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# Analyzing Efficiency of Coffee Agribusiness in Malang: Data Envelopment Analysis Approach

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**Abstract.** The Malang Regency holds significant potential for the advancement of coffee plantations as a leading commodity. The Dampit District has emerged as the top district in coffee production, producing 2,280.30 tons. The aim of this research is to assess the technical effectiveness of the robusta coffee sector in the Dampit District of Malang, Indonesia. The approach employed in this research to achieve its aims is Data Envelopment Analysis (DEA). Technical efficiency is evaluated to measure the productivity of robusta coffee farms located in the Dampit District of Malang Regency. The results of the research suggest that there exists a particular region with a relatively efficient score of 1. This region acts as a standard by which other regions can be evaluated. We engaged 10 groups of farmers, referred to as DMUs (Decision Making Units) in the DEA method. Based on the results of the Data Envelopment Analysis (DEA), it is clear that the robusta coffee plantations in Dampit District, Malang Regency, have not achieved optimal levels of efficiency in their operations. The use of different input variables, such as land area, tree quantity, and fertilizer volume, has resulted in less-than-optimal results.

## 1 Introduction

Indonesia has the potential to become a major coffee producer. According to data from the Food and Agriculture Organization (FAO), Indonesia is projected to rank as the third largest coffee producer in the world, following Brazil and Vietnam, in 2023. Nevertheless, the projected coffee exports from Indonesia are not expected to surpass the exports from Brazil, Vietnam, and Colombia [1] [2]. Indonesia is globally recognized for its diverse range of specialty coffees, which have gained a notable reputation in the international coffee market [3] [4] [5]. According to information provided by the United States Department of Agriculture (USDA), global coffee production is projected to reach 170 million 60-kilogram bags in the 2022/2023 season. There was a 2.8 percent increase in this figure compared to the previous period (year-on-year/yoy), when the production of coffee reached 165.37 million bags in 2021/2022. In specific, Indonesia's production amounts to 1.3 million bags of Arabica coffee and 10.5 million bags of Robusta coffee. Up to 75 percent of the coffee cultivated in Indonesia originates from the lowland regions in South Sumatra and Java.

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In 2021, Indonesia's coffee exports totaled a value of USD 842,500,000 with a volume of 380,200 kg, as reported by the Central Statistics Agency. In the year 2020, the export value of coffee commodities experienced a slight decrease compared to 2021, amounting to USD 809,200,000 with a volume of 375,600 kg. In 2021, Indonesia's export value to the United States from the coffee sector alone amounted to USD 194,769.10. In the year 2020, the value of coffee exports to the United States exceeded that of the previous year, reaching a total of USD 202,352.00. Based on the available data, Indonesia encountered variations in its economic performance [6]. This occurrence was the result of multiple influences, among which the Covid-19 virus played a significant role in the alteration of the exchange rate, coffee prices, and GDP of both the United States and Indonesia.

According to Putri et al. [7], the coffee producing regions in Indonesia are categorized into distinct areas based on the percentage of each region. These regions include South Sumatra (Pagar Alam, Indragiri Hulu), Lampung (West Lampung Regency, Tanggamus, North Lampung), Bengkulu (Kepahiang, Curup, Rejang Lebong), East Java (Jember, Banyuwangi, Situbondo, Bondowoso, Malang, Jombang), North Sumatra (Tapanuli, Pematang Siantar, Samosir, Sidikalang), NAD (Central Aceh, Bener Meriah), South Sulawesi (Toraja, Polmas, and Enrekang), and West Sumatra (Agam, Padang Pariaman, Tanah Datar, Solok, and Pasaman). Indonesian coffee benefits from its authentic nature, presenting a diverse range of varieties, differing in quality and flavor profiles. Indeed, the global recognition of Indonesian coffee attests to its superiority. The unique flavor of coffee is impacted by the geographic location in which the coffee beans are cultivated. The favorable conditions for coffee cultivation in Indonesia include its tropical climate, extensive land area, numerous mountainous regions, and ample water resources. These factors contribute to the country's suitability for the successful cultivation of coffee. Hameed Et al. [8] point out that various factors such as soil fertility, nutrient availability, soil chemical composition, geographical conditions, and rainfall, as well as the maintenance of coffee plantations, are significant influencers of taste in Indonesia.

