mu E_{GB} - \mu E_{CC} = 0$

$H_{1:}$ $\mu E_{GB} - \mu E_{CC} \neq 0$

where μ represents mean, E_{CG} represents the financial aspects of green bean coffee, and E_{CC} represents the coffee cherry.

The quantitative causality was approached using recursive path linear regression, as explained in Figure 1. The model explains that farmers' income is mainly affected by product type, and farmers' characteristics influence the product type. Other technical and economic factors are considered as confounding variables controlling the robustness of the effect.

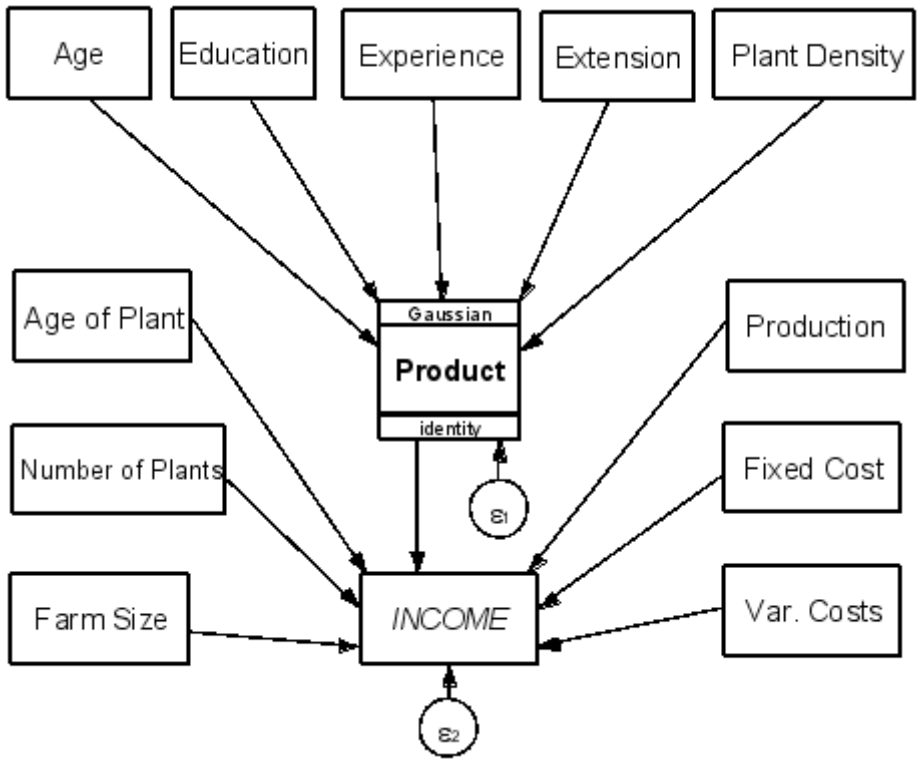


Figure 1. Analytical model of farmer income in coffee farming

In mathematical terms, the analytical model can be simultaneously expressed as follows.

$$Y_2 = \alpha_0 + \sum_{i=1}^{6} \alpha_i X_i + \alpha_7 Y_1 + \varepsilon_2 \quad (1)$$

$$Y_1 \begin{cases} 1 \\ 0 \end{cases} = \beta_0 + \sum_{j=1}^{5} \beta_j Z_j + \varepsilon_1 \quad (2)$$

where Y_2 is farmers income (IDR/year); X_i for i=1…6 is age of plant (year), number plants (unit), farm size (ha), production (kg/year), fixed cost (IDR/year) and variable cost (IDR/year); Y_1 is product type (1: green bean coffee, 0: otherwise); Z_j for j=1…5 is farmer age (year), farmer education (year), farmer experience (year), extension (times); plant density (tree/ha); α_i and β_j are coefficients to be estimated; ε_1 and ε_2 are error terms. Equation (1) represents the linear multiple regression model, and Equation (2) represents the logit regression model.

Hypotheses of the analytical model to be tested can be expressed as follows.

H_0: $\alpha_i = \beta_j = 0$

H_1: H_0 is not true

The analytical model was estimated using generalised structural equation modelling (GSEM) provided in STATA ver. 13 (StataCorp,2013). The use of GSEM can eliminate heteroskedasticity due to binary dependent variables (Verbeek, 2003). All hypotheses were tested at least a 90% confidence interval. The goodness of fit measures associated with the estimation was provided to show the robustness.

Results and Discussion

Harvesting coffee

Farmers usually in Temanggung harvest Robusta coffee in terms of cherry coffee from July to August every year. The standard measure for coffee maturity is marked by a change in the colour of the coffee fruit skin from green to red or reddish yellow. However, some coffee farmers harvest their coffee when it is not entirely ripe because of several factors. The main factor is the urgent economic needs of the family.

Harvesting mature coffee has the following advantages: (i) coffee is easy to process because the skin is easy to peel off; (ii) the ratio of the weight of coffee beans to the weight of fresh coffee is higher; (iii) the coffee beans are pithier so that the bean size is big; (iv) fast coffee drying time; (v) good physical quality and flavour. Harvesting unripe coffee (yellow), overripe coffee (black fruit), or unhealthy conditions will cause the coffee beans' low physical quality, and the taste is unfavourable.

The coffee marketed by farmers based on post-harvest handling (shape) can be classified into two types, namely cherries and green beans. Marketing in the form of coffee logs if the coffee fruit is not subject to post-harvest handling, or in other words, after harvesting, it can be directly marketed to buyers, who are generally collector traders. Meanwhile, the marketing of coffee in the form of coffee beans is carried out by

farmers when there is post-harvest processing. Processing of coffee from coffee cherries into green bean coffee is conducted by dry processing.

Coffee farmers mostly carry out the dry processing process because the farmer capacity is small. It is easy to do even though it only uses simple equipment. In dry processing, after the coffee fruit is harvested, it is dried immediately. The coffee fruit must be dried immediately to avoid undergoing chemical processes that can reduce product quality. Peeling the fruit's flesh, peeling the horn skin, and peeling the epidermis are carried out after the coffee becomes dry. Peeling the dry coffee fruit skin aims to separate the coffee beans from the fruit skin, horn skin and epidermis. Peeling the horn skin uses a pulper and strips the epidermis using a huller. This condition is in line with Najiyati and Danarti (2004) opinion that the difference between dry processing and wet processing is thetreatment using water. Wet processing uses water to peel and wash the coffee cherries, while dry processing after the coffee cherries are harvested immediately dried and then stripped.

Financial aspects

The different forms of coffee marketed by farmers have different consequences for post-harvest processing costs. Farmers who market in the form of coffee beans have a higher variable cost than farmers who market in the form of the coffee cherry. The financial aspects of coffee farming per one hectare basis are presented in Table 1.

Table 1 compares the financial aspects between cherry coffee and green bean coffee management. Mostly, there are no significant differences in general aspects of farm management. The significant aspects related to harvesting and post-harvest handling where farmers conducting bean processing spent extra labour costs. Post-harvest processing costs refer to labour costs for drying and milling or stripping the coffee skin. However, the post-harvest handling resulted in higher revenue than the counterparts and improved net revenue significantly. The farmers producing green bean coffee enjoyed about 33 % higher than those who sold cherry coffee.

Table 1. Average values of financial coffee farming aspects

Items	IDR/ha		
	Cherry coffee	Green coffee	Gap
Fixed cost:			
▪ Building Tax	90,278	90,707	429
▪ Land rent	4,242,500	4,238,981	- 3,519
▪ Depreciation	1,554,763	1,553,946	- 816
Sub total	5,887,543	5,883,635	- 3,908
Variable cost:			
▪ Manure	336,680	199,154	- 137,527*
▪ NPK fertiliser	783,929	810,526	26,597
▪ SP-36 fertiliser	412,769	412,085	- 683
▪ Urea fertiliser	739,190	710,185	- 29,005
▪ Fertilisation labour	798,661	797,920	- 740
▪ Weeding labour	1,197,512	1,186,483	- 11,028

▪ Pruning labour	1,974,175	1,980,506	6,331
▪ Harvesting labour	4,059,300	4,350,715	291,415*
▪ Bean processing labour	0	1,964,680	1,964,680*
Sub total	10,302,224	12,412,259	2,110,036*
Total cost	16,189,767	18,295,894	2,106,128*
Revenue	43,478,718	54,559,770	11,081,053*
Net revenue	27,288,949	36,263,874	8,974,925*

Source: authors' analysis; Note: *) denotes significant difference at 0.05

Another significant gap is the cost of manure, where farmers producing green bean coffee applied less manure than their counterparts. This is because the farmers have not done fertilisation optimally according to the recommendations. Based on the recommendation from related technical agencies, the dosage of manure use for mature coffee plants is 14,000 kg/ha/year, but coffee farmers in the regions only applied manure for an average of 587 kg/ha/year. This is due to the lack of manure availability in the coffee farming area and the relative lack of understanding of farmers about the benefits of organic fertilisers for the coffee production process.

The production of coffee for each farmer was different. This is due partly to the different scales of coffee farming, the coffee plants' age, and the varying care of coffee plants. Coffee prices varied due to the different forms of coffee marketed, the quality of the coffee, and the different marketing channels chosen by farmers. Farmers who marketed their coffee products in the form of green beans enjoyed a higher average price than farmers who marketed their coffee in the form of cherry coffee, which accounted for IDR 25,688.60/kg of green beans coffee and IDR 5,443.90/kg for cherry coffee. The farmers in the regions marketed coffee in the form of green beans to collectors, wholesalers, and coffee producers. Cherry coffee was marketed only to coffee collectors and artisans because large traders generally only accepted coffee in the form of coffee beans.

The quality of coffee also affects the marketing price of Robusta coffee. For example, Coffee beans with a moisture content above 12% are slightly lower than coffee beans with a moisture content of 12%, where the price difference is around IDR 500/kg. Based on the results of Listyati's study (2017), farmers sell coffee to collectors and wholesalers, and if the price in the market is not much different, farmers usually choose to sell to collector traders.

