A comparative study of Jarak Towo cassava farming in the mountainous areas of Karanganyar Regency in supporting the availability of raw materials for food processing industry

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Abstract. Cassava is a commodity that is commonly marginalized. However, jarak towo cassava is exceptional as this variety has a large market potential with a more competitive price. However, only a few farmers are aware of this business potential. This study aimed to conduct a comparative study of the cropping patterns of jarak towo cassava to investigate the farmers' income or profit more thoroughly. This study was carried out in three sub-districts, including Jatiyoso, Tawangmangu, and Ngargoyoso, the respondents were taken using snowball sampling, with 20 respondents from each sub-district. The results showed that farmers in Ngargoyoso Sub-district spent the highest total cost. Meanwhile, farmers in Jatiyoso Sub-district received the highest income and profit. The highest efficiency was shown by farmers in Jatiyoso, while the lowest efficiency was performed by farmers in Tawangmangu. These findings depict how farmers develop jarak towo cassava farming in meeting the market demand.

1. Introduction
Cassava is a food commodity serving as a buffer against food insecurity [1]. Cassava substitutes food and diversifies daily consumption patterns [2]. According to Praswida [3], the economic value of cassava commodities as food and the main livelihood of the Wonogiri people has decreased, but this is different at the national level. The consumption of food made from cassava tends to increase which is indicated by the increasing cassava import from year to year. This condition is inversely proportional with the tendency of decreasing the production and harvest area at the national level. It can be seen from the average growth rate, which decreased by 0.89% per year, with the harvested area of 1.41 million hectares in 1980 to 0.87 million hectares in 2016. In the last five years, the growth rate in the cassava harvested area has decreased more significantly, 5.37% per year. Meanwhile, the import growth in the 2000-2015 period reached 76.32% [4].

Cassava is cultivated in tegalan (non-irrigated dry fields) and yards because it does not require much water. A type of cassava that is currently in people's demand in Karanganyar Regency is jarak towo cassava. The local farmers call this jarak towo cassava based on the name given by the ancestors because the Ministry of Agriculture has not provided the official name for this variety. Farmers cultivate this cassava with intercropping or monoculture patterns on mountain slopes or arable land. The variety of
processed food from cassava is very promising for the development of culinary businesses [5]. The development of cassava processing agro-industry, restaurants, and hotels, as well as the development of tourist areas in Karanganyar Regency, have increased the demand for jarak towo cassava.

The high demand for jarak towo cassava is not followed by the availability as not all areas in Karanganyar Regency are suitable for cultivating jarak towo cassava with high-quality yields. This variety can only be harvested at a minimum of eight months harvest period. Jarak towo cassava is sweet, soft, and delicious so that it is suitable to be used as a raw material for cassava-based processed food, one of which is frozen food. The selling price is IDR3,000.00 - IDR5,000.00 per kilogram, which is much higher than the price of other types of cassava in general (IDR500.00 to IDR1,500.00 per kilogram). However, farmers are not yet oriented to cultivate it massively on their agricultural land. Therefore, it is necessary to conduct a comparative study of the cropping patterns of jarak towo cassava to investigate more deeply the income or benefit farmers obtain from their farming. The results of this study can serve as references for making policies for developing jarak towo cassava in supporting the availability of food processing industries.

2. Research method
The basic method applied in this study was analytical descriptive, which explains the extent of agreement on the presented results [6]. The research data were obtained using a cross-sectional technique, with the survey, interview, and observation methods [7]. The study was conducted in Karanganyar Regency, with the characteristic of distinctive taste as mentioned in Figure 1. Based on the information, good quality jarak towo cassava was found in three sub-districts, namely Tawangmangu, Karangpandan, and Jatiyoso, as displayed in Figure 2.