The Malang Regency exhibits significant potential for the advancement of coffee plantation production as a premium commodity. According to the statistics provided by the Central Statistics Agency (BPS) of Malang Regency, Dampit District has the highest coffee production at 2280.30 tons, followed by Tirtoyudo District as the second highest coffee producer at 1948.78 tons. The Dampit District has the capacity to support the cultivation of Robusta coffee plantations, with a particular potential for the development of smallholder plantations. The agricultural landscape and climate in this region are highly conducive to the cultivation and growth of Robusta coffee. Nevertheless, at present, farmers in the Dampit region are encountering numerous challenges in cultivating Robusta coffee. The fluctuation of selling prices and a year-on-year decrease in production pose a challenge for farmers in assessing the profitability of their coffee plants. Additionally, there is competition from other regional coffee varieties entering the market in the Dampit area, leading to a decrease in the price of Robusta coffee in the region. Hence, this study was undertaken to assess the effectiveness of robusta coffee cultivation in the Dampit District of Malang Regency.

Exploring the coffee agribusiness in Dampit District using Data Envelopment Analysis (DEA) presents several novel aspects that can contribute significantly to the field of agricultural economics and business management. applying DEA to explore the coffee agribusiness in Dampit District offers a novel approach by providing detailed, localized efficiency assessments, guiding resource optimization, influencing policy and development strategies, and fostering comparative and sustainable practices. This focused analysis can lead to more effective interventions and improvements in the coffee industry specific to the region.

## 2 Research method

This study included a total of 100 participants who were drawn from 10 farmer associations located in 3 villages within Dampit District. The participants in this study are individuals residing in rural villages who are engaged in the cultivation of robusta coffee and are affiliated with the "Sridonoretno" agricultural collective in villages situated within the Dampit District. The research findings were derived from data gathered from surveys and on-site observations. This data comprises the demographic traits of survey participants sourced from the indicator data pertaining to the level of technical effectiveness among robusta coffee farmers in the region.

The initial phase of this study involved administering surveys to farmers categorized according to DMU (Decision Making Unit) criteria within the framework of the Data Envelopment Analysis (DEA) method [9]. Subsequently, the collected data was subjected to analysis utilizing the DEA model. Researchers typically utilize the regional DMU category, in which the region under examination is characterized by identical input and output parameters. A quantitative analysis was conducted to assess the efficiency outcomes of the inputs and outputs utilized in the Data Envelopment Analysis (DEA) model [10] [11] [12]. This study employs the assistance of Banxia Frontier Analyst software for conducting quantitative research.

The study was conducted in rural areas located within the Dampit sub-district of Malang Regency. We will collect samples from villages identified as having the potential for robusta coffee production as part of their business operations. These samples will be selected based on similar input and output factors and will be analyzed using the Data Envelopment Analysis (DEA) approach.

DEA is a method for conducting linear programming analysis, which serves to evaluate the comparative efficiency of individual production units in relation to others that share the same production objectives [13]. The production unit within the context of Data Envelopment Analysis (DEA) is referred to as the Decision-Making Unit (DMU) [14] [15]. This study will focus on the evaluation of several DMUs located in the Dampit District of Malang Regency. The DEA will generate an efficiency score that falls within the range of 0-100 percent. This score is indicative of the level of efficiency achieved by the entity under evaluation. A DMU with a score lower than 100 percent is indicative of inefficiency, as per the principles of DEA. An efficient DMU is characterized by achieving a score of 100 percent in DEA analysis.

The technical efficiency analysis findings will categorize the regions into three conditions: efficient, near efficient, and inefficient areas. Regions that are considered to be inefficient and operating close to the efficiency frontier will be assigned a score of less than 100 percent, 0-89% will be assigned to Inefficient and 90-99 classified as Almmost-Eficient. These regions will exhibit input-output factors as depicted by the frontier diagram, without approaching the value of zero. In contrast, regions with a satisfactory outcome score are represented with a value of 100 percent, indicating the input-output factor displayed in the frontier diagram as 0, highlighting the untapped potential and efficiency of the area utilized in the DMU.

## 3 Results and discussion

According to the analysis conducted using the Banxia Frontier Analysis for the Data Envelopment Analysis (DEA) method, it was determined that the DMU utilized consists of 10 farmer group units located in 3 villages within the Dampit District of Malang Regency. The status of the 10 currently operational DMUs has been understood. The DMUs with a 100% score are considered to be the most efficient areas and are indicated by being colored in green. Subsequently, DMUs with a rating of 90-99% represent regions that are in close proximity to being efficient and are indicated with a yellow label. Last but not least, an area with an

DMU score of 89-0% is identified as inefficient and denoted in red. Table 1 depicts the findings of the analysis.