Regarding business investment feasibility, the ability of capital in coffee farming to generate income is 168 % for cherry coffee and 198 % for green bean coffee. This profitability value is very high compared with the small business loan interest rate at the farmer level. For example, Food and Energy Security Credit (*Kredit Ketahanan Pangan dan Energi* = KKPE) and People's Business Credit (*Kredit Usaha*

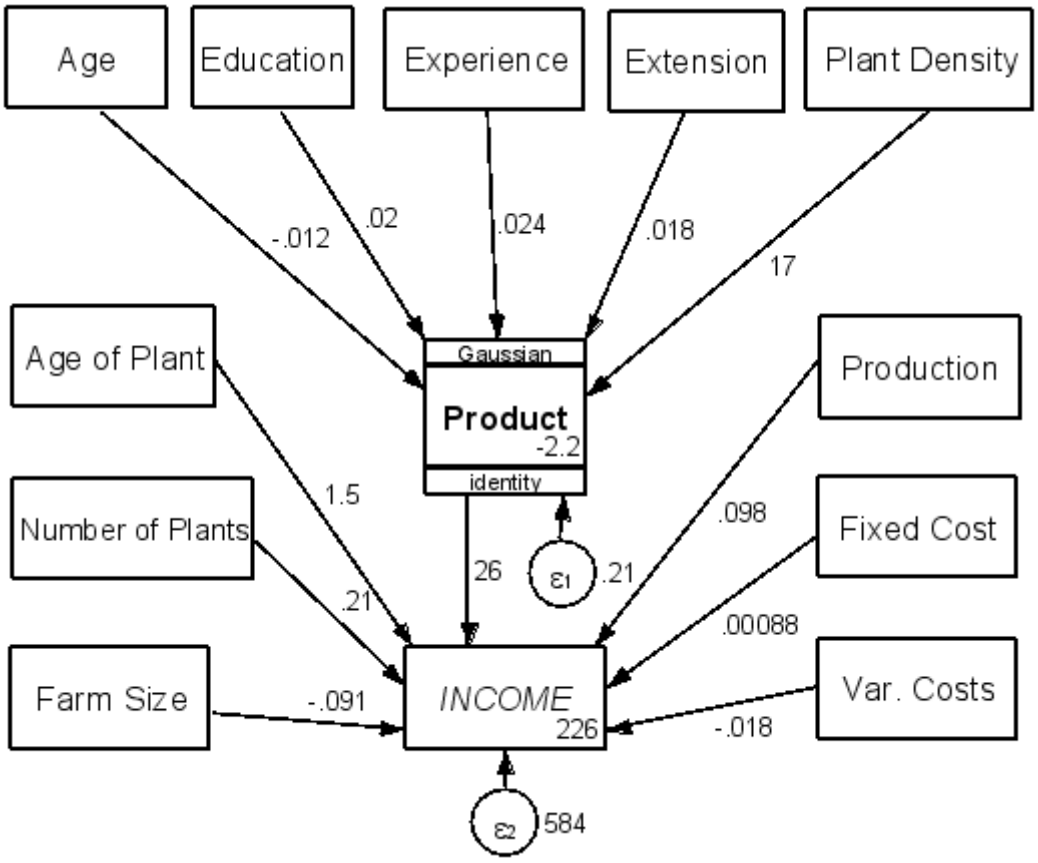
Rakyat = KUR) pegged interest rates ranging from 6% to 7 %. This means that agribusiness based on Robusta coffee, whose products are marketed in cherry coffee, is worth the effort

Despite farmer income is quite high, coffee farming is an estate crop that produces once or twice a year. This makes farmers wait for the harvest too long. Farmers need cash for daily life, and there is a risk of wasting money during the harvesting season. To guarantee sufficient cash for daily needs while waiting for coffee harvest, it needs to introduce seasonal cash crops in the community. Wijaya et al. (2021a; 2021b) show examples that vegetable cultivation helps farmer households increase income. Temanggung is hilly areas that fit for cultivating vegetables and other horticultural crops that are very feasible to cultivate. Another alternative is to integrate the coffee plantation with poultry farming that raise either chicken (Santoso et al., 2016; 2017) or duck (Setiadi et al., 2021) since such farming is also potentially generate cash in a relatively short. The farming can fill the gap in the harvesting seasons of coffee.

Factors determining income and products

Many factors influence the variation of income gained by farmers. Based on Figure 2, the farm size, age of coffee plants, production of coffee logs, fixed production costs, variable production costs, and the form of product simultaneously provide significant effects on the income of coffee farmers in the regions. At the same time, the form of the product was determined by personal characteristics of farmers, extension and density of the plant. The significance shows $p>\chi^2=0.000$, with an overall R^2 of 0.5906, which means that explanatory factors explained about 60% variation in farmer income; the rest were explained by other factors not included in the simultaneous regression equation model (Gujarati, 2012).

In partial analysis, it can be seen that farmers selling green bean coffee products received significantly higher income than those selling un-processed products. This advantage is robust since other confounding factors have controlled it. The high income from processed coffee is in line with Saragih (2019) results those farmers who carry out primary processing (processing red logs into un-hulled coffee) get higher income and are significantly different from farmers who sell red logs. For this reason, efforts are needed to motivate farmers to process their products into coffee beans to increase the added value of their farming. Other studies by Hariyati (2014), Saria and Fitria (2012) and Wahyu and Suwandari (2012) show that most farmers sell their produce in the form of ground coffee (bean coffee) to collector traders who have collaborated for a long time, while a small proportion of farmers sell in the form of coffee cherries.



Source: authors' analysis

Figure 2. Estimated model of farmer income in coffee farming

The age of coffee plants has a significant effect on the income, which means that the more mature coffee plant, the higher the income received by farmers. This condition implies that the longer the age of the coffee plant, the more it has a positive role in increasing production so that it will also affect the increase in income. This condition reflects that the average age of coffee plants in the regions was still productive, or it has not been required to regenerate plants.

The farm size has a significant effect and has a negative effect on the income, which means that extended farm size of coffee farming reduced the income. This phenomenon indicates that the farmers have reached peak capacity in managing the farm. It would be drudgery when the limited resources operate a large farm. Normatively, farm size represents the scale of the farm. It could also be the case that the density of plants is getting lower when the size of the farm increases. Although the size of a farm is large, the number of plants is almost the same. Another possible factor is that the plants in the extended farm were not in the productive stage; thus, the production was low, despite the large farm.

Table 2. Estimated coefficients and significance

Variables	Coefficients	Std. errors	z value	p>z
INCOME <-				
Constant	225.7	10.73	21.03	0.000
Product	26.40	8.685	3.04	0.002
Age of plant	1.548	0.349	4.44	0.000
Number of plants	0.207	0.121	1.72	0.088
Farm size	-0.091	0.026	-3.55	0.000

Production	0.098	0.013	7.59	0.000
Fixed cost	0.001	0.002	0.49	0.623
Var. costs	-0.018	0.007	-2.66	0.008
Product <-				
Constant	-2.246	1.255	-1.79	0.074
Age	-0.012	0.007	-1.70	0.090
Education	0.020	0.015	1.36	0.173
Experience	0.024	0.008	3.16	0.002
Extension	0.018	0.032	0.57	0.570
Plant density	16.78	7.888	2.13	0.033
# Observations	98			
Log-likelihood	-513.16			
LR test, χ^2 (23)	201.80	$p>\chi^2=0.000$		
Overall R2	0. 5906			

Source: authors' analysis

The number of plants shows a positive effect on the income. This indicates that the plants were in the production stages—this finding related to the fact that a large farm does not necessarily improve the income. The production level also has a significant effect on the income, which means that the production of coffee increases the income. This is also an obvious finding and co-inside with the number of plants that positively affect income. The higher the number of productive plants, the higher the production harvested by farmers. As the production significantly increases farmers' income, keeping the coffee in high productivity is necessary. The improvement of crop management can conduct it. The agronomic aspect and maintenance of coffee trees need to be conducted in a sustainable fashion to provide social benefits for both producers and consumers (Mariyono, 2009). Organic fertilisers can replace the inorganic ones, and botanical and biological pesticides can replace synthetic ones (Mariyono, 2020); crop protection can apply a concept of integrated pest management that can reduce chemical pesticides (Mariyono, 2008). Adoption of technology applicable to coffee farming has the potentials to improve income, and in this case, providing microfinance assistance to the farmers will catalyse the technology adoption (Mariyono, 2019a; 2019b). Soekartawi (2005) states that the level of technology application in agriculture is one factor that determines the level of production and income of agricultural businesses.

Fixed production costs have no significant effect on income. This means that regardless of the quantity of fixed production cost, it does not affect the income, as explained by the theory of production costs, that the amount of production costs remains independent of the amount of product. Variable production costs have a significant effect on income with a negative correlation. This condition occurs because the variable production costs positively correlate to the scale of farming or the amount of coffee production. However, if the increase in variable production costs is more significant than the increase in farm income, then the variable production costs negatively correlate with the income of coffee farmers.

From Figure 2 and Table 2, it can be seen that the farmers' intention to create a valued product in the form of green bean coffee depends on several factors. The age of farmers significantly reduced the intention of farmers to process further the harvested coffee bean into green bean form. This finding is reasonable since the post-harvest handling of coffee is drudgery, and it is pretty difficult for old farmers to do so. Education and experience significantly increased the farmers' intention to process the harvested coffee into green bean form, and so did the extension service.

Education and experience represent human capital or capacity in coffee-based agribusiness, and the extension service enhances the capacity. Concerning education, sending back to formal education might be effective to enhance the capacity; however, it was too late in the stage. Providing training with special topics for coffee will be helpful, like one for vegetable and rice farmers through special training (Mariyono, 2019c; 2020). Note that human capital improvement can lead to high motivation of farmers. Hariyati (2014) states that the highest driving factor in developing processed coffee products in Jember Regency is the high motivation of farmers.