![Figure 1. Description of jarak towo cassava plan](image1.png)

![Figure 2. Location map](image2.png)

Two villages in Jatiyoso (Wonorejo and Beruk), three villages in Tawangmangu (Tengklik, Sepanjang, and Plumbon), and two villages in Ngargoyoso (Kemuning and Ngargoyoso) were taken as samples. It was based on the information from local field extension officers that recognize deeply high-quality jarak towo cassava. A total of 20 farmers cultivating jarak towo cassava with monoculture and intercropping systems in each sub-district took part in this study. The total respondents were 60 farmers,
which were taken using a snowball sampling technique because the data of farmers and the amount of jarak towo cassava production were not available at the village, sub-district, and regency levels. The obtained data were then cross-checked with field extension officers and the managers of the farmer groups cultivating the cassava. The data analysis was performed by examining the income and profit from farming, while efficiency was analyzed using the concept of the R/C ratio. If R/C > 1 is efficient; R/C = 1 is break even point (BEP); and R/C < 1 is not efficient. T-test was used to find out the differences among jarak towo farming practices with monoculture and intercropping [8]. Cost and revenue were calculated for 2019.

3. Results and discussion

3.1. The characteristics of respondents

Understanding the farmers’ socio-economic characteristics is important to attain the depiction of farmers’ capacity as the main subjects in farming activities [9]. The characteristics of respondents include land tenure, gender, age, status in the household, education, number of family members, number of family members active in jarak towo cassava farming, and experience. Table 1 provides information on the characteristics of respondents in jarak towo cassava cultivation in Jatiyoso, Ngargoyoso, and Tawangmangu Sub-districts.

| Description | Jatiyoso Sub-district | Ngargoyoso Sub-district | Tawangmangu Sub-district |
|-------------|-----------------------|-------------------------|--------------------------|
| Number of the respondent (people) | 20 | 20 | 20 |
| Average land tenure (m$^2$) | 1,243 | 625 | 2,535 |
| Average age of farmer (year) | 43 | 58 | 54 |
| Average length of education (year) | 7.8 | 9.2 | 5 |
| Majority of gender | Male | Male | Male |
| Majority of status in the household | Head of a family | Head of a family | Head of a family |
| Average number of farmer’s family member (people) | 4 | 4 | 4 |
| Average number of a family active in jarak towo cassava cultivation (people) | 2 | 1 | 2 |
| Average experience in cultivating jarak towo cassava (year) | 19 | 18 | 31 |

Source: Primary Data Analysis, 2020

In general, based on the area of land ownership, farmers in Tawangmangu were classified as small-scale farmers, while those in Ngargoyoso and Jatiyoso were categorized as peasants [10]. The average cassava farmers in the three sub-districts are not young but are productive [11]. Productive farmers commonly have stronger physical energy and a higher working spirit because they are responsible for meeting family needs and have more family members. Moreover, it is easier for productive farmers to adopt and implement innovations to improve their skills in growing jarak towo cassava [9]. They plant jarak towo cassava because the price of this cassava is higher than those of other types of cassava. However, in terms of business management, young farmers are more responsive in responding to dynamic business changes [11].

Education level contributes to farmers’ ability in understanding information in agriculture and encourages the adoption of innovation and technology in agriculture [9]. This factor also influences farmers’ mindset and attitude when practicing farming. Table 1 presents that most farmers in Ngargoyoso are junior high school-graduates, while those in Tawangmangu and Jatiyoso have a lower level of education. The level of education affects farmers’ way of thinking and the ability to develop their farming [12]. Jarak towo cassava farmers tend to practice farming by continuing the systems that have been passed down from their parents and ancestors.
The length of farmers’ experience in cultivating jarak towo cassava varies; most farmers in Tawangmangu have the longest experience, followed by the farmers in Ngargoyoso and Jatiyoso, respectively. The longer the experience in farming is, the more experienced farmers will be in managing their farming [13]. Risks and uncertainties in practicing farming have been well calculated based on previous experiences [14]. This shows that this type of cassava was planted for a long time in Tawangmangu, but it was not as well-known as it is today.