**Table 1**. Results of Analysis

| Unit Name | Score | Efficient Condition |
|---|---|---|
| AbdiTani | 83.20% | 🔴 |
| BumiSubur | 66.50% | 🔴 |
| SuburMakmur | 83.80% | 🔴 |
| SumberTani | 97.60% | 🟡 |
| TaniHarapan | 60.50% | 🔴 |
| TaniMaju | 66.70% | 🔴 |
| TaniMakmur 74 | 95.60% | 🟡 |
| TaniRukun | 100.00% | 🟢 |
| Tugusari | 78.30% | 🔴 |
| kopisari | 83.60% | 🔴 |

As depicted in Figure 1, all inputs and outputs indicate a value of 0, suggesting that all aspects of the Tani Rukun DMU exhibit maximum efficiency, achieving a level of 100 percent efficiency. As a result, the Tani Rukun DMU has established itself as a benchmark for other DMUs. The Tani Rukun DMU will serve as a benchmark for efficiency for other DMUs, aiming to achieve higher efficiency standards.

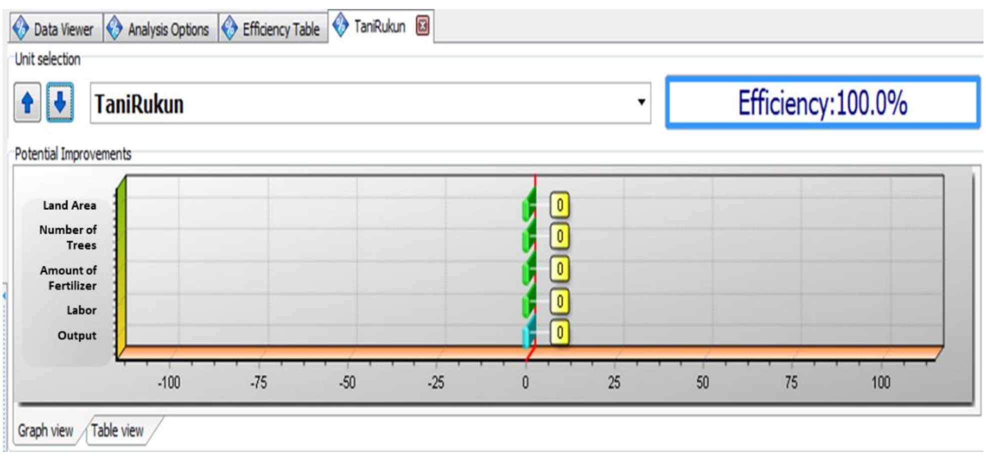


**Fig 1**. Result for Abdi Tani Rukun

### 3.1 Abdi Tani Group

According to the calculations, the DMU of Abdi Tani is classified as inefficient, as indicated by the red color (Fig 2). In order to enhance the efficiency of the Abdi Tani DMU, it is imperative to undertake various measures, including reducing the utilization of fertilizer and labor, and subsequently enhancing the output. The Abdi Tani DMU exhibits efficient land area and tree count in comparison with the reference efficient DMU, the Tani Rukun DMU.

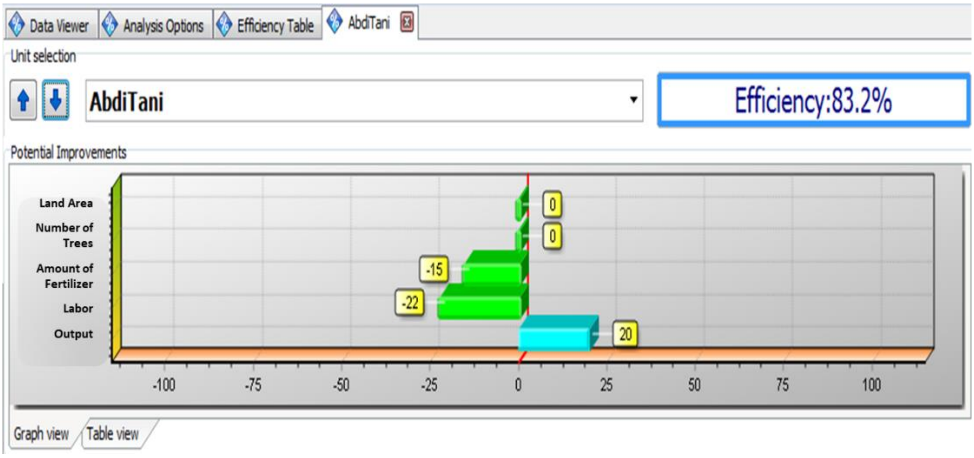


**Fig 2**. Result for Abdi Tani Group

Based on the data presented in Figure 2, it is essential for the Abdi Tani DMU to carefully manage its land area, quantity of trees, fertilizer usage, labor input, and production output in order to attain an efficient DMU rating. The land area and tree count have both registered zero, indicating that the land area and number of trees are operating at peak efficiency. The quantity of fertilizer is indicated by the number 15 on the left (-15), indicating that the quantity of fertilizer should be decreased by 15% of the quantity utilized by the DMU. The graph depicted in Fig 2 indicates a decrease of 22 workers, represented by the negative value -22. This signifies a reduction of 22% from the overall workforce employed by the DMU. Subsequently, the Abdi Tani DMU's output displays a value of 20 on the right side, indicating that an increase in output is necessary for the Abdi Tani DMU to achieve maximum efficiency of 100%.