Conclusions

Coffee farming has been widely grown in Indonesia. This crop is one of the commodities that has been internationally traded. The commercialisation of this crop leads to agricultural economic development in rural areas where farmer households cultivate the crop. The commercialisation at a household level, coffee farming becomes an income source for smallholder estate crops in Java, Indonesia. Coffee products' value chains, starting from farm production to end-users at coffee shops, have distributed considerable income for the marketing channels. Farmers as producers can get more income when they take one step of the chains by processing the products. This study concludes that shortsheeting one step of value chains by farmers improve farmers income considerably. The step is to process coffee cherry became green bean coffee before selling to the market. Other factors determining the income were the age of coffee plants, the number of plants, production quantity, operational costs, farm size. However, not all farmers did not take the opportunity to get the value. Personal characteristics, extension programme and density of crops led to different actions. Old farmers were reluctant to take the opportunity. Trained and educated farmers were enthusiastic about getting the value-added in the supply chain. The density of crops highly affected farmers to utilise the chance. This study recommends that policymakers intensify the extension services, particularly to encourage farmers to increase crop density. This action has double impacts on income and likelihood for farmers to process the coffee cherry to green bean coffee with high value in the market. Practically, the action can be conducted by the extension services at district levels to collaborate with seed agency at a provincial level that provides high-quality coffee seedlings; and engage the local universities that provide improved technology for coffee

farming. The extension services are expected to send the extensionist to training centres to enhance their capacity to assist farmers in operating coffee farming efficiently.

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Factors determining income and product type of Robusta coffee farming in Central Java, Indonesia

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Abstract
Coffee farmers in Central Java have widely cultivated Robusta cultivars. During the last decade, the demand for coffee has increased substantially. The coffee commodity is cultivated because of the high price, which potentially generates income for the farmers. The study aimed to analyse the farmers' income associated with the post-harvest processing and analyse the factors that affect the post-harvest processing from coffee farming in the Temanggung Regency. Primary data were obtained from direct interviews with 98 farmers running the coffee farming business. The results show that the product processed in green bean coffee boosted the farmers' income, and the socio-economic characteristics, extension service, and plan density influenced product processing. The confounding factors influencing the income were the farm size, the age of coffee plantations, production level, and the variable cost. It is recommended that farmers sell green bean coffee by intensifying extension services and increasing plant density.

1 | INTRODUCTION

Indonesia is one of the coffee producers in the world and has contributed significant market share. At a national level, the farm size of coffee plantations in Indonesia in 2015 has reached 1,230,001 ha. Smallholder farmers dominate the coffee plantation, with a total of up to 1.9 million farmers. Based on the farm size, around 1.2 million ha (96.16 per cent) is owned by farmers in rural areas, and the government manages 22.59 ha (1.8 per cent), and 25.54 ha (2.04 per cent) is owned by private companies (Directorate General of Plantation 2016a, 2016b).

The coffee plantation has roles as a source of income and job opportunity for people and is one of the sources of foreign exchange since coffee is exported to some extent. According to Directorate General of Plantation (2016a), coffee consumption in Indonesia in 2016 was 249,824 tons, and in 2021 it will be projected to increase by 48.06 per cent, which accounts for about 369,886 tons. The export of coffee plantations in Indonesia is the fourth largest export value, following rubber, palm oil, and cacao (Directorate General of Plantation 2017). In the last decade, the domestic demand for coffee has rapidly increased, especially as a raw material for a beverage. Coffee consumption has been seen as

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part of a lifestyle in people's social existence. The coffee price in Indonesia from 2014 to 2017 showed an increasing trend with an average of 4.80 per cent per year.

Temanggung district is one of the centres of coffee production and coffee processing in Central Java, especially Robusta coffee. Based on the Decree of the Ministry of agriculture No. 830 of 2016 about developing a centre for coffee plantations, Temanggung is predicted to be one of the centres of Indonesian coffee production. There are eight sub-districts in the area that have the potential to become centres for coffee production.

Temanggung is supported by its large land size and is highly favourable in agro-climate, especially for Robusta coffee plantations. The farm size and coffee production in the region has the highest coffee production in Central Java Province. An estimated total of 4,583 tons of Robusta coffee was produced, as there was 9,338 ha of coffee planted in the region. In comparison, the production of Robusta coffee in Central Java was 14,921 tons. It means that the region contributes around 30 per cent of Robusta coffee production in Central Java (Directorate General of Plantation 2017).

Based on post-harvest handling carried out by the farmers, coffee products in Temanggung could be categorised into raw coffee fruit (cherry coffee) and green bean coffee. The processing into green beans is the first stage process carried out by farmers. According to Listiyaningsih et al. (2019), there would be value-added obtained by the farmers by selling their coffee into green beans compared to farmers selling their coffee in the form of cherries. Farmers not only get benefits from their increasing income, but they can also have maximised added value by using waste from coffee plantations for organic fertiliser. Farmers also utilise residue from post-harvest processing as animal feed. Improving the value-added of coffee in different products theoretically would influence the price and farmers' incomes. Moreover, increasing farmers' incomes will motivate the farmers to focus and sustain their coffee plantations.

This research was conducted to analyse the income effect of post-harvest processing from freshly harvested coffee into green bean coffee and analyse the factors influencing farmers' intention to conduct the post-harvest handling in Temanggung Regency, Central Java, Indonesia. This study is expected to benefit farmers by increasing income, the policymakers by formulating appropriate and practical actions related to the market orientation of the coffee industry, and researchers by exploring scientific information or providing a reference for further studies, especially in developing a strategy for the development of the Robusta coffee industry.

1.1 | Literature review

Coffee is one of the commodities globally traded. At a global level, Richards and Smith (2015) reveal that the coffee industry undergoes booming and has escalated more recently because of its enormous popularity and consumption. ICO (2020) reports that the international export and the total consumption worldwide increased from 83.8 million gunnies in October 2019 to 168.5 million gunnies in May 2020 (a gunny is equivalent to 60 kg). It has become one of the foremost consumed products in modern life and has become the second most popular beverage (Bae et al. 2014; Esquivel and Jiménez 2012; Farah 2012). It has flourished and prospered worldwide since it was discovered initially in Ethiopia, absconding the people who hanker for the product (Flamen 1989; Smith 1985). The high demand for coffee makes the coffee-based business profit-making (Hameed et al. 2018).

Coffee production is one of the businesses that is currently growing over the globe. Studies on the coffee business have been carried out by researchers such as Geibler et al. (2016) and Mishra (2013) that show promising prospects. Farming based on the coffee plantation is also a vital economic production in many developing countries (Daviron and Ponte 2005). In Colombia, the commodity is the most important exported agricultural product for the country's economy, in which Colombian coffee production in 2019 generated approximately 2.7 billion USD (OEC 2020).

The commercialisation of agriculture is the key to success in economic development. In the decentralised period (Sasana and Nugroho 2018) it helps local governments reduce rural poverty.

Commercialisation can be conducted by intensifying the farm. In vegetable production, for example, changing from subsistence to profit-oriented farming can happen because of the adoption of technology at the farm (Mariyono 2019a), and the result is the improvement of rural prosperity (Mariyono 2019b; Weatherspoon et al. 2021). In general, growing smallholder coffee commercialisation becomes a viable pathway for agricultural economic development in coffee-growing areas (Gebreselassie and Ludi 2007).

The success of the coffee agribusiness starts with a good business model that pays attention to the value chain (Mishra 2013). Ferreira et al. (2021) stated that going to a coffee shop is a lifestyle for people in urban areas. A good coffee business with respect to the value chain will generate high profits. Lee and Bateman (2021) state that organic coffee is now gaining more attention in the international coffee business than conventional ones. Currently, both Robusta and Arabica coffee are developed organically for high profit.

At the farm level, the primary constraint of coffee-based agribusiness is the long marketing channel of coffee. There are many players in the value chains of coffee that reduce profit gained by farmers. Ahmad et al. (2019) show that farmers in East Java Indonesia gained the lowest profit share in the marketing channel. Ntimbaa and Akyoob (2017) show broad variations of farmgate prices among farmers selling in different market channels. Three factors significantly influenced the farmer's marketing channel choice: the price of coffee, farmer's age, and distance to the selling centre from the farmstead. This condition is similar to commercial vegetable farming, where farmers get a small fraction of their profit (Mariyono et al. 2020). Restructuring farmer cooperatives, providing formal credit facilities to provide favourable credit to farmers, and establishing more rural primary cooperative and private coffee buying centres in remote villages to reduce transportation costs will benefit the farmers.

Smallholders produce around 90 per cent of coffee in some countries (Velez-Vallejo 2018). This condition makes the farmers sensitive to economic shocks. For instance, coffee bean prices sharply dropped during the coffee crisis of the late 1990s, which sank from around US$1.50 per pound in 1997 to about one-third of that amount in 2001 (Taylor 2007) because of oversupply (Ponte 2001). Another shock comes from a natural situation. Harvey et al. (2018) report that climate change is already causing significant adverse impacts on smallholder coffee farmers across the Central American region.

Consequently, most small-scale coffee farmers have difficulties making a decent living due to low coffee prices, high production costs, and climate variability, among other factors (Berdegué and Fuentealba 2014). Therefore, estimation of coffee profitability is essential for sustainable farming systems and the wider coffee industry. Furthermore, estimating profitability continues to be a research challenge due to a lack of adequate tools adapted to specific characteristics of small-scale crop production in developing countries. Small-scale coffee farms in developing countries do not have information systems with accurate data on their agricultural micro-economic activities (Poole 2017). Furthermore, the omission of relevant information in estimating profitability results in values far from reality (Giovannucci and Koekoek 2007; Kilian et al. 2006). This current paper is expected to fill the gap.

2 | RESEARCH METHODOLOGY

The study was conducted in Temanggung Regency. Temanggung Regency has been purposively selected; the region is one the largest centres of production and processing of Robusta coffee in Central Java Province. Study sites were purposively determined in three main sub-districts: Gemawang, Candiroto, and Kandangan. The study was carried from November 2018 to January 2019.