3.2. The characteristics of jarak towo cassava farming

Farming practiced by the farmers in the study areas, including cropping patterns, is the result of past experiences influenced by physical, economic, cultural, and climatic conditions [15]. Cultivation of jarak towo cassava is carried out by monoculture and intercropping in the three sub-districts. The monoculture cropping pattern is applied on land with a great inclination of the slope, with enough rainwater availability, and in the yard. Meanwhile, the intercropping pattern is a cultivation system in which cassava is planted together with other crops. On land with adequate water, vegetables and cassava are planted with intercropping, where two to three types of plants, including jarak towo cassava are grown together, such as cassava-cabbage-mustard greens, cassava-mustard greens-chili, cassava-corn, cassava-cabbage-mustard greens, cassava-green beans-mustard greens, cassava-mustard greens-carrots, cassava-leeks, and the other combination. The vegetables can be planted two to four times based on the type. When cassava and mustard greens are grown together, the mustard greens can be planted four times a year. Vegetables are the main sources of income of farmers in mountainous areas [16]. On the land with sufficient water throughout the year, cassava is planted with the talisman, in which several cassava plants are grown on the edges of the land with 5-6 m distance from each other. This planting model is also carried out on relatively narrow land areas. Vegetables become the main commodities, while cassava is the secondary one.

3.3. Analysis of jarak towo cassava farming

The analysis of farming is based on the assumption that all explicit and implicit costs can be separated in the intercropping cropping pattern. The costs incurred by the farmers for cassava farming in Jatiyoso and Tawangmangu were 40% and 33% of the total explicit and implicit costs. The total cost is the sum of explicit and implicit costs [8], in this case in jarak towo cassava farming. The followings are the explicit and implicit costs for cultivating jarak towo cassava in each sub-district.

Table 2 demonstrates that no farmers grow jarak towo cassava in Tawangmangu with a monoculture system. This sub-district is one of the vegetable-producing centers in Karanganyar Regency, which is supported by the availability of relatively sufficient water throughout the year, compared to the other two sub-districts, where the vegetable is the main commodity [16].

Farmers in Ngargoyoso incurred the greatest explicit costs for intercropping and monoculture systems than farmers in the other two sub-districts. The largest cost was spent to purchase inorganic and manure fertilizers. The relatively high purchase of manure is because farmers tend to use more manure to produce quality crops. Also, the use of manure supports sustainable agricultural systems [17].

In terms of labor costs, farmers in Ngargoyoso spent the highest implicit costs for monoculture cropping patterns. They paid labor to help them cultivate cassava because they had other main jobs and planting cassava was merely their side job [9]. On the other hand, farmers in Jatiyoso and Tawangmangu incurred the highest costs for labor in the intercropping system. This indicates that the use of family members in managing farming is limited. One of the reasons is the shift of occupations of family members, in which children tend to work in non-agricultural sectors [18].

As presented in Table 3, farmers in Ngargoyoso spent the highest implicit costs for both intercropping and monoculture farming than the other sub-districts. The highest cost was for renting the agricultural land, which was getting higher because of the development of agro-tourism, natural tourism, restaurants, off-road tourism, and others. The increase in land price contributes to the increase in the land lease fee [19].
The second greatest implicit cost was spent on family labor, both with intercropping and monoculture farming patterns, in all sub-districts. Family labor has great potential in farming management [20]. This indicates that the agricultural sector is still in demand by farmers in the study areas as the main livelihood for farmer households [9].

Table 2. The explicit costs of jarak towo cassava farming in 2019

| Description of Cost | Intercropping | Monoculture |
|---------------------|---------------|-------------|
|                     | Unit Area per Farming Business Area of 1,285 m² | Unit Area per Farming Business Area of 450 m² | Unit Area per Farming Business Area of 485 m² | Unit Area per Farming Business Area of 560 m² | Unit Area per Farming Business Area of 0 m² | Unit Area per Farming Business Area of 2,535 m² | Unit Area per Farming Business Area of 760 m² | Unit Area per Farming Business Area of 850 m² | Unit Area per Farming Business Area of 350 m² | Unit Area per Farming Business Area of 650 m² |
| Seedlings (IDR)     | 0.00          | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        |
| Fertilizers (IDR)   | 83,052.63     | 646,456.37  | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        |
| Pesticides and herbicides (IDR) | 252.63 | 53,420.73 | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        |
| Lime (IDR)          | 6,863.16      | 194,592.38  | 20,000.00   | 444,444.44  | 2,000,000.00 | 2,444,444.44 | 2,444,444.44 | 2,444,444.44 | 2,444,444.44 | 2,444,444.44 |
| Labor (IDR)         | 238,605.26    | 1,857,230.64| 90,000.00   | 2,000,000.00| 2,444,444.44 | 2,444,444.44 | 2,444,444.44 | 2,444,444.44 | 2,444,444.44 | 2,444,444.44 |
| Total               | 353,773.68    | 2,753,666.53| 110,000.00  | 2,444,444.44| 2,444,444.44 | 2,444,444.44 | 2,444,444.44 | 2,444,444.44 | 2,444,444.44 | 2,444,444.44 |