## 3.2 Bumi Subur Group

Figure 3 displays the efficiency score of the Bumi Subur DMU at 66.5% and is marked in red, indicating that this DMU is also deemed inefficient. For the Bumi Subur DMU to operate efficiently, it is essential for the DMU to consider the optimal utilization of land area, tree count, fertilizer quantity, labor input, and output in order to achieve a high efficiency score.

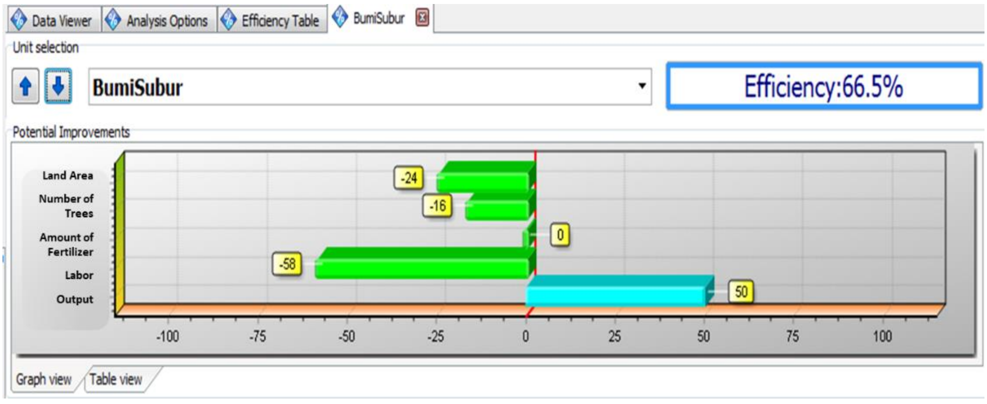


**Fig. 3**. Result for Bumi Subur Group

The indicated notation of -24 on the land area of DMU Bumi Subur signifies a reduction of 24% from the current land area. The quantity of trees is represented by the coefficient -15, indicating a 15% reduction in the number of trees within the Decision-Making Unit (DMU). The level of fertilization is indicated as 0, suggesting that the fertilizer utilization in this DMU is optimal. The figure on the graph indicates a decrease of 58 workers to the left (-58), signifying a corresponding reduction of 58% in the total workforce employed by the DMU. Subsequently, the Bumi Subur DMU produces an output of 50, indicating a need for a 50% increase in output to attain efficiency at 100%.

### 3.3 Subur Makmur Group

The analytical findings for Subur Makmur DMU are depicted in Figure 4. The efficiency score of Subur Makmur is 83.8 percent, indicating that it is not as efficient as Tani Rukun, which is the most efficient DMU.


**Fig. 4**. Result for Subur Makmur Group

For the Subur Makmur DMU to operate at top efficiency, it is essential for the DMU to carefully consider aspects such as land area, tree quantity, fertilizer quantity, labor, and output in order to attain an optimal efficiency rating. The expanse of DMU Subur Makmur bears the mark 33 to its left (-33), denoting a requisite reduction of the land area by 33%. The numerical representation to the left (-26) indicates a reduction of 26%, thus necessitating a decrease in the current number of trees by a corresponding amount. The quantity of fertilizer is indicated as 0, suggesting that its utilization in this DMU is deemed efficient. The graph shows a workforce tally of 63 to the left, indicating a 63% reduction in the DMU's total labor force. After much anticipation, the Subur Makmur DMU's output reveals a figure of 19 on the right-hand side, indicating that a 19% increase in output is necessary for the Subur Makmur DMU to achieve optimal efficiency at 100%.

### 3.4 Sumber Tani Group

The efficiency score of Sumber Tani Group is 97.6 percent, indicating a high level of efficiency (see Fig 5.). This demonstrates that the organization operates close to an optimal level of effectiveness in its processes and operations. Based on the graph displayed, for the Sumber Tani DMU to operate efficiently, it is necessary for the DMU to optimally consider factors such as land area, number of trees, amount of fertilizer, labor, and output in order to achieve an efficient score.