A survey method was used in this research. The research was conducted by taking the sample from a population and developed a questionnaire as the primary data collecting instrument. The respondents of Robusta coffee farmers were determined by a three-stage cluster random sampling method: (i) Determining sub-districts. This was based on the largest Robusta coffee production in Temanggung Regency, namely Gemawang, Candiroto, and Kandangan sub-districts; (ii) Determining sample of villages. Two villages were selected from each sub-district with the largest Robusta coffee

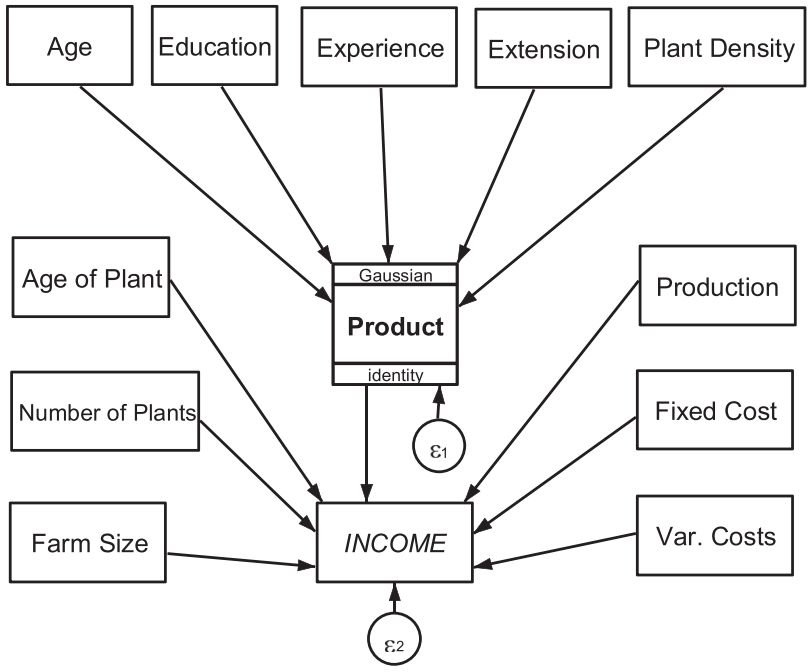

FIGURE 1 Analytical model of farmer income in coffee farming

production: Gemawang and Kemiriombo village, Muneng and Plosogaden village, and Blimbing and Gesing village; (iii) Determining the number of Robusta coffee farmers. Respondents were calculated based on Slovin's formula of determining the number of samples. There were 98 sampled farmers obtained from a 4,653 population of Robusta coffee farmers in Temanggung Regency. The 98 farmers were distributed in six regions of Gemawang village (36 farmers), Kemiriombo village (21 farmers), Muneng village (eight farmers), Plosogaden village (11 farmers), Blimbing village (four farmers), and Gesing village (18 farmers).

The primary data used in this research were collected from Robusta coffee farmers by interviewing selected farmers based on the questionnaire. The information included cost analysis, price of production input, and the price of output production based on the post-harvesting product (cherry coffee and green bean coffee). This study employed a data analysis method of quantitative comparison and causality approaches. The comparison analysis was conducted to compare the financial aspects of coffee farming of two different product types. Following a standard procedure of statistical mean comparison, the mean of each financial aspect was tested using independent sample t-test analysis, which was hypothesised as follows.

$$\mathrm{H}_0 : \mu E_{GB} - \mu E_{CC} = 0$$

$$\mathrm{H}_1 : \mu E_{GB} - \mu E_{CC} \neq 0$$

where μ represents mean, E_{CG} represents the financial aspects of green bean coffee, and E_{CC} represents the coffee cherry.

The quantitative causality was approached using recursive path linear regression, as explained in Figure 1. The model explains that farmers' income is mainly affected by product type, and farmers' characteristics influence the product type. Other technical and economic factors are considered as confounding variables controlling the robustness of the effect.

In mathematical terms, the analytical model can be simultaneously expressed as follows.

$$Y_2 = \alpha_0 + \sum_{i=1}^{6} \alpha_i X_i + \alpha_7 Y_1 + \varepsilon_2 \quad (1)$$

$$Y_1 \begin{cases} 1 \\ 0 \end{cases} = \beta_0 + \sum_{j=1}^{5} \beta_j Z_j + \varepsilon_1 \quad (2)$$

where Y_2 is farmers income (IDR/year); X_i for I = 1…6 is age of plant (year), number plants (unit), farm size (ha), production (kg/year), fixed cost (IDR/year), and variable cost (IDR/year); Y_1 is product type (1: green bean coffee, 0: otherwise); Z_j for j = 1…5 is farmer age (year), farmer education (year), farmer experience (year), extension (times); plant density (tree/ha); α_i and β_j are coefficients to be estimated; ε_1 and ε_2 are error terms. Equation (1) represents the linear multiple regression model, and Equation (2) represents the logit regression model.

Hypotheses of the analytical model to be tested can be expressed as follows.

$$H_0 : \alpha_i = \beta_j = 0$$

$$H_1 : H_0 \text{ is no true}$$

The analytical model was estimated using generalised structural equation modelling (GSEM) provided in STATA ver. 13 (StataCorp 2013). The use of GSEM can eliminate heteroskedasticity due to binary dependent variables (Verbeek 2003). All hypotheses were tested with at least a 90 per cent confidence interval. The goodness of fit measures associated with the estimation were provided to show the robustness.

3 | RESULTS AND DISCUSSION

3.1 | Harvesting coffee

Farmers in Temanggung usually harvest Robusta coffee in terms of cherry coffee from July to August every year. The standard measure for coffee maturity is marked by a change in the colour of the coffee fruit skin from green to red or reddish yellow. However, some coffee farmers harvest their coffee when it is not entirely ripe because of several factors. The main factor is the urgent economic needs of the family.

Harvesting mature coffee has the following advantages: (i) coffee is easy to process because the skin is easy to peel off; (ii) the ratio of the weight of coffee beans to the weight of fresh coffee is higher; (iii) the coffee beans are pithier so that the bean size is big; (iv) fast coffee drying time; (v) good physical quality and flavour. Harvesting unripe coffee (yellow), overripe coffee (black fruit), or unhealthy conditions will cause the coffee beans to have low physical quality, and the taste is unfavourable.

The coffee marketed by farmers based on post-harvest handling (shape) can be classified into two types: cherries and green beans. Marketing in the form of coffee logs if the coffee fruit is not subject to post-harvest handling, or in other words, after harvesting, it can be directly marketed to buyers, who are generally collector traders. Meanwhile, the marketing of coffee in the form of coffee beans is carried out by farmers when there is post-harvest processing. Processing of coffee from coffee cherries into green bean coffee is conducted by dry processing.

Coffee farmers mostly carry out the dry processing process because the farmer capacity is small. It is easy to do even though it only uses simple equipment. In dry processing, after the coffee fruit

TABLE 1 Average values of financial coffee farming aspects

Items	IDR/ha		
	Cherry coffee	**Green coffee**	**Gap**
Fixed cost:			
• Building Tax	90,278	90,707	429
• Land rent	4,242,500	4,238,981	–3,519
• Depreciation	1,554,763	1,553,946	–816
Sub total	5,887,543	5,883,635	–3,908
Variable cost:			
• Manure	336,680	199,154	–137,527*
• NPK fertiliser	783,929	810,526	26,597
• SP-36 fertiliser	412,769	412,085	–683
• Urea fertiliser	739,190	710,185	–29,005
• Fertilisation labour	798,661	797,920	–740
• Weeding labour	1,197,512	1,186,483	–11,028
• Pruning labour	1,974,175	1,980,506	6,331
• Harvesting labour	4,059,300	4,350,715	291,415*
• Bean processing labour	0	1,964,680	1,964,680*
Sub total	10,302,224	12,412,259	2,110,036*
Total cost	16,189,767	18,295,894	2,106,128*
Revenue	43,478,718	54,559,770	11,081,053*
Net revenue	27,288,949	36,263,874	8,974,925*

Source: authors' analysis; Note: *) denotes significant difference at 0.05.

is harvested, it is dried immediately. The coffee fruit must be dried immediately to avoid undergoing chemical processes that can reduce product quality. Peeling the fruit's flesh, peeling the horn skin, and peeling the epidermis are carried out after the coffee becomes dry. Peeling the dry coffee fruit skin aims to separate the coffee beans from the fruit skin, horn skin, and epidermis. Peeling the horn skin uses a pulper and strips the epidermis using a huller. This condition is in line with Najiyati and Danarti (2006), who state that the difference between dry processing and wet processing is the treatment using water. Wet processing uses water to peel and wash the coffee cherries, while dry processing after the coffee cherries are harvested immediately dries and then strips the cherries.

3.2 | Financial aspects

The different forms of coffee marketed by farmers have different consequences for post-harvest processing costs. Farmers who market in the form of coffee beans have higher variable costs than farmers who market in the form of coffee cherries. The financial aspects of coffee farming per one hectare basis are presented in Table 1.

Table 1 compares the financial aspects between cherry coffee and green bean coffee management. Mostly, there are no significant differences in general aspects of farm management. The significant

aspects related to harvesting and post-harvest handling where farmers conducting bean processing spent extra labour costs are shown. Post-harvest processing costs refer to labour costs for drying and milling or stripping the coffee skin. However, the post-harvest handling resulted in higher revenue than the counterparts and improved net revenue significantly. The farmers producing green bean coffee enjoyed about 33 per cent higher than those who sold cherry coffee.

Another significant gap is the cost of manure, where farmers producing green bean coffee applied less manure than their counterparts. This is because the farmers have not done fertilisation optimally according to the recommendations. Based on the recommendations from related technical agencies, the dosage of manure use for mature coffee plants is 14,000 kg/ha/year, but coffee farmers in the regions only applied manure for an average of 587 kg/ha/year. This is due to the lack of manure availability in the coffee farming area and the relative lack of understanding of farmers about the benefits of organic fertilisers for the coffee production process.

The production of coffee for each farmer was different. This is due partly to the different scales of coffee farming, the coffee plants' age, and the varying care of coffee plants. Coffee prices varied due to the different forms of coffee marketed, the quality of the coffee, and the different marketing channels chosen by farmers. Farmers who marketed their coffee products in the form of green beans enjoyed a higher average price than farmers who marketed their coffee in the form of cherry coffee, which accounted for IDR 25,688.60/kg of green beans coffee and IDR 5,443.90/kg for cherry coffee. The farmers in the regions marketed coffee in the form of green beans to collectors, wholesalers, and coffee producers. Cherry coffee was marketed only to coffee collectors and artisans because large traders generally only accepted coffee in the form of coffee beans.

The quality of coffee also affects the marketing price of Robusta coffee. For example, coffee beans with a moisture content above 12 per cent are slightly lower than coffee beans with a moisture content of 12 per cent, where the price difference is around IDR 500/kg. Based on the results of Listyati et al. (2017), farmers sell coffee to collectors and wholesalers, and if the price in the market is not much different, farmers usually choose to sell to collector traders.

