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# Technical Efficiency Level of Organic Coffee and Inorganic Coffee Farming in Cilengkrang District, Bandung Regency, Indonesia

**Gunawan Prawira♥, Harianto, and Adi Hadianto**
Agricultural Economics Study Program, IPB University, Bogor, Indonesia
♥Corresponding author email: gunawanprawira18@gmail.com

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**Abstract.** Cilengkrang District is a sub-district in West Java recognized for its potential contribution to Indonesia's coffee productivity. However, the overall productivity of coffee farming remains relatively low due to inefficiencies in farming practices. The coffee grown in Cilengkrang consists of two types: organic and inorganic. This research aims to analyze factors that influence coffee production and analyze the level of technical efficiency of coffee farming. The study was conducted in Cilengkrang District, Bandung Regency, chosen purposively for its significant potential to contribute to the region's coffee productivity. The sample consisted of 34 organic farmers and 34 inorganic farmers. Data collection began in August 2023 and ended in December 2024. The Stochastic Frontier Analysis (SFA) method was used to evaluate farming efficiency. The results of the analysis show that the variables of land area, liquid organic fertilizer, urea fertilizer, and KCl fertilizer influence production. Then the variables of education level, number of family members, experience, and financing dummy influence increasing farming efficiency. The efficiency level of coffee farming is included in the inefficient category.

**Keywords**: coffee farming; efficiency; inorganic; organic; stochastic frontier

## INTRODUCTION

Indonesia as an agrarian country, has a strong dependence on the agricultural sector. According to Wahab (2023), Indonesia is recognized as an agrarian nation, meaning that the country relies on the agricultural sector both as a livelihood source and as a pillar for national development. The agricultural sector consists of several sub-sectors. BPS (2022) data shows that the plantation sub-sector in 2020 contributed to total GDP based on current year prices of 735,907 billion rupiah. The GDP value of the plantation sub-sector is the highest contribution to the GDP of the agricultural sector. During 2018-2022, it is also known that the value of the plantation sub-sector is the most dominant value in GDP when compared with the contribution of other sub-sector values. Based on this data, it is known that plantations in Indonesia are one of the platforms for the country in obtaining sources of livelihood. GDP values by business field for 2018-2022 can be seen in **Table 1.**

**Table 1.** Gross Domestic Product based on current prices according to business fields in 2018-2022 (Billion Rupiah)

| Business Field | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|
| Crops | 449,553 | 446,497 | 474,271 | 441,365 | 454,735 |
| Horticultural Plants | 218,713 | 238,831 | 250,458 | 262,471 | 281,505 |
| Plantation Plants | 489,186 | 517,508 | 560,226 | 668,38 | 735,907 |
| Farm | 232,275 | 256,85 | 260,238 | 268,199 | 298,014 |
| Agricultural and Hunting Services | 27,59 | 29,301 | 30,188 | 32,524 | 35,293 |
| Forestry and Logging | 97,397 | 104,122 | 108,646 | 112,009 | 118,386 |
| Fishery | 348,828 | 385,908 | 419,635 | 469,594 | 505,061 |
| Agriculture | 1,900,622 | 2,012,743 | 2,115,495 | 2,254,541 | 2,428,901 |

Source: (BPS 2022); processed

A commodity with a significant contribution to the plantation sub-sector is coffee. Indonesia is the fourth-largest producer of coffee in the world, with an

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average annual production of 725.68 thousand tons (Pusdatin Pertanian 2022). There are two coffee species commonly cultivated by farmers: Arabica coffee and Robusta coffee. Each type of coffee has different characteristics and environmental needs, which affect where it grows and its production levels. According to Ardhiarisca et al. (2022) Arabica coffee is more suitable for cultivation in highland areas, typically above 800 meters above sea level. Arabica coffee plants produce a milder and more acidic taste with a distinctive aroma compared to Robusta. On the other hand, Robusta coffee thrives in lowland areas, where the climate is warmer and more humid. Robusta coffee is known for its stronger, slightly bitter flavor and higher caffeine content than Arabica. However, despite the fact that Arabica coffee is favored by international markets for its flavor data from Pusdatin (the Agricultural Data Center) (2022) shows that Robusta coffee production in Indonesia is significantly higher than that of Arabica. The average production of Robusta reaches 508,327 tons per year, while Arabica only produces about 187,977 tons. This indicates that Robusta is easier to cultivate and yields higher outputs in Indonesia. The relatively low production of Arabica coffee is a concern for Indonesia, especially when considering the issue of profit loss. Despite its higher market value, the lower production of Arabica means less revenue for farmers and the country as a whole. This discrepancy highlights the need for strategies to improve Arabica cultivation and increase its yield, ensuring that Indonesia can benefit more from both types of coffee.

