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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

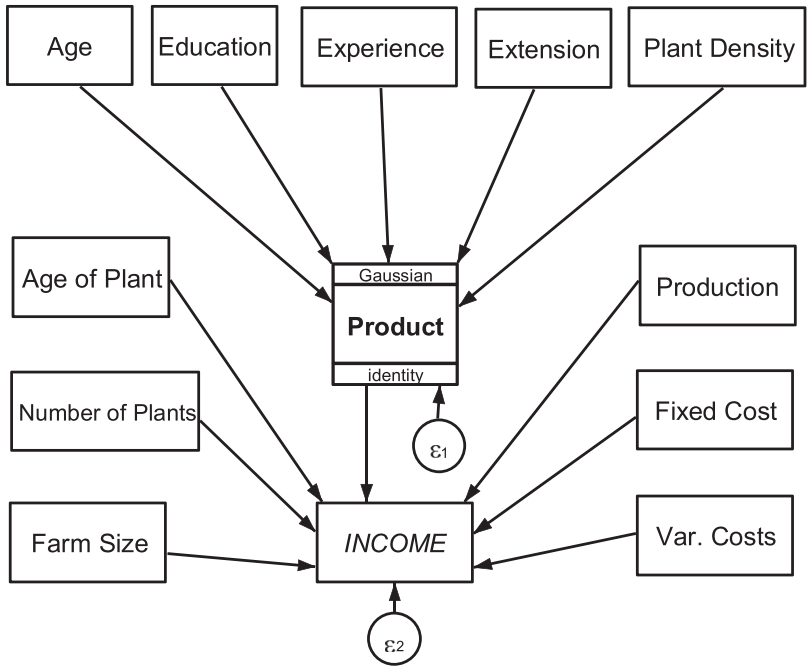


**FIGURE 1** Analytical model of farmer income in coffee farming

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 $\mu$ 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); $\alpha_i$ and $\beta_j$ are coefficients to be estimated; $\varepsilon_1$ and $\varepsilon_2$ 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

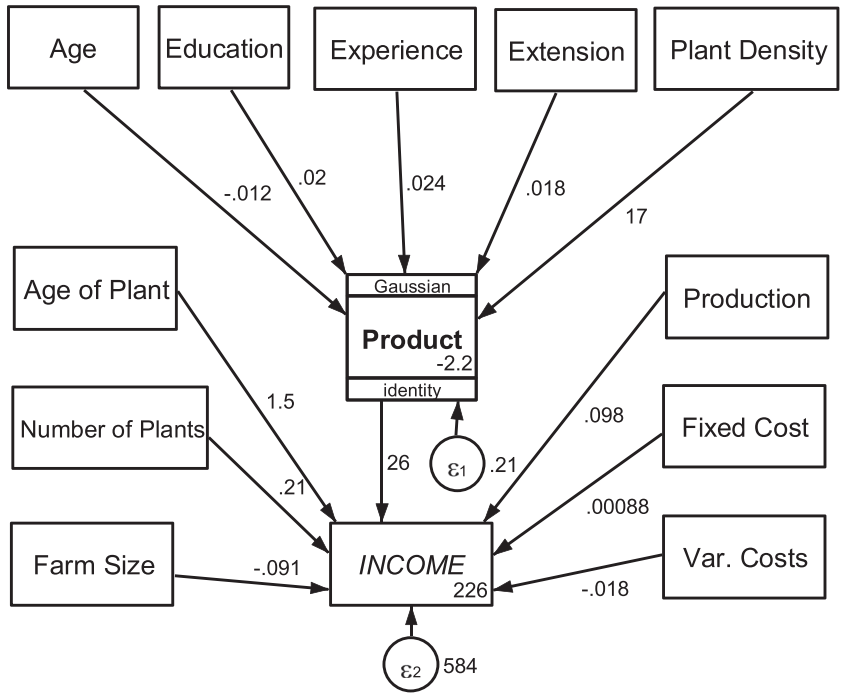


**FIGURE 2** Estimated model of farmer income in coffee farming
Source: Authors' analysis.

$R^2$ 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, $\chi^2$ (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

The peer review history for this article is available at https://publons.com/publon/10.1111/issj.12362.

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