Regarding business investment feasibility, the ability of capital in coffee farming to generate income is 168 per cent for cherry coffee and 198 per cent for green bean coffee. This profitability value is very high compared with the small business loan interest rate at the farmer level. For example, Food and Energy Security Credit (*Kredit Ketahanan Pangan dan Energi* = KKPE) and People's Business Credit (*Kredit Usaha Rakyat* = KUR) pegged interest rates ranging from 6 per cent to 7 per cent. This means that agribusiness based on Robusta coffee, whose products are marketed as cherry coffee, is worth the effort

Despite farmer income being quite high, coffee farming is an estate crop that produces once or twice a year. This makes farmers wait for harvest too long. Farmers need cash for daily life, and there is a risk of wasting money during the harvesting season. To guarantee sufficient cash for daily needs while waiting for coffee harvest, seasonal cash crops need to be introduced in the community. Wijaya et al. (2021a, 2021b) show examples that vegetable cultivation helps farmer households increase income. Temanggung is a hilly area that is fit for cultivating vegetables and other horticultural crops. Another alternative is to integrate the coffee plantation with poultry farming of either chickens (Santoso et al., 2016, 2017) or ducks (Setiadi et al., 2021) since such farming can also potentially generate cash in a relatively short time. This farming can fill the gap in the harvesting seasons of coffee.

3.3 | Factors determining income and products

Many factors influence the variation of income gained by farmers. Based on Figure 2, the farm size, age of coffee plants, production of coffee logs, fixed production costs, variable production costs, and the form of product simultaneously provide significant effects on the income of coffee farmers in the regions. At the same time, the form of the product was determined by personal characteristics of farmers, extension and density of the plant. The significance shows $p > \chi^2 = 0.000$, with an overall

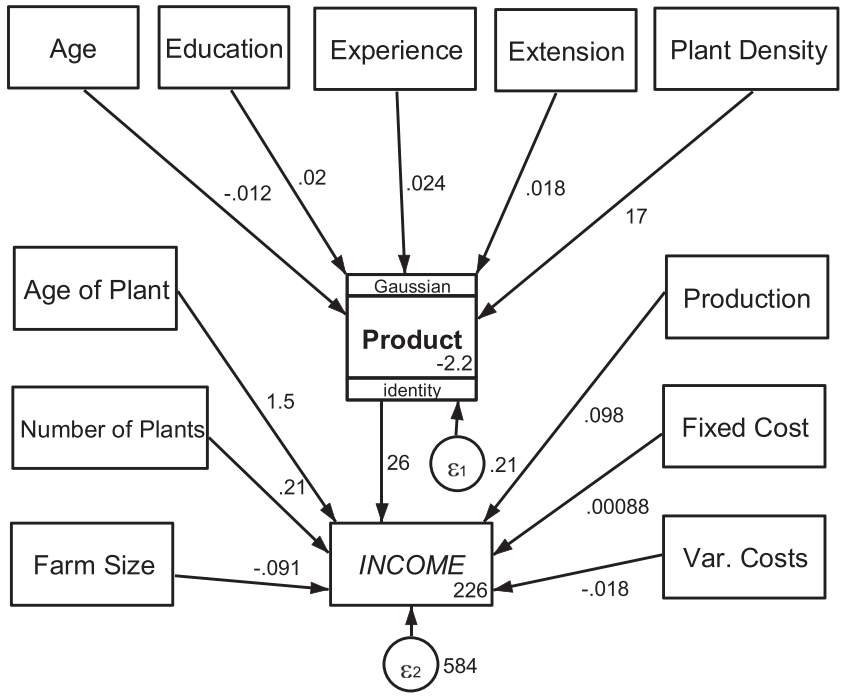

FIGURE 2 Estimated model of farmer income in coffee farming
Source: Authors' analysis.

R^2 of 0.5906, which means that explanatory factors explained about 60 per cent variation in farmer income; the rest were explained by other factors not included in the simultaneous regression equation model (Gujarati 2012).

In partial analysis, it can be seen that farmers selling green bean coffee products received significantly higher income than those selling un-processed products. This advantage is robust since other confounding factors have controlled it. The high income from processed coffee is in line with Saragih's (2019) results, that those farmers who carry out primary processing (processing red logs into un-hulled coffee) get higher income and are significantly different from farmers who sell red logs. For this reason, efforts are needed to motivate farmers to process their products into coffee beans to increase the added value of their farming. Other studies by Hariyati (2014), Saria and Fitria (2018), and Wahyu and Suwandari (2012) show that most farmers sell their produce in the form of ground coffee (bean coffee) to collector traders who have collaborated for a long time, while a small proportion of farmers sell in the form of coffee cherries.

The age of coffee plants has a significant effect on the income, which means that the more mature a coffee plant, the higher the income received by farmers. This condition implies that the longer the age of the coffee plant, the more it has a positive role in increasing production so it will also affect the increase in income. This condition reflects that the average age of coffee plants in the regions was still productive, or it has not been required to regenerate plants.

The farm size has a significant effect and has a negative effect on the income, which means that extended farm size of coffee farming reduced the income. This phenomenon indicates that the farmers have reached peak capacity in managing the farm. It would be drudgery when the limited resources operate a large farm. Normatively, farm size represents the scale of the farm. It could also be the case that the density of plants is getting lower when the size of the farm increases. Although the size of a farm is large, the number of plants is almost the same. Another possible factor is that the plants in

the extended farm were not in the productive stage; thus, the production was low, despite the large farm.

The number of plants shows a positive effect on the income. This indicates that the plants were in the production stages – this finding related to the fact that a large farm does not necessarily improve the income. The production level also has a significant effect on the income, which means that the production of coffee increases the income. This is also an obvious finding and coexists with the number of plants that positively affect income. The higher the number of productive plants, the higher the production harvested by farmers. As the production significantly increases farmers' income, keeping the coffee in high productivity is necessary. The improvement of crop management can conduct it. The agronomic aspect and maintenance of coffee trees need to be conducted in a sustainable fashion to provide social benefits for both producers and consumers (Mariyono 2009). Organic fertilisers can replace the inorganic ones, and botanical and biological pesticides can replace synthetic ones (Mariyono 2020); crop protection can apply a concept of integrated pest management that can reduce chemical pesticides (Mariyono 2008). Adoption of technology applicable to coffee farming has the potentials to improve income, and in this case providing microfinance assistance to the farmers will catalyse the technology adoption (Mariyono 2019a, 2019b). Soekartawi (2005) states that the level of technology application in agriculture is one factor that determines the level of production and income of agricultural businesses.

Fixed production costs have no significant effect on income. This means that regardless of the quantity of fixed production cost, it does not affect the income, as explained by the theory of production costs, that the amount of production costs remains independent of the amount of product. Variable production costs have a significant effect on income with a negative correlation. This condition occurs because the variable production costs positively correlate to the scale of farming or the amount of coffee production. However, if the increase in variable production costs is more significant than the increase in farm income, then the variable production costs negatively correlate with the income of coffee farmers.

From Figure 2 and Table 2, it can be seen that the farmers' intention to create a valued product in the form of green bean coffee depends on several factors. The age of farmers significantly reduced the intention of farmers to process further with the harvested coffee bean into green bean form. This finding is reasonable since the post-harvest handling of coffee is drudgery, and it is pretty difficult for old farmers. Education and experience significantly increased the farmers' intention to process the harvested coffee into green bean form, and so did the extension service.

Education and experience represent human capital or capacity in coffee-based agribusiness, and the extension service enhances the capacity. Concerning education, going back to formal education might be effective to enhance the capacity; however, it was too late in the stage. Providing training with special topics for coffee will be helpful, like one for vegetable and rice farmers through special training (Mariyono 2019c, 2020). Note that human capital improvement can lead to high motivation of farmers. Hariyati (2014) states that the highest driving factor in developing processed coffee products in Jember Regency is the high motivation of farmers.

4 | CONCLUSIONS

Coffee farming has been widely grown in Indonesia. This crop is one of the commodities that has been internationally traded. The commercialisation of this crop leads to agricultural economic development in rural areas where farmer households cultivate the crop. With the commercialisation happening at a household level, coffee farming becomes an income source for smallholder estate crops in Java, Indonesia. The value chains of coffee products, starting from farm production to end-users at coffee shops, have distributed considerable income for the marketing channels. Farmers as producers can get more income when they take one step off the chain by processing the products. This study concludes that shortsheeting one step of value chains by farmers improves farmers income

TABLE 2 Estimated coefficients and significance

Variables	Coefficients	Std. errors	z value	p > z
INCOME ←				
Constant	225.7	10.73	21.03	0.000
Product	26.40	8.685	3.04	0.002
Age of plant	1.548	0.349	4.44	0.000
Number of plants	0.207	0.121	1.72	0.088
Farm size	–0.091	0.026	–3.55	0.000
Production	0.098	0.013	7.59	0.000
Fixed cost	0.001	0.002	0.49	0.623
Var. costs	–0.018	0.007	–2.66	0.008
Product ←				
Constant	–2.246	1.255	–1.79	0.074
Age	–0.012	0.007	–1.70	0.090
Education	0.020	0.015	1.36	0.173
Experience	0.024	0.008	3.16	0.002
Extension	0.018	0.032	0.57	0.570
Plant density	16.78	7.888	2.13	0.033
# Observations	98			
Log-likelihood	–513.16			
LR test, χ^2 (23)	201.80	$p > \chi^2 = 0.000$		
Overall R2	0. 5906			

Source: authors' analysis.

considerably. The step is to process coffee cherry into green bean coffee before selling to the market. Other factors determining the income were the age of coffee plants, the number of plants, production quantity, operational costs, farm size. However, not all farmers did not take the opportunity to increase value. Personal characteristics, extension programme, and density of crops led to different actions. Old farmers were reluctant to take the opportunity. Trained and educated farmers were enthusiastic about getting the value-added in the supply chain. The density of crops highly affected farmers to utilise the chance. This study recommends that policymakers intensify the extension services, particularly to encourage farmers to increase crop density. This action has double impacts on income and likelihood for farmers to process the coffee cherry to green bean coffee with high value in the market. Practically, the action can be conducted by the extension services at district levels to collaborate with seed agency at a provincial level that provides high-quality coffee seedlings and engage the local universities that provide improved technology for coffee farming. The extension services are expected to make the extensionist training centres enhance their capacity to assist farmers in operating coffee farming efficiently.