Data Pusdatin Pertanian (2022) also shows that in terms of productivity, Arabica coffee reaches 824.60 kg.ha$^{-1}$, while Robusta coffee can only achieve 756.06 kg.ha$^{-1}$. Based on this, it can be concluded that Indonesia still has greater potential to contribute to the production of Arabica coffee. Although the productivity data for Arabica coffee is better than robusta, the productivity level is still considered to be in the low category. According to Zen & Budiasih (2018), the low productivity of coffee in Indonesia indicates that the coffee farming industry, particularly Arabica coffee, has not been efficient, especially in terms of the use of production factors. Coelli & Battese (1996); Tambi (2023) explains that coffee productivity can be increased through improving the technical efficiency of farming.

One way to improve efficiency is by implementing organic farming (Fritz et al. 2021). Based on Fritz, organic farming presents an effort to create an environmentally friendly agricultural ecosystem. This initiative arises due to the extensive use of chemical-based agricultural inputs that can affect health and pollute the environment. Cultivating coffee without using chemical fertilizers adds value to the coffee plants, and it is hoped that this added value will encourage farmers to establish efficient organic coffee farming. SPOI (2023) or Statistik Pertanian Organik Indonesia shows that one of the regions contributing significantly to the development of organic coffee production in Indonesia is Java. In 2022, Java had an organic coffee production capacity of 3,200 tons.ha$^{-1}$. Despite the island of Java has a large contribution to organic coffee production in Indonesia, organic coffee production on the island of Java is still low compared to organic coffee production on the island of Sumatra which can reach almost 27,000 tons.ha$^{-1}$, this is thought to be due to problems of input combination which describing the problem of technical efficiency. The SPOI data shows that there is a gap in the field conditions regarding existing theories regarding organic farming.

West Java is one of the production centers for Arabica coffee with an average production reaching 11,598 tons seen from production data for 2018-2022 (Pusdatin Pertanian 2022). One of the regions that contributes quite significantly to Arabica coffee production is Bandung Regency, however coffee production in Bandung Regency is not commensurate with its productivity, where in 2020 the productivity

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achieved was less than 1,000 Kg.ha$^{-1}$ (Direktorat Jendral Perkebunan 2022). The low productivity of Arabica coffee indicates technical efficiency issue in coffee farming. In response to the problem in Bandung Regency, Cilengkrang District came up with a specialty Arabica coffee farm, namely specialty Java Preanger. Based on Herminingsih et al. (2023), when coffee is said to be a speciality or in the sense that it has been given a high selling value, one of which is through the establishment of a Geographical Indication, then there is hope for farmers to get high income and encourage farmers to create efficient agriculture. This statement supported by pre-research, the results of interviews with BPP (Balai Penyuluhan Pertanian) Cilengkrang in 2023, it is also known that Cilengkrang District is holding Java Preanger arabica organic coffee in order to get more profits that can be received by farmers, so it is hoped that farmers will be oriented towards achieving efficient agriculture.

The statement regarding increasing coffee productivity through speciality Java Preanger coffee or organic Java Preanger coffee apparently does not match the reality on the ground in Cilengkrang District. Coffee productivity in Cilengkrang District is still low; it's only reached 435 Kg.ha$^{-1}$ (BPS 2023). Khalifatullah et al. (2022), conducting research on coffee farming in Cilengkrang District, found that Cilengkrang District still has the potential to continue to increase the productivity of its farming businesses. Based on these findings, it is known that farming in Cilengkrang District is still not efficient, so research is needed on the level of technical efficiency of coffee farming in Cilengkrang District.

There has not been much research on the level of technical efficiency of coffee farming in Cilengkrang District, especially research that compares organic Java Preanger farming and inorganic Java Preanger farming owned by Cilengkrang District. This research aims to 1) Analyze the factors that influence the production of inorganic coffee and organic coffee in Cilengkrang District, and 2) What is the level of technical efficiency of organic coffee and inorganic coffee farming in Cilengkrang District.

## METHODS

The research was conducted in Cilengkrang District, Bandung Regency, West Java Province, which was determined purposively with the consideration that Cilengkrang District is a producer of inorganic Java Preanger coffee and organic Java Preanger coffee in Bandung Regency. Based on the results of interviews with BPP Cilengkrang in 2023, two villages in Cilengkrang District simultaneously produce organic and inorganic java preanger coffee.