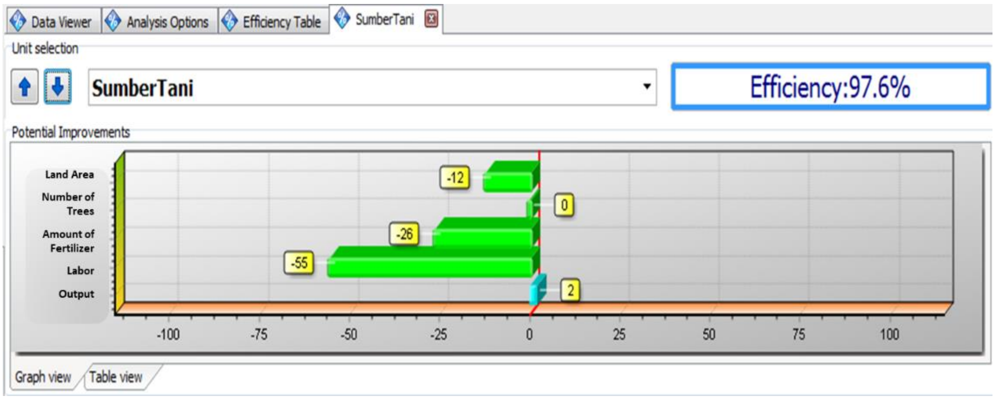


**Fig. 5**. Result for Sumber Tani Group

The land area of DMU Sumber Tani indicates a value of -12 to the left, signifying a necessary reduction of 12 percent in the land area. The zero count of trees indicates that the use of fertilizers in this Decision-Making Unit (DMU) is effective. The quantity of fertilizer is indicated by the number 26 to the left (-26), corresponding to a required reduction of 26 percent in the amount of fertilizer. The graph indicates that there is a decrease of 55 workers, denoted by -55 to the left of the graph. This signifies a reduction of 55 percent of the total workforce belonging to the DMU. Subsequently, the Sumber Tani DMU's output reveals a figure of 2 on the right, signifying that a 2 percent increase in output is necessary in order for the Sumber Tani DMU to attain an optimal level of 100 percent efficiency.

### 3.5 Tani Harapan Group

The efficiency score of the Tani Harapan DMU is 60.5 percent and is indicated as red, implying that this particular DMU is operating inefficiently. This is illustrated in Figure 6. For Tani Harapan to operate efficiently, it must carefully consider the land area, tree count, fertilizer quantity, labor input, and output level in order to achieve an optimal efficiency score.

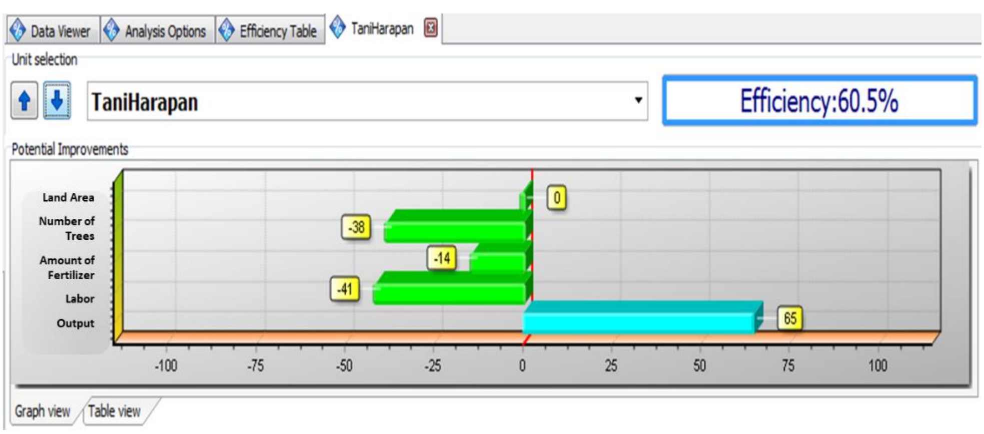


**Fig. 6**. Result for Tani Harapan Group

The DMU has a land area indicating 0, which suggests that the land area in this DMU is being utilized efficiently. The numerical representation of trees indicates a value of 38 to the left (-38), signifying a necessary reduction of 38 percent in the total number of trees. The indicated fertilizer quantity is denoted by the numerical value -14, signifying a necessary reduction of 14 percent in the fertilizer amount. The quantity of employees depicted in the graph indicates a figure of 41 to the left (-41), indicating that the workforce must also be diminished by 41 percent of the total workforce possessed by the DMU. Subsequently, the Tani Harapan DMU output registers at 65 to the right, indicating that a 65 percent increase in output is necessary for the "Tani Harapan" DMU to achieve an optimal efficiency level of 100 percent.