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DATA AVAILABILITY STATEMENT

The author has provided the required Data Availability Statement, and if applicable, included functional and accurate links to said data therein.

PEER REVIEW

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OPEN FORUM

Factors determining income and product type of Robusta coffee farming in Central Java, Indonesia

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Abstract
Coffee farmers in Central Java have widely cultivated Robusta cultivars. During the last decade, the demand for coffee has increased substantially. The coffee commodity is cultivated because of the high price, which potentially generates income for the farmers. The study aimed to analyse the farmers' income associated with the post-harvest processing and analyse the factors that affect the post-harvest processing from coffee farming in the Temanggung Regency. Primary data were obtained from direct interviews with 98 farmers running the coffee farming business. The results show that the product processed in green bean coffee boosted the farmers' income, and the socio-economic characteristics, extension service, and plan density influenced product processing. The confounding factors influencing the income were the farm size, the age of coffee plantations, production level, and the variable cost. It is recommended that farmers sell green bean coffee by intensifying extension services and increasing plant density.

1 | INTRODUCTION

Indonesia is one of the coffee producers in the world and has contributed significant market share. At a national level, the farm size of coffee plantations in Indonesia in 2015 has reached 1,230,001 ha. Smallholder farmers dominate the coffee plantation, with a total of up to 1.9 million farmers. Based on the farm size, around 1.2 million ha (96.16 per cent) is owned by farmers in rural areas, and the government manages 22.59 ha (1.8 per cent), and 25.54 ha (2.04 per cent) is owned by private companies (Directorate General of Plantation 2016a, 2016b).

The coffee plantation has roles as a source of income and job opportunity for people and is one of the sources of foreign exchange since coffee is exported to some extent. According to Directorate General of Plantation (2016a), coffee consumption in Indonesia in 2016 was 249,824 tons, and in 2021 it will be projected to increase by 48.06 per cent, which accounts for about 369,886 tons. The export of coffee plantations in Indonesia is the fourth largest export value, following rubber, palm oil, and cacao (Directorate General of Plantation 2017). In the last decade, the domestic demand for coffee has rapidly increased, especially as a raw material for a beverage. Coffee consumption has been seen as

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part of a lifestyle in people's social existence. The coffee price in Indonesia from 2014 to 2017 showed an increasing trend with an average of 4.80 per cent per year.

Temanggung district is one of the centres of coffee production and coffee processing in Central Java, especially Robusta coffee. Based on the Decree of the Ministry of agriculture No. 830 of 2016 about developing a centre for coffee plantations, Temanggung is predicted to be one of the centres of Indonesian coffee production. There are eight sub-districts in the area that have the potential to become centres for coffee production.

Temanggung is supported by its large land size and is highly favourable in agro-climate, especially for Robusta coffee plantations. The farm size and coffee production in the region has the highest coffee production in Central Java Province. An estimated total of 4,583 tons of Robusta coffee was produced, as there was 9,338 ha of coffee planted in the region. In comparison, the production of Robusta coffee in Central Java was 14,921 tons. It means that the region contributes around 30 per cent of Robusta coffee production in Central Java (Directorate General of Plantation 2017).

Based on post-harvest handling carried out by the farmers, coffee products in Temanggung could be categorised into raw coffee fruit (cherry coffee) and green bean coffee. The processing into green beans is the first stage process carried out by farmers. According to Listiyaningsih et al. (2019), there would be value-added obtained by the farmers by selling their coffee into green beans compared to farmers selling their coffee in the form of cherries. Farmers not only get benefits from their increasing income, but they can also have maximised added value by using waste from coffee plantations for organic fertiliser. Farmers also utilise residue from post-harvest processing as animal feed. Improving the value-added of coffee in different products theoretically would influence the price and farmers' incomes. Moreover, increasing farmers' incomes will motivate the farmers to focus and sustain their coffee plantations.

This research was conducted to analyse the income effect of post-harvest processing from freshly harvested coffee into green bean coffee and analyse the factors influencing farmers' intention to conduct the post-harvest handling in Temanggung Regency, Central Java, Indonesia. This study is expected to benefit farmers by increasing income, the policymakers by formulating appropriate and practical actions related to the market orientation of the coffee industry, and researchers by exploring scientific information or providing a reference for further studies, especially in developing a strategy for the development of the Robusta coffee industry.

1.1 | Literature review

Coffee is one of the commodities globally traded. At a global level, Richards and Smith (2015) reveal that the coffee industry undergoes booming and has escalated more recently because of its enormous popularity and consumption. ICO (2020) reports that the international export and the total consumption worldwide increased from 83.8 million gunnies in October 2019 to 168.5 million gunnies in May 2020 (a gunny is equivalent to 60 kg). It has become one of the foremost consumed products in modern life and has become the second most popular beverage (Bae et al. 2014; Esquivel and Jiménez 2012; Farah 2012). It has flourished and prospered worldwide since it was discovered initially in Ethiopia, absconding the people who hanker for the product (Flamen 1989; Smith 1985). The high demand for coffee makes the coffee-based business profit-making (Hameed et al. 2018).

Coffee production is one of the businesses that is currently growing over the globe. Studies on the coffee business have been carried out by researchers such as Geibler et al. (2016) and Mishra (2013) that show promising prospects. Farming based on the coffee plantation is also a vital economic production in many developing countries (Daviron and Ponte 2005). In Colombia, the commodity is the most important exported agricultural product for the country's economy, in which Colombian coffee production in 2019 generated approximately 2.7 billion USD (OEC 2020).

The commercialisation of agriculture is the key to success in economic development. In the decentralised period (Sasana and Nugroho 2018) it helps local governments reduce rural poverty.

Commercialisation can be conducted by intensifying the farm. In vegetable production, for example, changing from subsistence to profit-oriented farming can happen because of the adoption of technology at the farm (Mariyono 2019a), and the result is the improvement of rural prosperity (Mariyono 2019b; Weatherspoon et al. 2021). In general, growing smallholder coffee commercialisation becomes a viable pathway for agricultural economic development in coffee-growing areas (Gebreselassie and Ludi 2007).

The success of the coffee agribusiness starts with a good business model that pays attention to the value chain (Mishra 2013). Ferreira et al. (2021) stated that going to a coffee shop is a lifestyle for people in urban areas. A good coffee business with respect to the value chain will generate high profits. Lee and Bateman (2021) state that organic coffee is now gaining more attention in the international coffee business than conventional ones. Currently, both Robusta and Arabica coffee are developed organically for high profit.

At the farm level, the primary constraint of coffee-based agribusiness is the long marketing channel of coffee. There are many players in the value chains of coffee that reduce profit gained by farmers. Ahmad et al. (2019) show that farmers in East Java Indonesia gained the lowest profit share in the marketing channel. Ntimbaa and Akyoob (2017) show broad variations of farmgate prices among farmers selling in different market channels. Three factors significantly influenced the farmer's marketing channel choice: the price of coffee, farmer's age, and distance to the selling centre from the farmstead. This condition is similar to commercial vegetable farming, where farmers get a small fraction of their profit (Mariyono et al. 2020). Restructuring farmer cooperatives, providing formal credit facilities to provide favourable credit to farmers, and establishing more rural primary cooperative and private coffee buying centres in remote villages to reduce transportation costs will benefit the farmers.

Smallholders produce around 90 per cent of coffee in some countries (Velez-Vallejo 2018). This condition makes the farmers sensitive to economic shocks. For instance, coffee bean prices sharply dropped during the coffee crisis of the late 1990s, which sank from around US$1.50 per pound in 1997 to about one-third of that amount in 2001 (Taylor 2007) because of oversupply (Ponte 2001). Another shock comes from a natural situation. Harvey et al. (2018) report that climate change is already causing significant adverse impacts on smallholder coffee farmers across the Central American region.

Consequently, most small-scale coffee farmers have difficulties making a decent living due to low coffee prices, high production costs, and climate variability, among other factors (Berdegué and Fuentealba 2014). Therefore, estimation of coffee profitability is essential for sustainable farming systems and the wider coffee industry. Furthermore, estimating profitability continues to be a research challenge due to a lack of adequate tools adapted to specific characteristics of small-scale crop production in developing countries. Small-scale coffee farms in developing countries do not have information systems with accurate data on their agricultural micro-economic activities (Poole 2017). Furthermore, the omission of relevant information in estimating profitability results in values far from reality (Giovannucci and Koekoek 2007; Kilian et al. 2006). This current paper is expected to fill the gap.

2 | RESEARCH METHODOLOGY

The study was conducted in Temanggung Regency. Temanggung Regency has been purposively selected; the region is one the largest centres of production and processing of Robusta coffee in Central Java Province. Study sites were purposively determined in three main sub-districts: Gemawang, Candiroto, and Kandangan. The study was carried from November 2018 to January 2019.