Farmer sampling was carried out using Cluster Random Sampling with 103 respondents. The Cluster Random Sampling sampling technique is a sampling process by dividing the population into several areas (clusters), and then selecting samples randomly in each area (Sugiyono 2011). In this research, the areas or clusters referred to are; 1) Farmers cultivating organic Java Preanger coffee in Cilengkrang District; and 2) Farmers cultivating inorganic Java Preanger coffee. The number of samples in this study was calculated based on the Slovin formula with an error percentage of 10%. Calculations from the Slovin formula show that the number of samples used for both populations is 34 respondents. Data were analyzed using the Cobb-Douglas production function via the Stochastic Frontier Analysis (SFA) method. The production function can be described by **Equation 1 and 2**.

Equation 1 and Equation 2 show that there are 2 different production functions in this research. Based on this, a different test of the two production functions is needed before carrying out stochastic frontier analysis. The purpose of the difference test is to ensure that the production functions used need to be separated because there are differences in the production functions of organic coffee farming and inorganic coffee farming. The

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different test applied in this research is the Mann-Whitney U-Test. Susetyo (2012) explains that the Mann-Whitney U-Test is used to test differences between two independent groups taken from a population. If the value of asymp.sig. (2-tailed) < α, then it means that the resulting production function has a difference. It is known that in this research, the value of Asymp.Sig. (2-tailed) the result is 0.00 < 0.05. So based on these results, it is known that the production function of organic farmers and the production function of inorganic farmers have differences.

**Organic Farming:**

$$Ln\boldsymbol{Y} = Ln\boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 LnX_1 + \boldsymbol{\beta}_2 LnX_2\, \boldsymbol{\beta}_6 LnX_6 + \boldsymbol{\beta}_7 LnX_7 + \boldsymbol{\beta}_8 LnX_8 + (v_i - u_i) \quad (1)$$

**Inorganic Farming:**

$$Ln\boldsymbol{Y} = Ln\boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 LnX_1 + \boldsymbol{\beta}_2 LnX_2 + \boldsymbol{\beta}_3 LnX_3 + \boldsymbol{\beta}_4 LnX_4 + \boldsymbol{\beta}_5 LnX_5 + \boldsymbol{\beta}_8 LnX_8 + (v_i - u_i) \quad (2)$$

Note: $Y$: Coffee Production (Kg), $X_1$: Coffee land area (ha), $X_2$: Age of coffee trees (Tahun), $X_3$: Urea (Kg), $X_4$: KCl (Kg), $X_5$: SP-36 (Kg) $X_6$: Organic manure (Kg), $X_7$: Liquid organic fertilizer (ml), $X_8$: Labor (HOK), $\beta_0$: Intercept, $\beta_i$ : Estimator Parameter Coefficient, i = 1,2….*N*, $v_i - u_i$ : *error term* ($v_i$ is a random variable; $u_i$ is technical inefficiency in the model).

The expected coefficient value is $\beta_i > 0$. positive coefficient value means that if additional input is added in the form of βi, it will be able to increase the amount of production.

Measuring the technical efficiency of coffee farming uses a stochastic model (SFA). The stochastic modeller can be written as **Equation 3.**

$$TE_i = exp\,(-E[u_i \mid \varepsilon_i])\; i = 1,\ldots,N \quad \ldots..(3)$$

Note: $TE_i$: technical efficiency carried out by farmer i, $exp\,(-E[u_i \mid \varepsilon_i])$ : expected value (*mean*) dari $u_i$ (technical inefficiency effect).

The technical efficiency value has a range of values (0 ≤ TEi ≤ 1). If the farmer's technical efficiency value is ≥ 0.7, then it is classified as technically efficient, if the farmer's technical efficiency value is < 0.7, then it is classified as inefficient. Based on the formula above, it is known that the technical efficiency model refers to the analysis of $u_i$ (technical inefficiency effect). The inefficiency effect equation ($u_i$) is seen using socio-economic variables in coffee farming, which can be seen in **Equation 4.**

$$\boldsymbol{u}_i = \boldsymbol{\delta}_0 + \boldsymbol{\delta}_1 Z_1 + +\boldsymbol{\delta}_2 Z_2 + \boldsymbol{\delta}_3 Z_3 + \boldsymbol{\delta}_4 Z_4 + \boldsymbol{\delta}_5 Z_5 + \boldsymbol{\delta}_6 Z_6 + w_{it} \quad (4)$$

Note: $u_i$: Effects of Coffee Farming Inefficiencies, $Z_1$: Farmer's Age (Years), $Z_2$: Farmer's Formal Education (Years), $Z_3$: Number of Family Members (People), $Z_4$: Farming Experience (Years), $Z_5$: Farming status dummy (1= Main Job, 0 = Side Job), $Z_6$: Financing dummy (1 = Obtained Financing, 0 = Did Not Obtained Financing), $w_{it}$: *error*, $\delta_0$: Constanta, $\delta_i$: Coefisien; i= 1, 2…*N*.

