Analysis of the income and household welfare of organic and non-organic rice farmers in the Sambirejo Sub-Regency of Sragen Regency, Indonesia

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Abstract. Climate change can be caused by various factors, including carbon emissions. The adoption of an organic farming system on a large scale can reduce the use of chemicals in factory production. Therefore, in the long term, it can reduce the operation of chemical factories and reduce carbon emissions. However, the organic system cannot be applied extensively to Indonesian rice farmers. The complexity of the system, certification, the initial decrease in production, and higher cost allocation leads farmers to think that the organic system is not making an impact on their income and welfare. This study aims to determine the farming income, household income, and household welfare of organic and non-organic rice farmers in the Sambirejo sub-district. It uses a descriptive method, and the respondents were determined by the proportional random sampling method. The results show that the organic rice farming income and household income are higher than their non-organic equivalents. There is a very small difference in the price of organic and non-organic rice of only IDR 855.00/kg, so it is understandable that many non-organic farmers are reluctant to switch to the organic system.

Based on the comparative test of the Rice Farmer Exchange Rate, the welfare of organic rice farmers is higher than non-organic ones, whereas, based on Food Expenditure Share, the welfare of organic rice farmers is not significantly different to their non-organic compatriots.

1. Introduction
Climate change can be caused by various factors, including carbon emissions. Carbon emissions occur due to the increase of carbon dioxide concentration as a result of the combustion of fossil fuels by the motor vehicle fuel and chemical product industries [1]. The large-scale adoption of organic farming can reduce the use of chemicals, and indirectly reduce carbon emissions from chemical factories, therefore reducing climate change. Rice is a potential commodity for large-scale application, because it is a staple food for almost the entire Indonesian population.

Organic and non-organic rice farming display differences in production inputs and pest control. Non-organic farming uses chemical inputs, whereas organic farming uses organic inputs and integrated pest management [2]. The organic system is more complicated, because the condition of land and inputs must be free from chemicals. Furthermore, the complicated cultivation and certification involved with organic farming, along with the initial decline in production, mean that it cannot be extensively applied to rice farmers in Indonesia. The higher price of organic rice also does not ensure a higher income,
because its cultivation requires more labor, so farmers believe that their income and welfare are not too impacted by organic rice farming. Therefore, this study analyses the income and welfare of organic and non-organic rice farmers to assess this belief.

2. Methodology

2.1. Study area, sampling, and data collection
This research uses descriptive and analytical methods, with a survey technique. The location of the Sambirejo Sub-district, Sragen Regency was chosen because Sragen became the first regency in Central Java to have applied for national organic certification since 2001, and Sambirejo is the first sub-district to have achieved it [3]. The respondents were 60 farmers, consisting of 30 organic and 30 non-organic rice farmers, who were determined by the proportional random sampling method. Primary and secondary data were used.

2.2. Data Analysis

2.2.1. Analysis of the organic and non-organic rice farming income. This analysis calculated the organic and non-organic farming income on a planting season and compared them. The total cost consists of fixed and variable costs. The fixed cost includes the land cost and the farming tools depreciation [4]. Depreciation was calculated by the straight-line method, which is based on the principle of applying the fixed percentage found according to the asset’s service life to the value which remains after deducting the salvage value from the fixed asset’s cost [5].

Annual depreciation amount = (cost of fixed asset−residual value)/estimated useful life (1)

The variable cost involves the cost of seeds, manures, pesticides, human and machinery labor, and irrigation [4]. Soekartawi [6] have proposed that the revenue was a multiplication of production and product selling price, formulated as follows:

\[ TR = Y \times Py \] (2)

where TR is total revenue (IDR ha\(^{-1}\)), Y is production (kg ha\(^{-1}\)), and Py is product price (IDR kg\(^{-1}\)).

The rice farming income is the difference between revenue and total cost [6], formulated as follows:

\[ Pd = TR - TC \] (3)

where Pd is income (IDR ha\(^{-1}\)), TR is total revenue (IDR ha\(^{-1}\)), and TC is total cost (IDR ha\(^{-1}\)).