A survey method was used in this research. The research was conducted by taking the sample from a population and developed a questionnaire as the primary data collecting instrument. The respondents of Robusta coffee farmers were determined by a three-stage cluster random sampling method: (i) Determining sub-districts. This was based on the largest Robusta coffee production in Temanggung Regency, namely Gemawang, Candiroto, and Kandangan sub-districts; (ii) Determining sample of villages. Two villages were selected from each sub-district with the largest Robusta coffee

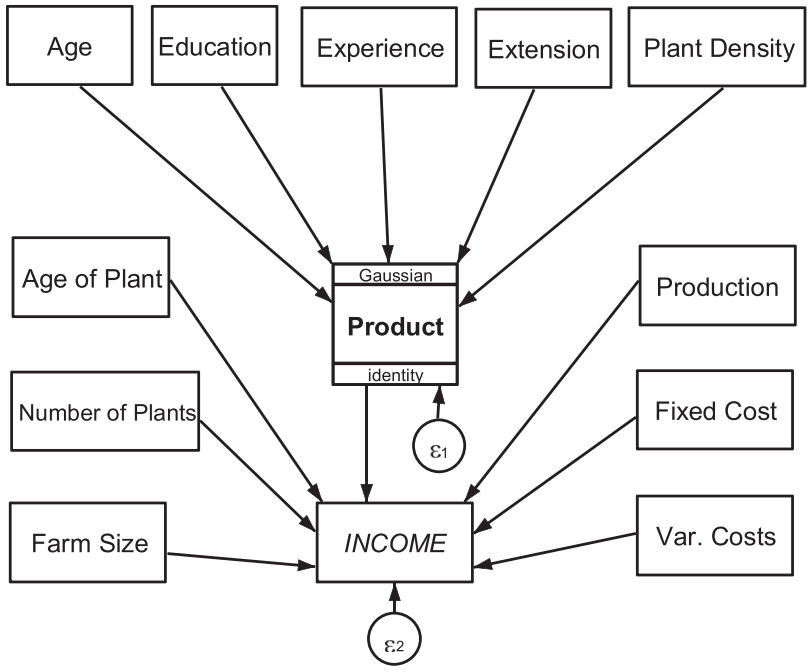

FIGURE 1 Analytical model of farmer income in coffee farming

production: Gemawang and Kemiriombo village, Muneng and Plosogaden village, and Blimbing and Gesing village; (iii) Determining the number of Robusta coffee farmers. Respondents were calculated based on Slovin's formula of determining the number of samples. There were 98 sampled farmers obtained from a 4,653 population of Robusta coffee farmers in Temanggung Regency. The 98 farmers were distributed in six regions of Gemawang village (36 farmers), Kemiriombo village (21 farmers), Muneng village (eight farmers), Plosogaden village (11 farmers), Blimbing village (four farmers), and Gesing village (18 farmers).

The primary data used in this research were collected from Robusta coffee farmers by interviewing selected farmers based on the questionnaire. The information included cost analysis, price of production input, and the price of output production based on the post-harvesting product (cherry coffee and green bean coffee). This study employed a data analysis method of quantitative comparison and causality approaches. The comparison analysis was conducted to compare the financial aspects of coffee farming of two different product types. Following a standard procedure of statistical mean comparison, the mean of each financial aspect was tested using independent sample t-test analysis, which was hypothesised as follows.

$$\mathrm{H}_0 : \mu E_{GB} - \mu E_{CC} = 0$$

$$\mathrm{H}_1 : \mu E_{GB} - \mu E_{CC} \neq 0$$

where μ represents mean, E_{CG} represents the financial aspects of green bean coffee, and E_{CC} represents the coffee cherry.

The quantitative causality was approached using recursive path linear regression, as explained in Figure 1. The model explains that farmers' income is mainly affected by product type, and farmers' characteristics influence the product type. Other technical and economic factors are considered as confounding variables controlling the robustness of the effect.

In mathematical terms, the analytical model can be simultaneously expressed as follows.

$$Y_2 = \alpha_0 + \sum_{i=1}^{6} \alpha_i X_i + \alpha_7 Y_1 + \varepsilon_2 \quad (1)$$

$$Y_1 \begin{cases} 1 \\ 0 \end{cases} = \beta_0 + \sum_{j=1}^{5} \beta_j Z_j + \varepsilon_1 \quad (2)$$

where Y_2 is farmers income (IDR/year); X_i for I = 1…6 is age of plant (year), number plants (unit), farm size (ha), production (kg/year), fixed cost (IDR/year), and variable cost (IDR/year); Y_1 is product type (1: green bean coffee, 0: otherwise); Z_j for j = 1…5 is farmer age (year), farmer education (year), farmer experience (year), extension (times); plant density (tree/ha); α_i and β_j are coefficients to be estimated; ε_1 and ε_2 are error terms. Equation (1) represents the linear multiple regression model, and Equation (2) represents the logit regression model.

Hypotheses of the analytical model to be tested can be expressed as follows.

$$H_0 : \alpha_i = \beta_j = 0$$

$$H_1 : H_0 \text{ is no true}$$

The analytical model was estimated using generalised structural equation modelling (GSEM) provided in STATA ver. 13 (StataCorp 2013). The use of GSEM can eliminate heteroskedasticity due to binary dependent variables (Verbeek 2003). All hypotheses were tested with at least a 90 per cent confidence interval. The goodness of fit measures associated with the estimation were provided to show the robustness.

3 | RESULTS AND DISCUSSION

3.1 | Harvesting coffee

Farmers in Temanggung usually harvest Robusta coffee in terms of cherry coffee from July to August every year. The standard measure for coffee maturity is marked by a change in the colour of the coffee fruit skin from green to red or reddish yellow. However, some coffee farmers harvest their coffee when it is not entirely ripe because of several factors. The main factor is the urgent economic needs of the family.

Harvesting mature coffee has the following advantages: (i) coffee is easy to process because the skin is easy to peel off; (ii) the ratio of the weight of coffee beans to the weight of fresh coffee is higher; (iii) the coffee beans are pithier so that the bean size is big; (iv) fast coffee drying time; (v) good physical quality and flavour. Harvesting unripe coffee (yellow), overripe coffee (black fruit), or unhealthy conditions will cause the coffee beans to have low physical quality, and the taste is unfavourable.

The coffee marketed by farmers based on post-harvest handling (shape) can be classified into two types: cherries and green beans. Marketing in the form of coffee logs if the coffee fruit is not subject to post-harvest handling, or in other words, after harvesting, it can be directly marketed to buyers, who are generally collector traders. Meanwhile, the marketing of coffee in the form of coffee beans is carried out by farmers when there is post-harvest processing. Processing of coffee from coffee cherries into green bean coffee is conducted by dry processing.

Coffee farmers mostly carry out the dry processing process because the farmer capacity is small. It is easy to do even though it only uses simple equipment. In dry processing, after the coffee fruit

TABLE 1 Average values of financial coffee farming aspects

Items	IDR/ha		
	Cherry coffee	**Green coffee**	**Gap**
Fixed cost:			
• Building Tax	90,278	90,707	429
• Land rent	4,242,500	4,238,981	–3,519
• Depreciation	1,554,763	1,553,946	–816
Sub total	5,887,543	5,883,635	–3,908
Variable cost:			
• Manure	336,680	199,154	–137,527*
• NPK fertiliser	783,929	810,526	26,597
• SP-36 fertiliser	412,769	412,085	–683
• Urea fertiliser	739,190	710,185	–29,005
• Fertilisation labour	798,661	797,920	–740
• Weeding labour	1,197,512	1,186,483	–11,028
• Pruning labour	1,974,175	1,980,506	6,331
• Harvesting labour	4,059,300	4,350,715	291,415*
• Bean processing labour	0	1,964,680	1,964,680*
Sub total	10,302,224	12,412,259	2,110,036*
Total cost	16,189,767	18,295,894	2,106,128*
Revenue	43,478,718	54,559,770	11,081,053*
Net revenue	27,288,949	36,263,874	8,974,925*

Source: authors' analysis; Note: *) denotes significant difference at 0.05.

is harvested, it is dried immediately. The coffee fruit must be dried immediately to avoid undergoing chemical processes that can reduce product quality. Peeling the fruit's flesh, peeling the horn skin, and peeling the epidermis are carried out after the coffee becomes dry. Peeling the dry coffee fruit skin aims to separate the coffee beans from the fruit skin, horn skin, and epidermis. Peeling the horn skin uses a pulper and strips the epidermis using a huller. This condition is in line with Najiyati and Danarti (2006), who state that the difference between dry processing and wet processing is the treatment using water. Wet processing uses water to peel and wash the coffee cherries, while dry processing after the coffee cherries are harvested immediately dries and then strips the cherries.

3.2 | Financial aspects

The different forms of coffee marketed by farmers have different consequences for post-harvest processing costs. Farmers who market in the form of coffee beans have higher variable costs than farmers who market in the form of coffee cherries. The financial aspects of coffee farming per one hectare basis are presented in Table 1.

Table 1 compares the financial aspects between cherry coffee and green bean coffee management. Mostly, there are no significant differences in general aspects of farm management. The significant

aspects related to harvesting and post-harvest handling where farmers conducting bean processing spent extra labour costs are shown. Post-harvest processing costs refer to labour costs for drying and milling or stripping the coffee skin. However, the post-harvest handling resulted in higher revenue than the counterparts and improved net revenue significantly. The farmers producing green bean coffee enjoyed about 33 per cent higher than those who sold cherry coffee.

Another significant gap is the cost of manure, where farmers producing green bean coffee applied less manure than their counterparts. This is because the farmers have not done fertilisation optimally according to the recommendations. Based on the recommendations from related technical agencies, the dosage of manure use for mature coffee plants is 14,000 kg/ha/year, but coffee farmers in the regions only applied manure for an average of 587 kg/ha/year. This is due to the lack of manure availability in the coffee farming area and the relative lack of understanding of farmers about the benefits of organic fertilisers for the coffee production process.

The production of coffee for each farmer was different. This is due partly to the different scales of coffee farming, the coffee plants' age, and the varying care of coffee plants. Coffee prices varied due to the different forms of coffee marketed, the quality of the coffee, and the different marketing channels chosen by farmers. Farmers who marketed their coffee products in the form of green beans enjoyed a higher average price than farmers who marketed their coffee in the form of cherry coffee, which accounted for IDR 25,688.60/kg of green beans coffee and IDR 5,443.90/kg for cherry coffee. The farmers in the regions marketed coffee in the form of green beans to collectors, wholesalers, and coffee producers. Cherry coffee was marketed only to coffee collectors and artisans because large traders generally only accepted coffee in the form of coffee beans.

The quality of coffee also affects the marketing price of Robusta coffee. For example, coffee beans with a moisture content above 12 per cent are slightly lower than coffee beans with a moisture content of 12 per cent, where the price difference is around IDR 500/kg. Based on the results of Listyati et al. (2017), farmers sell coffee to collectors and wholesalers, and if the price in the market is not much different, farmers usually choose to sell to collector traders.