The expected coefficient value is $\delta_i < 0$. A negative coefficient value indicates that the higher the production factors used, the lower the level of inefficiency.

## RESULTS AND DISCUSSION

### Stochastic Frontier Production Function Analysis

The first stage in using the production function in the Stochastic Frontier Analysis (SFA) method is using the Ordinary Least Square (OLS) method. The OLS method is used to test violations of classical assumptions in the production function (normality test, multicollinearity test, and heteroscedasticity). It is known that both production functions have data that is normally distributed, free from multicollinearity, and free from heteroscedasticity. After testing the classical assumptions, the results of the estimated production function are identified. The

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results of the production function estimation analysis using the OLS method, the Adjusted R-Squared ($R^2$) value produced in organic farming is 0.563 and in organic farming is 0.526. The $R^2$ value illustrates that as much as 56.3% of the dependent variable (Y) the amount of organic coffee production can be explained by the independent variable ($X_{i\ organic}$) and with 51.4% of the dependent variable (Y) the amount of inorganic coffee production can be explained by the independent variable ($X_{i\ inorganic}$).

The F test on organic farming and inorganic farming shows Sig. F Statistics is 0.000 < α (0.05). The results of the F test on the two types of agriculture illustrate that the independent variables jointly influence the dependent variable. The results of the T test using the OLS method show that the land area variable in both types of agriculture has a significant coefficient value, this illustrates that when there is an addition of 1% of land area input, coffee farming production in Cilengkrang District will increase.

The results of the production function estimation analysis using the OLS method show that, in organic farming, the value of $\sum\beta_{i\ organic}$ = 1,08, while in inorganic farming the value of $\sum\beta_{i\ inorganic}$ = 1,248. These two values can illustrate that the Ep value is larger than 1 (Ep >1). An Ep value > 1 indicates that the research area, namely coffee farming in Cilengkrang District, is in area 1 on the production curve. This means that farmers need to consider the use of their inputs because when farmers decide to increase the use of inputs, the additional input will be accompanied by an increase in input. It can be concluded that the scale of coffee farming in Cilengkrang District is in the Increasing return to scale curve area.

The next stage in estimating the stochastic frontier production function is estimation using the MLE method. The results of the production function estimation analysis using the MLE method show that the Sigma-Square ($\sigma^2$) value for organic farming is 0.052 and for inorganic farming is 0.199. Both $\sigma^2$ values are more than zero (0), thus indicating that the technical inefficiency effect model is normally distributed. Then the gamma (γ) value in organic and inorganic farming is 0.999. This means that 99.9% of the residual variation in the stochastic frontier production function model comes from technical inefficiency ($u_i$) and the remaining 0.01% is caused by random error ($v_i$) outside the model.

The Log Likelihood Function MLE value for organic farming shows a value of 9.967 and for inorganic farming shows a value of 18.85. Both values are found to be higher than the Log Likelihood Function of OLS, which is 0.751 for organic farming and -13.210 for non-organic farming. The Log Likelihood Function of MLE > Log Likelihood Function of OLS indicates that the model using the MLE method is more suitable for field conditions compared to the model using the OLS method. The generalized-likelihood ratio (LR) for organic farming is 18.432, and for non-organic farming, it is 30.191. Both LR values have the same degree of freedom (df), which is 8, resulting in the Kodde and Palm table value of 14.853. The LR value > the Kodde and Palm table value at α 5% means that the model used can explain the effects of technical inefficiency.

The influence of each variable on the technical efficiency of coffee in Cilengkrang District varies depending on the type of coffee plant. In organic coffee farming, it is known that there are variables that significantly and positively affect production, namely the land area and liquid organic fertilizer. Meanwhile, in non-organic coffee farming, the variables that significantly and positively affect production are land area, urea fertilizer, and KCl fertilizer. In both types of farming, the variables that do not significantly affect production are tree age, manure, and labor in organic farming, and tree age, SP-36 fertilizer, and labor in non-organic farming. Detailed test results using the MLE method can be seen in **Table 2.**

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**Table 2.** Results of Estimation of the Coffee Production Function in Cilengkrang District using the MLE method