Source: Primary Data, 2020

One of the characteristics of farmers in mountainous areas is raising livestock to meet the need for manure for their farming. Farmers in the research area integrate agriculture-livestock in managing their farms. The need for manure can be partially fulfilled from livestock waste (cattle and goats waste) and the need for animal feed is fulfilled from agricultural waste and Para grass (Brachiaria mutica) planted on the edges of the land for reinforcing terraces. The farming practices in the study areas support sustainable agricultural systems [17].
Table 3. The implicit costs in jarak towu cassava farming in 2019

| Description of Cost                  | Unit Area per Farming Business Area of 1,285 m² | Unit Area per Ha | Unit Area per Farming Business Area of 450 m² | Unit Area per Ha |
|--------------------------------------|-----------------------------------------------|------------------|-----------------------------------------------|------------------|
| **Jatiyoso Sub-district**            |                                               |                  |                                               |                  |
| Seedlings (IDR)                      | 433.95                                        | 3,377.71         | 350.00                                        | 7,777.78         |
| Manure (IDR)                         | 160,000.00                                    | 1,245,391.23     | 120,000.00                                    | 2,666,666.67     |
| Bushes (IDR)                         | 5,052.63                                      | 39,328.14        | 0.00                                          | 0.00             |
| Shrinkage of tools (IDR)             | 174,534.84                                    | 1,358,525.97     | 28,000.00                                     | 622,222.22       |
| Lease fee of own land (IDR)          | 1,648,421.05                                  | 12,830,807.05    | 900,000.00                                    | 20,000,000.00    |
| Own capital interest (IDR)           | 19,878.00                                     | 154,724.29       | 5,400.00                                      | 120,000.00       |
| Implicit labor                       | 638,815.79                                    | 4,972,347.40     | 132,000.00                                    | 2,933,333.33     |
| Transportation                       | 10,000.00                                     | 77,836.95        | 0.00                                          | 0.00             |
| **Total**                            | 2,657,136.26                                  | 20,682,338.74    | 1,185,750.00                                  | 26,350,000.00    |

| **Ngargoyoso Sub-district**          |                                               |                  |                                               |                  |
| Seedlings (IDR)                      | 88.00                                         | 1,571.43         | 232.67                                        | 4,797.25         |
| Manure (IDR)                         | 50,000.00                                     | 892,857.14       | 18,333.33                                     | 378,006.87       |
| Bushes (IDR)                         | 0                                             | 0                | 0                                             | 0                |
| Shrinkage of tools (IDR)             | 112,400.00                                    | 2,007,142.86     | 128,877.78                                    | 2,657,273.77     |
| Lease fee of own land (IDR)          | 1,120,000.00                                  | 20,000,000.00    | 1,293,333.33                                  | 26,666,666.67    |
| Own capital interest (IDR)           | 9,300.00                                      | 166,071.43       | 22,273.60                                     | 459,249.48       |
| Implicit labor                       | 676,500.00                                    | 12,080,357.14    | 651,333.33                                    | 13,429,553.26    |
| Transportation                       | 20,000.00                                     | 357,142.86       | 20,000.00                                     | 412,371.13       |
| **Total**                            | 1,988,288.00                                  | 35,505,142.86    | 2,134,384.04                                  | 44,007,918.43    |