### 3.6 Tani Maju Group

Tani Maju Group attained a rating of 66.7 percent and is designated with a red mark, indicating inefficiency (refer to Figure 7). For the Tani Maju DMU to function efficiently, it must consider the land area, tree count, fertilizer usage, labor, and output in an optimal manner to attain a high efficiency score.

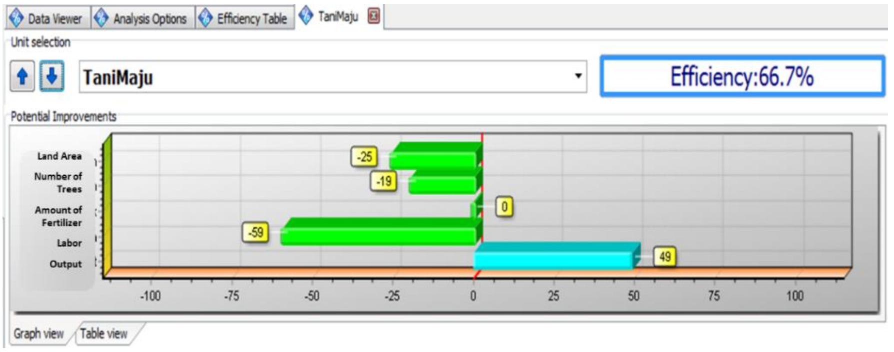


**Fig. 7**. Result for Tani Maju Group

The expanse of DMU Tani Maju reveals a conspicuous numeral to the tracts' left side (-25), indicative of a requisite reduction in land area by a quarter. The numeral 19 appears to the left, indicating a diminishment of trees by 19 percent. The fertilizer quantity is depicted as zero, indicating that the usage of fertilizer in this DMU is effective. The workforce figure is represented by the numeral 59 on the left (-59), indicating that a reduction of 59 percent of the total DMU workforce is necessary. Lastly, the Tani Maju DMU's output indicates a 49 to the right, indicating a need for a 49 percent increase in output to attain optimal efficiency of 100 percent.

### 3.7 Tani Makmur 74 Group

According to the calculations, The DMU of Tani Makmur 74 achieved a score of 95.6 percent, indicating it is nearing efficient levels and is highlighted in yellow in Figure 1.

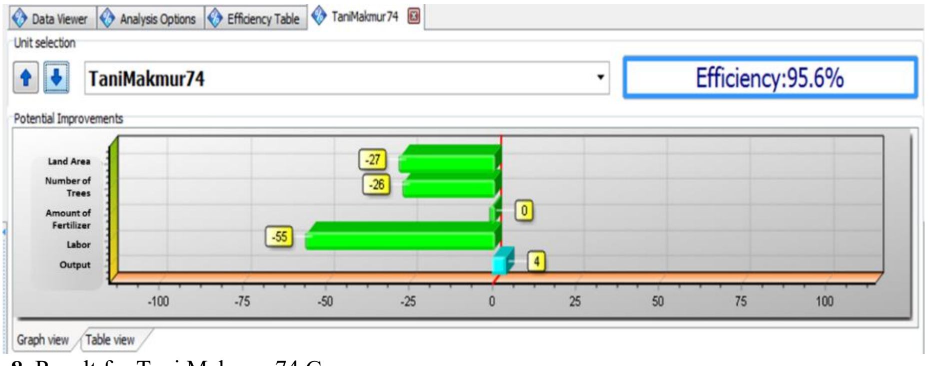


**Fig 8**. Result for Tani Makmur 74 Group

Figure 8 shows that Tani Makmur 74 needs to decrease its land area by 27 percent in order to improve efficiency. The trees are represented by the number 26 on the left, indicating a 26% reduction in the number of trees. The data indicates that the amount of fertilizer used in this DMU is efficient as it shows a value of 0 on the scale. The number of workers is indicated as -55, indicating the need for a reduction of 55 percent from the total workforce of the DMU. Finally, the reading on the display at DMU Tani Makmur 74 indicates 49 to the right, indicating that the output requires a 49 percent increase.

### 3.8 Tugusari Group

According to the data depicted in Figure 9, the efficiency score of the Tugusari DMU stands at 78.3%, indicating that this particular DMU is inefficient.