| Organic Farming | | | |
|---|---|---|---|
| Variable | Coefficient | Standar-error | T-calculation |
| Constant ($\beta_0$) | 7.981*** | 1.693 | 4.712 |
| Land Area ($\beta_1$) | 0.390*** | 0.079 | 4.924 |
| Tree Age ($\beta_2$) | 0.053 | 0.077 | 0.691 |
| Organic Manure ($\beta_3$) | -0.097 | 0.182 | -0.535 |
| Liquid Organic Fertilizer ($\beta_4$) | 0.009* | 0.005 | 1.717 |
| Labor ($\beta_5$) | 0.018 | 0.085 | 0.218 |
| Sigma Square | 0.052 | 0.012 | 4.202 |
| Gamma | 0.999 | 0.001 | 785.803 |
| Log Likelihood Function MLE | 9.967 | | |
| LR Test of the one-sides error | 18.432 | | |
| Inorganic Farming | | | |
| Variable | Coefficient | Standar-error | T-calculation |
| Constant ($\beta_0$) | 5.597*** | 0.855 | 6.541 |
| Land Area ($\beta_1$) | 0.849*** | 0.128 | 6.637 |
| Tree Age ($\beta_2$) | 0.157 | 0.132 | 1.186 |
| Urea ($\beta_3$) | 0.154*** | 0.146 | 1.052 |
| KCl ($\beta_4$) | 0.079*** | 0.025 | 3.103 |
| SP-36 ($\beta_5$) | 0.000 | 0.124 | 0.005 |
| Labor ($\beta_6$) | -0.075 | 0.255 | -0.293 |
| Sigma Square | 0.199 | 0.044 | 4.510 |
| Gamma | 0.999 | 0.000 | 19,622,016.0 |
| Log Likelihood Function MLE | 18.850 | | |
| LR Test of the one-sides error | 30.191 | | |

Source: Primary Data, processed

The estimation results show that land area is a significantly positive variable in both types of agriculture. The resulting regression coefficient value is 0.390 for organic farming and 0.849 for inorganic farming. The two coefficient values produced have meaning: if there is an increase in land area by 1%, it will increase production by 0.39% in organic farming and 0.84% in inorganic farming. This research is in line with research by Wambua et al. (2021) and Gessesse & He (2021). The findings from these two previous studies indicate that the larger the land cultivated by farmers, the more efficient their farming will be. Based on this, rational farmers will prefer to expand their land to increase their production.

Land expansion in the research area is considered less feasible. The limited potential for land expansion is primarily because farmers are still renting land from Perhutani. Based on interviews with farmers, it was found that they feel more comfortable working with the land they already own. This is due to the lengthy licensing process involved in acquiring additional working land, along with the knowledge that production yields would ultimately be reduced by 23%. The average land area owned by farmers in Cilengkrang District is 2.4 ha for organic coffee farming and 2.65 ha for non-organic farming. As a result, farmers are concerned about the potential losses they would face if crop failures occurred on larger areas of land. These findings indicate the

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need for the government's role in expediting the land control process by farmers, as well as the importance of providing specialized counseling to farmers so they don't have to worry about potential failures in coffee production in Cilengkrang District.

Liquid organic fertilizer (LOF) is an input variable used in organic farming. The average use of LOF on agricultural land is 1,399.12 ml per growing season. The LOF variable shows a positive significance in organic agricultural production. The regression coefficient for the LOF variable is 0.009. This finding suggests that when the addition of manure is increased by 1%, production will increase by 0.009%, assuming other inputs remain constant (ceteris paribus). The impact of LOF on coffee plants is explained in studies by Analianasari et al. (2021), and Humaida et al. (2023). These studies highlight that LOF is typically used to fulfil the potassium (K) nutrient needs, which is essential for the vegetative growth of plants. Proper vegetative growth, in turn, influences the quality of the products or fruits produced by the plants.

The use of liquid organic fertilizer in organic farming in Cilengkrang District is minimal due to the restriction on using any fertilizers other than manure and LOF for organic coffee farming. Based on field findings, it was observed that farmers are primarily focused on meeting the demand for manure. It was also found that the addition of manure leads to a decrease in production, as indicated by the negative regression coefficient. From these results, it can be concluded that farmers in Cilengkrang District need guidance or counseling on the application of liquid organic fertilizer. This is crucial because focusing solely on manure may have already reached a saturation point, where additional fertilizer no longer improves production (levelling off).

Urea is a fertilizer input variable that has a positive and significant effect on coffee production in inorganic farming in Cilengkrang District. The regression coefficient value for urea fertilizer is 0.154. Based on these significant results, it can be seen that when an additional 1% urea fertilizer is given, there will be an increase in production of 0.15. These findings are similar to the findings of Anis et al. (2023) and Chaira et al. (2024). In this research, it is explained that rational farmers will choose to increase the use of urea fertilizer because it can influence the amount of production. The regulation which is “Peraturan Menteri Pertanian Nomor 49/Permentan/OT.140/4/2014 Tahun 2014” concerning Technical Guidelines for Good Coffee Cultivation (Good Agricultural Practices/GAP on Coffee) explains that the recommended dose of urea fertilizer for coffee plants that have been more than 10 years old planting is 400g per planting season for 1 coffee tree. If we assume that farmers have at least 750 coffee trees, the urea fertilizer that must be fulfilled in one planting season is 300,000g per planting season or the equivalent of 300kg per planting season. Based on the findings of this research, it is known that the average use of urea fertilizer in Cilengkrang District is not in accordance with the coffee GAP reference because the average use is known to only reach 244.06 kg per planting season. Cilengkrang District still has the potential to increase the amount of urea fertilizer used.