| **Tawangmangu Sub-district**         |                                               |                  |                                               |                  |
| Seedlings (IDR)                      | 246.50                                        | 972.39           | 0                                             | 0                |
| Manure (IDR)                         | 178,867.50                                    | 705,591.71       | 0                                             | 0                |
| Bushes (IDR)                         | 3,547.13                                      | 13,992.64        | 0                                             | 0                |
| Shrinkage of tools (IDR)             | 62,537.06                                     | 246,694.52       | 0                                             | 0                |
| Lease fee of own land (IDR)          | 3,495,000.00                                  | 13,786,982.25    | 0                                             | 0                |
| Own capital interest (IDR)           | 30,038.27                                     | 118,494.15       | 0                                             | 0                |
| Implicit labor                       | 522,748.92                                    | 2,062,125.91     | 0                                             | 0                |
| Transportation                       | 10,318.94                                     | 40,705.87        | 0                                             | 0                |
| **Total**                            | 4,303,304.32                                  | 16,975,559.44    | 0                                             | 0                |

Source: Primary data, 2020

Table 4 shows that farmers in Ngargoyoso spent the highest costs in growing jarak towu cassava, both with intercropping and monoculture systems. Farmers in this sub-district make efforts to optimize agricultural land in managing their farming because land use in this area has the greatest opportunity cost than in other sub-districts [21]. The development of the tourism industry, including the culinary business, in this sub-district, is very promising for the development of jarak towu cassava farming. Farmers increase land productivity by providing agricultural inputs for cassava plants [22].
Table 4. Total costs (explicit and implicit costs) of jarak towo cassava farming in 2019

| Sub-district | Cost for Intercropping (IDR) | Cost for Monoculture (IDR) |
|--------------|------------------------------|---------------------------|
|              | Unit Area per Farming Business | Unit Area per Ha | Unit Area per Farming Business | Unit Area per Ha |
| Jatiyoso     | 3,010,909.94 | 23,436,005.27 | 1,295,750.00 | 28,794,444.44 |
| Ngargoyoso   | 2,165,288.00 | 38,665,857.15 | 2,531,810.71 | 52,202,282.70 |
| Tawangmangu  | 4,829,892.09 | 19,052,828.75 | 0.00 | 0.00 |

Source: Primary data analysis, 2020.

Table 5. Revenue, income, profit, and efficiency of Jarak Towo cassava farming in 2019

| Description | Cost for Intercropping (IDR) | Cost for Monoculture (IDR) |
|-------------|------------------------------|---------------------------|
|             | Unit Area per Farming Business | Unit Area per Ha | Unit Area per Farming Business | Unit Area per Ha |
| Jatiyoso Sub-district | | | | |
| Production (Kg) | 657.89 | 5,120.85 | | |
| Price (IDR/Kg) | 3,632.00 | 3,632.00 | | |
| Revenue (IDR) | 2,389,473.68 | 2,526,315.79 | 6,000,000.00 | 133,333,333.33 |
| Total revenue (IDR) | 4,915,789.47 | 4,562,015.79 | 6,000,000.00 | 133,333,333.33 |
| Income (IDR) | 4,562,015.79 | 1,904,879.53 | 5,890,000.00 | 130,888,888.89 |
| Profit (IDR) | 1,904,879.53 | 1,087,136.26 | 4,704,250.00 | 129,715,488.89 |
| Efficiency | 1.63 | 1.63 | 4.63 | 4.63 |
| Ngargoyoso Sub-district | | | | |
| Production (Kg) | 780 | 13,928.57 | 752 | 15,505.15 |
| Price (IDR/Kg) | 4,358.97 | 4,358.97 | 4,689.72 | 4,689.72 |
| Revenue (IDR) | 3,400,000.00 | 60,714,285.71 | 3,526,666.67 | 72,714,776.63 |
| Total revenue (IDR) | 3,400,000.00 | 60,714,285.71 | 5,413,333.33 | 111,615,120.27 |
| Income (IDR) | 3,400,000.00 | 57,553,570.88 | 5,015,906.66 | 103,420,756.00 |
| Profit (IDR) | 1,234,712.00 | 22,048,428.02 | 2,881,522.62 | 59,412,837.57 |
| Efficiency | 1.57 | 1.57 | 2.14 | 2.14 |
| Tawangmangu Sub-district | | | | |
| Production (Kg) | 631.70 | 2,491.91 | 0 | 0 |
| Price (IDR/Kg) | 4,548.12 | 4,548.12 | 0 | 0 |
| Revenue (IDR) | 2,873,050.00 | 11,333,530.57 | 0 | 0 |
| Total revenue (IDR) | 2,653,750.00 | 10,468,448.81 | 0 | 0 |
| Income (IDR) | 5,526,800.00 | 21,801,972.39 | 0 | 0 |
| Profit (IDR) | 5,000,212.23 | 19,724,703.08 | 0.00 | 0.00 |
| Efficiency | 1.14 | 1.14 | 0 | 0 |