The difference testing of rice farming income was determined by Independent Sample t-test, via the formula by Russo [7]:

\[
t_{count} = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2} \left[ \frac{1}{n_1} + \frac{1}{n_2} \right]}} (4)
\]

The hypothesis is:

- \( H_0: \bar{x}_1 = \bar{x}_2 \)
- \( H_1: \bar{x}_1 > \bar{x}_2 \)

There is no significant difference between organic and non-organic rice farming income

Organic rice farming income is higher than non-organic rice farming income

Decision-making criteria are as follows: if the \( t_{count} > t_{table} \), then \( H_0 \) is rejected and \( H_1 \) accepted.

2.2.2. Analysis of the household income of organic and non-organic rice farmers. Farmers’ household income is the addition of on-farm and off-farm income. On-farm income came from the farmers’ activities in the agricultural sector, whereas off-farm income came from outside of agriculture [8]. The differences between the rice farmers’ household incomes is tested by the formula of Russo [7]:
The $t$ count is calculated as:

$$t_{\text{count}} = \frac{(\bar{I}_1 - \bar{I}_2)}{\sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2} \left[ \frac{1}{n_1} + \frac{1}{n_2} \right]}}$$

The hypothesis is:

- $H_0: \bar{I}_1 = \bar{I}_2$
- $H_1: \bar{I}_1 > \bar{I}_2$

There is no significant difference between the household income of organic and non-organic rice farmers.

The household income of organic rice farmers is higher than that of non-organic rice farmers. Decision-making criteria are as follows: if the $t_{\text{count}} > t_{\text{table}}$, then $H_0$ is rejected and $H_1$ accepted.

2.2.3. Household welfare of organic and non-organic rice farmers. This welfare study was analyzed by using the Rice Farmer Exchange Rate (FER) and Food Expenditure Share (FES) indicator. FER is a measure of the ability to exchange the agricultural product with the goods or services needed by consumption and the cost to produce agricultural products [9], formulated as:

$$\text{FER} = \left( \frac{\sum P_x Q_x}{P_y Q_y + P_z Q_z} \right) \times 100$$

where FER is the rice farmer’s exchange rate (%), $P_x$ is the price of rice (IDR kg$^{-1}$), $Q_x$ is rice production (kg), $P_y$ is the price of rice production input (IDR kg$^{-1}$), $Q_y$ is the amount of rice production input (kg), $P_z$ is price of commodities that farmer’s paid (IDR unit$^{-1}$), and $Q_z$ is amount of commodities that farmer’s paid (unit).

The FER criteria based on the Indonesian Central Bureau of Statistics is: (1) If the Rice FER > 100%, rice farmers are classified as prosperous; (2) If the Rice FER = 100%, rice farmers break-even; (3) If the Rice FER < 100%, rice farmers are classified as unprosperous. The difference of organic and non-organic Rice FER was determined by the formula of Russo [7]:

$$t_{\text{count}} = \frac{(\bar{a}_1 - \bar{a}_2)}{\sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2} \left[ \frac{1}{n_1} + \frac{1}{n_2} \right]}}$$

The hypothesis is:

- $H_0: \bar{a}_1 = \bar{a}_2$
- $H_1: \bar{a}_1 > \bar{a}_2$

The organic rice FER is higher than the non-organic rice FER.

The decision-making criteria are as follows: if the $t_{\text{count}} > t_{\text{table}}$, then $H_0$ is rejected and $H_1$ is accepted, so the welfare of the organic rice farmers is higher than their non-organic counterparts.

FES is the ratio of food expenditure and household expenditure (food and non-food) [10]. FES became the welfare indicator based on Engel’s law, which states that when a household’s income increases, the food expenditure percentage becomes smaller, and a large portion goes into non-food expenditure. Therefore, if the percentage of household income spent on food increases, the welfare of that household is reduced [11]. Farmer households are categorized as prosperous if the FES does not exceed 50% of the total household expenditure [12]. The differences in farmer’s FES is determined by the formula of Russo [7]:

$$t_{\text{count}} = \frac{(\bar{b}_1 - \bar{b}_2)}{\sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2} \left[ \frac{1}{n_1} + \frac{1}{n_2} \right]}}$$

The hypothesis is:

- $H_0: \bar{b}_1 = \bar{b}_2$
- $H_1: \bar{b}_1 > \bar{b}_2$

There is no significant difference between the household FES of organic and non-organic rice farmers.
The household FES of organic rice farmers is lower than that for non-organic farmers. The decision-making criteria are as follows: if the \( t_{\text{count}} > t_{\text{table}} \), then \( H_0 \) is rejected and \( H_1 \) is accepted, so the organic rice farmer’s welfare is higher than their non-organic counterpart.