KCl is the next significant input variable in inorganic coffee farming in Cilengkrang District. The amount of KCl fertilizer used has an average of 103.32 Kg per planting season. The KCl fertilizer variable has a positive significance on inorganic agricultural coffee production in Cilengkrang District. The regression coefficient value is 0.079. The meaning of these findings is that when 1% KCl fertilizer is added, inorganic coffee production will increase by 0.07%. This finding is in accordance with research by Thamrin et al. (2021) who explains that Arabica coffee production is influenced by KCl, while research on other plantation crops, which research by Ayomi et al. (2022) who

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researched oil palm plants, in their research it was explained that rational farmers would increase their use of KCl fertilizer, because it is known that KCl affects production. Based on regulation which is "Peraturan Menteri Pertanian Nomor 49/Permentan/OT.140/4/2014 Tahun 2014" concerning the coffee GAP, the recommendation for using KCl fertilizer for coffee plants that have been planted for more than 10 years is 250g per planting season for 1 coffee tree. If it is assumed that farmers have at least 750 trees, then the recommended use of KCl in one planting season is 187,500g per planting season or the equivalent of 187.5 Kg per planting season. Based on this recommendation, it is known that the use of KCl fertilizer in Cilengkrang District still has the potential to be increased because there is still a gap in the amount with the GAP for coffee planting.

The potential for adding Urea and KCl fertilizer in Cilengkrang District needs to be maximized to increase coffee production. Based on the results of a survey of farmers in Cilengkrang District, it is known that farmers want to increase the use of Urea and KCl fertilizer inputs, but are hampered by availability and fairly high prices. Based on these field findings, it can be seen that there is a need for the government to play a role in the availability of Urea and KCl fertilizers and also consider the sales price of these two fertilizers.

**Level of Technical Efficiency of Cilengkrang District Farmers**

The results of the distribution of technical efficiency are categorized according to the area of land cultivated by each farmer. The results of the analysis of the technical efficiency level of Cilengkrang District can be seen in **Table 3.**

**Table 3.** Distribution Results of Technical Efficiency of Coffee Farming in Cilengkrang District

| Description | Farmer's Land | | | Total |
|---|---|---|---|---|
| | Narrow Land (≤ 1.5) | Medium Land (1.51-3.00) | Wide Land (≥ 3.00) | |
| Organic Farming | | | | |
| <0,69 (Not Efficient) | 8 | 14 | 2 | 24 |
| ≥0,7 (Efficient) | 1 | 5 | 4 | 10 |
| Number of Farmers | 9 | 19 | 6 | 34 |
| Average | 0.585 | 0.590 | 0.765 | 0.620 |
| Maksimum | 0.881 | 0.999 | 0.949 | 0.999 |
| Minimum | 0.471 | 0.419 | 0.401 | 0.401 |
| Inorganic Farming | | | | |
| <0,69 (Not Efficient) | 3 | 14 | 1 | 18 |
| ≥0,7 (Efficient) | 1 | 9 | 6 | 16 |
| Number of Farmers | 4 | 23 | 7 | 34 |
| Average | 0.547 | 0.614 | 0.822 | 0.649 |
| Maksimum | 0.806 | 0.999 | 0.998 | 0.999 |
| Minimum | 0.332 | 0.179 | 0.601 | 0.179 |

Source: Primary Data, processed

The distribution of efficiency levels shows that the two coffee farms in Cilengkrang District are not technically efficient. The average technical efficiency value produced is 0.62 for organic farming and 0.64 for inorganic farming. The meaning of the value indicated is that both organic and non-organic farmers are technically inefficient, as the efficiency levels achieved are 62% for organic farming and 64% for non-organic farming. This means that farmers still have the potential to improve

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production by 38% for organic farming and 36% for non-organic farming through better use of production factors. The findings in this research are different from the research of Tamirat & Tadele (2023) which found that coffee farming on average had a technical efficiency level of ≥ 0.70.

The results of the distribution of technical efficiency provide an overview of the number of efficient and inefficient farmers in coffee farming in Cilengkrang District based on cultivated land. In organic farming, it was found that there are 10 farmers with efficient farming practices, with the highest efficiency among farmers with medium-sized land, totaling 5 farmers, while the lowest efficiency was found among farmers with small land, totaling 1 farmer. There are 24 farmers whose farming practices are inefficient, with the highest number of inefficient farmers found among those with medium-sized land, totaling 14 farmers, and the lowest number of inefficient farmers found among those with large land, totaling 2 farmers. In non-organic farming, there are 16 farmers with efficient farming practices, and 18 farmers with inefficient practices.