Source: Primary data analysis, 2020.

Farmers apply their cultivating strategies to produce cassava with good quality and quantity. The seedlings of cassava cultivated with monoculture patterns with 1.5m x 1.5m spacing are 4,444 pieces per ha. The productivity of cassava grown with monoculture at the study areas ranges from 22 to 28 tons per ha, which is higher than the national productivity, 23 tons per ha [24]. However, this productivity is
still much lower than the productivity as reported by Sheela and Kunju [25] and Ayyaswamy et al. [26] that reaching 36 tons per ha. Water availability is the underlying factor for this cassava high productivity.

The lowest average price of jarak towo cassava is in Jatiyoso because the area is located far from a tourist destination, food-processing industry, hotels and culinary centers. Road access from agricultural land to the street needs to be improved to facilitate transportation in Jatiyoso and transportation of cassava products [27]. Currently, cassava tubers are available throughout the year because farmers are starting to adapt to the farming practices and to meet the high demand. Farmers in the study area should adapt to growing businesses [28]. When cassava tubers are difficult to obtain, a cassava plant with about 20 kg of tubers can sell for IDR150,000.00. Cassava tubers are rarely traded in the market because they are directly processed by the farmers into other forms of food. If cassava is not immediately processed, the taste will be different or less delicious.

Table 5 also presents that jarak towo cassava farming, either with intercropping or monoculture, is efficient, as shown with an efficiency level of more than 1. This suggests that jarak towo cassava is feasible to cultivate and develop [29-32]. The monoculture planting system is considered more efficient than intercropping. However, the problem lies in the fact that in a monoculture system, cassava plants can only be harvested after eight months of planting, while farmers need to fulfill their needs on a daily basis. They find it difficult to meet their needs without having a source of regular income.

Jarak towo cassava farming is efficient, but the yields vary among farmers. Efforts to multiply productivity by adopting cassava cultivation technology are necessary [22]. The roles of field extension officers need to be improved through training on the adoption of jarak towo cassava cultivation technology to increase productivity [33]. On the other hand, cassava development must also be based on local wisdom values that already exist in the community in maintaining sustainable agricultural systems [2].

Farmers can also increase productivity by improving water availability and calculating spacing. Water availability is ensured by building water reservoirs on agricultural land and taking full advantage of them in the dry season. Farmers occupying agricultural land with a high level of inclination are advised to grow cassava with a monoculture system and plant para grass on the terraces of land to reduce erosion. Fertilization with organic fertilizers or manures during tillage with 50cm depth will result in high productivity of cassava, 15 kg per plant. This increase in productivity can support the rise in the availability of cassava on the market to meet the needs of the processing industry, tourism industry, restaurants and hotels. The business stretching in various fields can improve the welfare of farmers and those working in the industry.

4. Conclusion
Jarak towo cassava farming, either with intercropping or monoculture, provides income, profit, and efficiency for farmers. Monoculture cultivation brings about higher income, benefit, and efficiency than intercropping. Land productivity can be improved by applying better farming management, namely increasing the use of organic fertilizers or manures, adopting jarak towo cassava cultivation technology and increasing water availability. This productivity growth can multiply the availability of cassava in fulfilling the needs of the downstream industry.

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