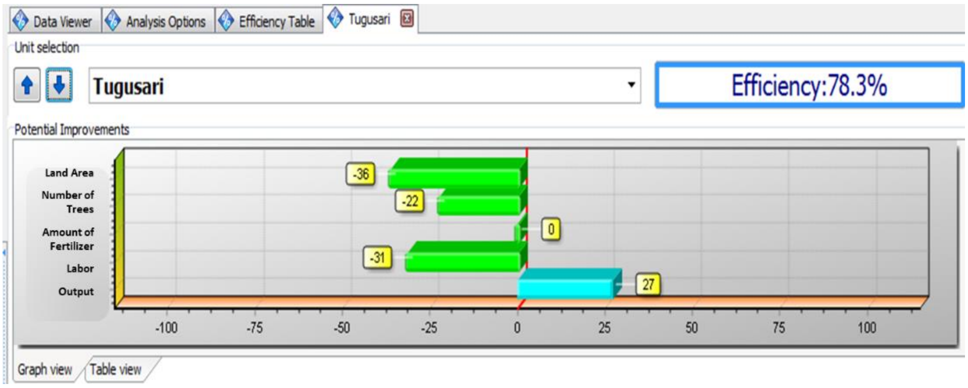


**Fig. 9**. Result for Tugusari Group

Figure 9 indicates the Tugusari DMU land area aspect, displaying a value of -36 to the left, signifying a required reduction of 36 percent in the land area. The quantity of trees is indicated by -22, signifying a decrease of 22 percent in the total number of trees. The quantity of fertilizer present indicates a value of 0, reflecting the efficient utilization of fertilizer in this Decision-Making Unit (DMU). The figure of 31 indicated to the left (-31) represents the quantity of workers, signifying a necessity to decrease the workforce by 31 percent of the total DMU workforce. Subsequently, the output displayed at the Tugusari DMU indicates a 27 percent shortfall, necessitating a corresponding increase in output to achieve optimal efficiency of 100 percent.

### 3.9 Kopisari Group

The final DMU identified is the Kopisari Group, which possesses an efficiency rating of 83.6 percent. According to the data depicted in Figure 10, for the Kopisari DMU to operate efficiently, it is imperative that it carefully manages factors such as land area, tree count, fertilizer quantity, labor, and output in order to attain a high efficiency score.

The land area of the Kopisari DMU indicates a value of 0, signifying that the utilization of fertilizer in this DMU is deemed efficient. The quantity of trees represents the value of 0, signifying the efficient utilization of trees in this DMU. The quantity of fertilizer is indicated by the figure 15 to the left (-15), signifying a reduction of 15 percent in the number of trees. The numerical representation indicates a decrease in the workforce of 13 percent, aligning with the reduction of 13 workers from the total workforce belonging to the DMU. Ultimately, the result displayed on the Kopisari DMU indicates a value of 19 to the right, signifying a requirement for a supplementary output of 19 percent.

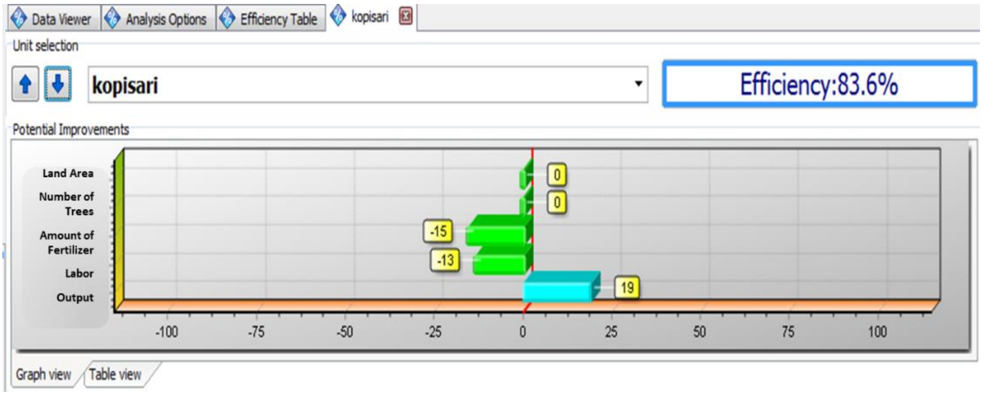


**Fig. 10**. Result for Kopisari Group

### 3.10 Discussion

This research conducted on 100 respondents from three villages (Srimulyo, Sukodono, and Baturetno) in Dampit District, Malang Regency, Indonesia, which are part of the "Sridon-oretno" coffee farmers' association, revealed that coffee farming in the district is generally efficient. However, the study also identified several Decision-Making Units (DMUs) that exhibited less than optimal efficiency. Among the surveyed DMUs, Tani Rukun achieved the highest efficiency score of 100%, followed by Sumber Tani with 97.6% and Tani Makmur with 95.6%.