The highest technical efficiency in non-organic farming was achieved by farmers with medium-sized land, totaling 9 farmers, while the lowest efficiency was seen among farmers with small land, totaling 1 farmer. The highest frequency of inefficient farmers in non-organic farming is also found among those with medium-sized land, totaling 14 farmers, while the lowest frequency of inefficient farmers was found among those with large land, totaling 1 farmer.

This data aligns with the research by Daini et al. (2020) which states that although farmers with larger land areas often have lower efficiency levels, there are also cases where these farmers achieve higher efficiency. This happens when the production inputs used on larger farms are more optimized. Another factor is that farmers with larger landholdings tend to monitor plant growth more frequently. Based on this, it can be concluded that coffee farming in Cilengkrang District on larger farms involves farmers who are more capable of optimizing input usage compared to those with medium or small landholdings.

According to survey data from farmers, this phenomenon occurs because many coffee farmers in Cilengkrang plant their crops on Perhutani land. When granted land use permits, each farmer is provided with at least 1,000 coffee seedlings. This provision is part of a cooperation agreement between the farmers and the Badan Penyuluhan Pertanian (BPP), which acts as an intermediary between farmers and Perhutani. Based on these field findings, it is clear that farmers with larger landholdings have more coffee trees, leading to a greater contribution to production.

The high or low value of technical efficiency is related to the variables that influence technical inefficiency. The results of the distribution of factors that influence technical inefficiency can be seen in **Table 4.**

**Table 4.** Distribution Results of Technical Efficiency of Coffee Farming in Cilengkrang District

| Variable | Organic Farming | | | Inorganic Farming | | |
|---|---|---|---|---|---|---|
| | Coef. | S. Error | t-ratio | Coef. | S. Error | t-ratio |
| Farmer Age ($Z_1$) | -0,002 | 0,005 | -0,447 | 0,023 | 0,014 | 1,562 |
| Farmer Education ($Z_2$) | 0,044 | 0,028 | 1,565 | -0,093** | 0,038 | -2,411 |
| Farming Experience ($Z_3$) | -0,164*** | 0,030 | -5,307 | -0,038 | 0,123 | -0,315 |
| Family Members ($Z_4$) | -0,023** | 0,009 | -2,410 | -0,026 | 0,034 | -0,748 |
| Farming Status dummy ($Z_5$) | -0,063 | 0,126 | -0,503 | -0,173 | 0,272 | -0,635 |
| Financing dummy ($Z_6$) | -0,034 | 0,123 | -0,280 | -1,169*** | 0,308 | -3,786 |

Source: Primary Data, processed

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The impact of each variable on technical inefficiency in coffee farming in Cilengkrang District varies depending on the type of coffee being cultivated. In organic coffee farming, the significant variables are the number of family members and farming experience. In non-organic coffee farming, the significant variables are the farmer's education and financing dummy. The variables that are not significant in both types of farming include farmer age, farmer education, business status dummy, and financing dummy in organic farming. In non-organic farming, the non-significant variables are farmer age, number of family members, farming experience, and business status dummy.

Farmer education is a significant variable in non-organic farming with a 5% significance level. The coefficient is negative, indicating that as a farmer's education level increases, technical inefficiency in farming decreases. This suggests that farmers with higher education tend to run more efficient farms compared to those with lower levels of education. It is known that 32% of farmers in Cilengkrang District have an education level equivalent to high school, followed by 29% with an education level equivalent to elementary school. The remaining 35% consists of 26% with a junior high school education and 12% with a diploma or university degree. This finding aligns with the research by Sudjarmoko & Randriani (2019) which states that education negatively affects inefficiency. Additionally, research on plantation farming, such as Abdul et al. (2022) on oil palm farming, proves that a higher level of education impacts farming inefficiency, as more educated farmers can more easily adapt to agricultural developments, such as the use of technology. Based on this, there is a need to improve the education level of non-organic farmers in Cilengkrang District to achieve more efficient farming practices.

The level of education referred to in this research is the level of formal education, so the effort or solution that can be made is to equalize education. Equalization of formal education in Indonesia is possible, but this equality depends on the willingness of farmers to receive education. Based on field findings, it is known that many farmers do not feel the importance of equal education and are comfortable with the level of education they have. The comfort with the level of education that farmers have is also due to farmers' perceptions of their age, so farmers are concerned about their ability to absorb knowledge if they have to equalize education. These findings indicate the need for the government's role in providing education regarding the importance of farmer participation in equalizing formal education.