Regarding business investment feasibility, the ability of capital in coffee farming to generate income is 168 per cent for cherry coffee and 198 per cent for green bean coffee. This profitability value is very high compared with the small business loan interest rate at the farmer level. For example, Food and Energy Security Credit (*Kredit Ketahanan Pangan dan Energi* = KKPE) and People's Business Credit (*Kredit Usaha Rakyat* = KUR) pegged interest rates ranging from 6 per cent to 7 per cent. This means that agribusiness based on Robusta coffee, whose products are marketed as cherry coffee, is worth the effort

Despite farmer income being quite high, coffee farming is an estate crop that produces once or twice a year. This makes farmers wait for harvest too long. Farmers need cash for daily life, and there is a risk of wasting money during the harvesting season. To guarantee sufficient cash for daily needs while waiting for coffee harvest, seasonal cash crops need to be introduced in the community. Wijaya et al. (2021a, 2021b) show examples that vegetable cultivation helps farmer households increase income. Temanggung is a hilly area that is fit for cultivating vegetables and other horticultural crops. Another alternative is to integrate the coffee plantation with poultry farming of either chickens (Santoso et al., 2016, 2017) or ducks (Setiadi et al., 2021) since such farming can also potentially generate cash in a relatively short time. This farming can fill the gap in the harvesting seasons of coffee.

3.3 | Factors determining income and products

Many factors influence the variation of income gained by farmers. Based on Figure 2, the farm size, age of coffee plants, production of coffee logs, fixed production costs, variable production costs, and the form of product simultaneously provide significant effects on the income of coffee farmers in the regions. At the same time, the form of the product was determined by personal characteristics of farmers, extension and density of the plant. The significance shows $p > \chi^2 = 0.000$, with an overall

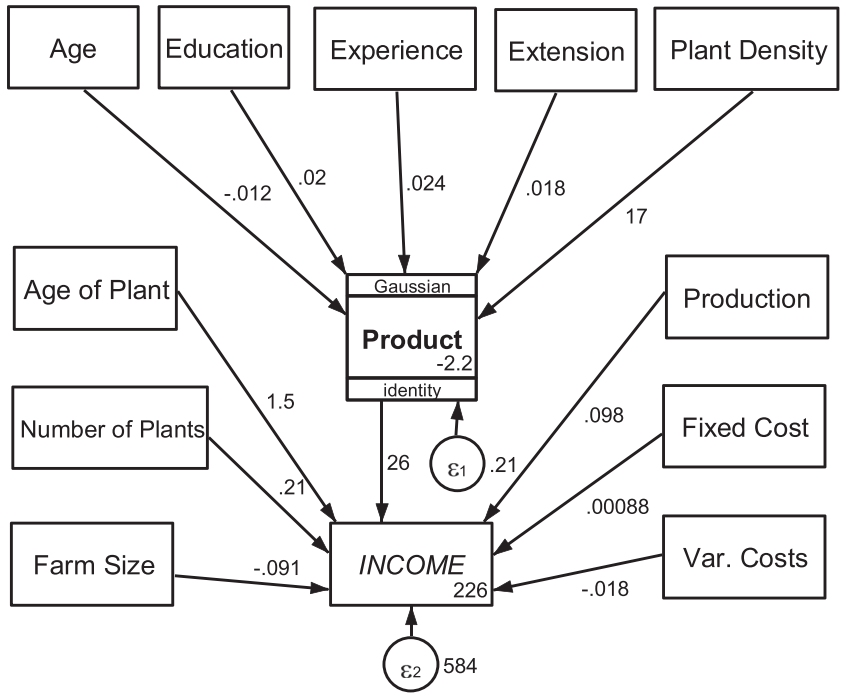

FIGURE 2 Estimated model of farmer income in coffee farming
Source: Authors' analysis.

R^2 of 0.5906, which means that explanatory factors explained about 60 per cent variation in farmer income; the rest were explained by other factors not included in the simultaneous regression equation model (Gujarati 2012).

In partial analysis, it can be seen that farmers selling green bean coffee products received significantly higher income than those selling un-processed products. This advantage is robust since other confounding factors have controlled it. The high income from processed coffee is in line with Saragih's (2019) results, that those farmers who carry out primary processing (processing red logs into un-hulled coffee) get higher income and are significantly different from farmers who sell red logs. For this reason, efforts are needed to motivate farmers to process their products into coffee beans to increase the added value of their farming. Other studies by Hariyati (2014), Saria and Fitria (2018), and Wahyu and Suwandari (2012) show that most farmers sell their produce in the form of ground coffee (bean coffee) to collector traders who have collaborated for a long time, while a small proportion of farmers sell in the form of coffee cherries.

The age of coffee plants has a significant effect on the income, which means that the more mature a coffee plant, the higher the income received by farmers. This condition implies that the longer the age of the coffee plant, the more it has a positive role in increasing production so it will also affect the increase in income. This condition reflects that the average age of coffee plants in the regions was still productive, or it has not been required to regenerate plants.

The farm size has a significant effect and has a negative effect on the income, which means that extended farm size of coffee farming reduced the income. This phenomenon indicates that the farmers have reached peak capacity in managing the farm. It would be drudgery when the limited resources operate a large farm. Normatively, farm size represents the scale of the farm. It could also be the case that the density of plants is getting lower when the size of the farm increases. Although the size of a farm is large, the number of plants is almost the same. Another possible factor is that the plants in

the extended farm were not in the productive stage; thus, the production was low, despite the large farm.

The number of plants shows a positive effect on the income. This indicates that the plants were in the production stages – this finding related to the fact that a large farm does not necessarily improve the income. The production level also has a significant effect on the income, which means that the production of coffee increases the income. This is also an obvious finding and coexists with the number of plants that positively affect income. The higher the number of productive plants, the higher the production harvested by farmers. As the production significantly increases farmers' income, keeping the coffee in high productivity is necessary. The improvement of crop management can conduct it. The agronomic aspect and maintenance of coffee trees need to be conducted in a sustainable fashion to provide social benefits for both producers and consumers (Mariyono 2009). Organic fertilisers can replace the inorganic ones, and botanical and biological pesticides can replace synthetic ones (Mariyono 2020); crop protection can apply a concept of integrated pest management that can reduce chemical pesticides (Mariyono 2008). Adoption of technology applicable to coffee farming has the potentials to improve income, and in this case providing microfinance assistance to the farmers will catalyse the technology adoption (Mariyono 2019a, 2019b). Soekartawi (2005) states that the level of technology application in agriculture is one factor that determines the level of production and income of agricultural businesses.

Fixed production costs have no significant effect on income. This means that regardless of the quantity of fixed production cost, it does not affect the income, as explained by the theory of production costs, that the amount of production costs remains independent of the amount of product. Variable production costs have a significant effect on income with a negative correlation. This condition occurs because the variable production costs positively correlate to the scale of farming or the amount of coffee production. However, if the increase in variable production costs is more significant than the increase in farm income, then the variable production costs negatively correlate with the income of coffee farmers.

From Figure 2 and Table 2, it can be seen that the farmers' intention to create a valued product in the form of green bean coffee depends on several factors. The age of farmers significantly reduced the intention of farmers to process further with the harvested coffee bean into green bean form. This finding is reasonable since the post-harvest handling of coffee is drudgery, and it is pretty difficult for old farmers. Education and experience significantly increased the farmers' intention to process the harvested coffee into green bean form, and so did the extension service.

Education and experience represent human capital or capacity in coffee-based agribusiness, and the extension service enhances the capacity. Concerning education, going back to formal education might be effective to enhance the capacity; however, it was too late in the stage. Providing training with special topics for coffee will be helpful, like one for vegetable and rice farmers through special training (Mariyono 2019c, 2020). Note that human capital improvement can lead to high motivation of farmers. Hariyati (2014) states that the highest driving factor in developing processed coffee products in Jember Regency is the high motivation of farmers.

4 | CONCLUSIONS

Coffee farming has been widely grown in Indonesia. This crop is one of the commodities that has been internationally traded. The commercialisation of this crop leads to agricultural economic development in rural areas where farmer households cultivate the crop. With the commercialisation happening at a household level, coffee farming becomes an income source for smallholder estate crops in Java, Indonesia. The value chains of coffee products, starting from farm production to end-users at coffee shops, have distributed considerable income for the marketing channels. Farmers as producers can get more income when they take one step off the chain by processing the products. This study concludes that shortsheeting one step of value chains by farmers improves farmers income

TABLE 2 Estimated coefficients and significance

Variables	Coefficients	Std. errors	z value	p > z
INCOME ←				
Constant	225.7	10.73	21.03	0.000
Product	26.40	8.685	3.04	0.002
Age of plant	1.548	0.349	4.44	0.000
Number of plants	0.207	0.121	1.72	0.088
Farm size	–0.091	0.026	–3.55	0.000
Production	0.098	0.013	7.59	0.000
Fixed cost	0.001	0.002	0.49	0.623
Var. costs	–0.018	0.007	–2.66	0.008
Product ←				
Constant	–2.246	1.255	–1.79	0.074
Age	–0.012	0.007	–1.70	0.090
Education	0.020	0.015	1.36	0.173
Experience	0.024	0.008	3.16	0.002
Extension	0.018	0.032	0.57	0.570
Plant density	16.78	7.888	2.13	0.033
# Observations	98			
Log-likelihood	–513.16			
LR test, χ^2 (23)	201.80	$p > \chi^2 = 0.000$		
Overall R2	0. 5906			

Source: authors' analysis.

considerably. The step is to process coffee cherry into green bean coffee before selling to the market. Other factors determining the income were the age of coffee plants, the number of plants, production quantity, operational costs, farm size. However, not all farmers did not take the opportunity to increase value. Personal characteristics, extension programme, and density of crops led to different actions. Old farmers were reluctant to take the opportunity. Trained and educated farmers were enthusiastic about getting the value-added in the supply chain. The density of crops highly affected farmers to utilise the chance. This study recommends that policymakers intensify the extension services, particularly to encourage farmers to increase crop density. This action has double impacts on income and likelihood for farmers to process the coffee cherry to green bean coffee with high value in the market. Practically, the action can be conducted by the extension services at district levels to collaborate with seed agency at a provincial level that provides high-quality coffee seedlings and engage the local universities that provide improved technology for coffee farming. The extension services are expected to make the extensionist training centres enhance their capacity to assist farmers in operating coffee farming efficiently.

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DATA AVAILABILITY STATEMENT

The author has provided the required Data Availability Statement, and if applicable, included functional and accurate links to said data therein.

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