The research findings indicate that land utilization in robusta coffee plantations within Dampit District is suboptimal, with certain areas exhibiting excessive land allocations relative to the number of coffee trees. This imbalance leads to inefficiencies in land use, as substantial portions of land remain unproductive. Nevertheless, the study identified a subset of Decision-Making Units (DMUs) that have optimized their land use. Through the application of Data Envelopment Analysis (DEA), the study revealed that four specific DMUs (Abdi Tani, Tani Harapan, Tani Rukun, and Kopisari) have attained an efficient frontier in terms of land allocation, signifying optimal utilization of land resources.

The research findings also indicate that the density of robusta coffee trees in Dampit District has been optimized. The implementation of shade trees, specifically Leucaena leucocephala, has been crucial in providing the necessary microclimate for young coffee plants. An evaluation of several Decision-Making Units (DMUs) reveals that the number of coffee trees cultivated by Abdi Tani, Sumber Tani, Tani Rukun, and Kopisari is in alignment with their respective land areas, suggesting an efficient allocation of resources and a maximization of coffee yields.

Fertilizer management in robusta coffee plantations of Dampit District is characterized by a mix of traditional and modern practices. While the prevalent use of organic fertilizers, particularly farmyard manure, reflects a growing awareness of soil health, the overall fertilizer application rates still exhibit inefficiencies. A subset of Decision-Making Units (DMUs), including Bumi Subur, Subur Makmur, Tani Maju, Tani Makmur 74, Tani Rukun, and Tugusari, have demonstrated efficient fertilizer utilization. However, the study highlights the need for a more balanced and sustainable fertilizer management approach in other DMUs to mitigate the risk of soil degradation and ensure long-term productivity.

The last input is the Labor Force. The research findings highlight the excessive use of labor in the agricultural sector of Dampit District. Although it is customary for entire families to be involved in farming, efficiency analysis has revealed that the majority of Decision-Making Units (DMUs) exhibit labor redundancy. Only DMU Tani Rukun has demonstrated optimal labor utilization. These results imply that there is scope for improving productivity by reallocating labor resources.

## 4 Conclusion and recommendation

Data Envelopment Analysis (DEA) reveals that robusta coffee plantations in Dampit District, Malang Regency, are operating below their optimal efficiency levels. The primary constraint hindering efficiency lies in the unbalanced allocation of input resources, such as land area, number of trees planted, and fertilizer application. This suboptimal resource allocation results in less-than-ideal coffee yields. Among the farmer groups studied, the Tani Rukun group stands out as the most efficient, demonstrating best practices in resource management and production techniques. The Malang Regency government should prioritize initiatives to enhance coffee production efficiency in Dampit District. By investing in training programs for coffee farmers, providing technical assistance, facilitating access to agricultural inputs, supporting farmer cooperatives, and improving infrastructure for coffee processing and storage, the government can create a more conducive environment for sustainable coffee production. These measures will empower farmers, improve the quality of coffee products, and strengthen the local coffee industry.

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## References

1. O. Capps, M. Cheng, J. Kee, and S. L. Priestley, Agribusiness **39**, (2022)
2. C. J. Ramirez-Gomez, M. S. M. Saes, V. L. dos S. Silva, and R. Souza Piao, International Journal of Agricultural Sustainability **20**, 1 (2022)
3. S. P. Nasution, R. P. Wibowo, T Supriana, and None Iskandarini, IOP Conference Series: Earth and Environmental Science **1302**, (2024)
4. D. Apriani, F. Marissa, and A. M. Igamo, Jurnal Paradigma Ekonomika **17**, 261 (2022)
5. S. O. Fortunika, Harianto, and Suharno, E3S Web of Conferences **232**, (2021)
6. Z. Bacsi, M. Fekete-Farkas, and M. I. Ma'ruf, Foods **11**, 3036 (2022)
7. S. P. Putri, T. Irifune, Yusianto, and E. Fukusaki, Metabolomics **15**, (2019)
8. A. Hameed, S. A. Hussain, and H. A. R. Suleria, Bioactive Molecules in Food 1 (2018)
9. L. M. Sabroso and A. M. Tamayo, European Journal of Economic and Financial Research **6**, (2022)
10. M. Gardijan Kedžo and Z. Lukač, European Journal of Operational Research **291**, (2020)
11. D. N. L. Tran, T. D. Nguyen, T. T. Pham, R. F. Rañola, and T. A. Nguyen, Sustainability **13**, 6603 (2021)
12. M. T. Rahman, R. Nielsen, M. A. Khan, and M. Asmild, Aquaculture **509**, 140 (2019)
13. S. A. Rakhshan, Journal of the Operational Research Society **68**, 906 (2017).
14. X. Xiong, G. Yang, and Z. Guan, Journal of Informetrics **14**, 101049 (2020).
15. S. A. Banihashemi and M. Khalilzadeh, World Journal of Engineering **17**, 573 (2020).