Farming experience is a significant variable in organic coffee farming with a 5% significance level. The coefficient is negative, indicating that as a farmer gains more experience, technical inefficiency in farming decreases. In other words, farmers with more years of experience tend to be more efficient compared to those with less experience. In organic farming, 35% of farmers have at least 21 years of farming experience. The remaining 65% includes 32% of farmers with 16-20 years of experience, followed by 18% with 5-10 years, and 15% with 11-15 years. This finding is consistent with studies by Setiawan et al. (2022) and Saldiman et al., (2021), which state that more experienced farmers tend to be more knowledgeable in managing their farms. Based on this, it is clear that solutions are needed to ensure that farmers in Cilengkrang District gain more farming experience.

The solution to coffee farming in Cilengkrang District can be done through booster activities for farming experience. Based on field results, it is known that farmers with longer experience do not automatically become proficient in coffee farming activities, but rather take part in many booster farming activities. The booster activity in question is taking part in many extension activities held by Farmer Groups or the Cilengkrang District BPP. These field

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findings show that there is a need to encourage farmers to take part in extension activities in order to achieve more efficient coffee farming.

The number of family members has a negative coefficient with a 1% significance level in organic coffee farming. This means that as the number of family members increases, technical inefficiency in farming decreases. In other words, farmers with more family members tend to have more efficient farming practices compared to those with fewer family members. A total of 62% of farmers have 1-3 family members, while the remaining 38% includes 32% of farmers with 4-6 family members and 6% with 7 or more family members. This finding aligns with the research by Neny et al. (2024) and Anh et al. (2019), which states that farmers with more family members are more likely to run efficient farms, as having more family members increases the number of dependents the farmer must support.

The solution that farmers with a smaller number of family members can take to equalize their farming business is to hold discussions with farmers with a larger number of family members. Based on the survey results, farmers with a larger number of family members have thoughts that are very oriented towards producing more coffee than in the previous season, this thinking is what can make farmers continue to improvise their farming business. These findings the need to establish a discussion space between farmers in order to obtain a better level of farming efficiency.

The financing dummy is a significant variable with a 1% significance level and a negative coefficient in non-organic coffee farming in Cilengkrang District. In this study, farmers who did not receive financing were given a value of zero (0), while those who received financing were given a value of one (1). The findings indicate that when farmers receive financing for their farming activities, it reduces technical inefficiency. In other words, farmers who have access to financing tend to run more efficient operations compared to those without financing. In non-organic farming, it is found that 62% of farmers do not receive financing, while 38% do. This finding is consistent with the research by Wambua et al. (2021) and Tamirat & Tadele (2023), which explains that farmers with access to financing are better equipped to address financial challenges in their operations. This is because they can afford to purchase better farming inputs compared to those who do not have financing access. Based on these findings, it is clear that access to financing is an important factor in achieving efficient farming practices.

Cilengkrang District farmers have access to financing from various sources. Based on field findings, it is known that farmers with large areas of land tend to get access to financing from banks, while farmers with medium-sized land get more access to financing through loans from family members or savings and loan cooperatives, while farmers with small areas of land tend not to get any financing. Farmers with limited land often do not get bank financing due to the too-small land area, the same thing applies to farmers with medium land. As for farmers with small land areas, it is known that they do not get loans from family members or savings and loan cooperatives due to the perception of borrowers, who think that the loans that will be given are not commensurate with the length of time for repayment of the loans given, this is because farmers with small land areas They have to use an installment system because the production from their cultivated land is not very large. Based on these findings, it is known that there is a need for the government's role to encourage farmers to access financing to make it easier to obtain financing, especially from banks that can only lend financing if their land area is categorized as large.

## CONCLUSION

The production factors of coffee farming that influence organic coffee farming are land area and liquid organic fertilizer (LOF). Meanwhile, in inorganic agriculture, the

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influencing variables are land area, urea fertilizer and KCl fertilizer. The average technical efficiency of coffee farmers in Cilengkrang District is 62% for organic farming and 64% for non-organic farming. There is an opportunity for improvement in efficiency by 38% in organic farming and 36% in non-organic farming. The factors influencing technical efficiency in organic farming include farming experience and the number of family members. In non-organic farming, the significant factors are education level and the financing dummy. This study focuses on the organic and non-organic Arabica coffee farming in Cilengkrang District, Bandung Regency, West Java. Therefore, the scope of this research is limited to analyzing the input factors that influence production and technical efficiency in Cilengkrang. The input factors considered in this study do not include the use of coffee plant pesticides. Additionally, the number of coffee trees was not used as an input factor in this research. This decision was made due to the violation of classic assumptions that must be met, leading the researcher to exclude this variable. Furthermore, this study can still be developed, as it does not include a cost efficiency assessment.

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