3. Results and discussions

3.1. Characteristics of respondents

Most respondents were at the productive age level (15–64 years). The formal education level of respondents was mainly elementary school. Farming education can complement agricultural sector development, because the application of scientific knowledge cannot be effective if human resources are unskilled and incompetent [13]. The average number of members of the organic and non-organic farmer’s household was 4 and 3 people respectively. This impacts the proportion of income allocation to expenditure, whereby larger households spend a higher share of their income on food and non-food expenditure [11].

More than 80% of rice farmers in the Sambirejo sub-district, both organic and non-organic, cultivate rice over a small area (of < 0.05 ha); the average of organic farmers is 0.38 ha and it is 0.27 ha for non-organic farmers. Most of the rice cultivation in Indonesia is practiced by farmers with very limited landholding, who are generally quite poor and lack the other means to generate income other than rice farming [14].

3.2. The income of organic and non-organic rice farming

Rice farming income was analyzed by using the income average of three planting seasons in 2018–2019. The production inputs were assumed to be derived from the purchase. The organic rice farming total cost is higher than the non-organic costs. The labor costs are significantly different, because of the use of manures in high quantities and natural pest control in organic farming. Non-organic manures and pesticides costs are much higher than the organic ones because of the higher distinction of their prices. The value of the total cost, revenue and income of organic and non-organic rice farming are shown in Table 1.

| Description | Organic rice farming | Non-organic rice farming |
|-------------|----------------------|--------------------------|
|             | Value per 0.38 ha    | Value per ha             | Value per 0.27 ha | Value per ha |
| Total cost (IDR ha\(^{-1}\)) | 3,490,967 | 9,186,755 | 2,178,375 | 8,068,055 |
| 1. Fixed costs |                      |                          |                   |               |
| a. Land | 282,584 | 743,642 | 218,356 | 808,726 |
| b. Depreciation | 169,283 | 445,482 | 156,937 | 581,247 |
| 2. Variable costs | 3,208,383 | 8,443,113 | 1,960,019 | 7,259,329 |
| a. Seeds | 221,200 | 582,105 | 108,824 | 403,053 |
| b. Manures | 315,833 | 831,140 | 513,239 | 1,900,885 |
| c. Pesticides | 3,333 | 8,772 | 19,328 | 71,584 |
| d. Human labor | 2,143,100 | 5,639,737 | 861,850 | 3,192,037 |
| e. Machinery labor | 431,667 | 1,135,965 | 415,111 | 1,537,449 |
| f. Irrigation | 2,917 | 7,675 | 1,000 | 3,704 |
| g. Transport | 90,333 | 237,719 | 40,667 | 150,617 |
| Revenue (IDR ha\(^{-1}\)) | 7,391,833 | 19,452,193 | 3,685,611 | 13,650,412 |
| Production (kg ha\(^{-1}\)) | 1,546 | 4,068 | 939 | 3,476 |
| Price (IDR kg\(^{-1}\)) | 4,782 | 4,782 | 3,927 | 3,927 |
| Income (IDR ha\(^{-1}\)) | 3,900,866 | 10,265,438 | 1,507,236 | 5,582,357 |

Source: Primary Data (2020)
Organic products are sold to the farmers’ group chairman, whereas non-organic products are sold to the middlemen traders. The revenue of organic rice farming was higher than non-organic, because the price differences are approximately IDR 855.00 kg\(^{-1}\), and production is approximately 592 kg ha\(^{-1}\). The price differences are not significant, so many non-organic farmers are reluctant to switch to organic farming. This is why it has not been possible to significantly apply organic farming systems in Indonesia.

Organic rice farming revenue was higher than non-organic, thought this does not confirm any significantly higher income, because at the same time there are higher production expenses, mainly due to the higher labor [15]. Furthermore, the complexity of the certification process and routine monitoring by the certification agency, as well as the initial decrease in production, has led to many farmers maintaining the non-organic system.

3.3. Household income of organic and non-organic rice farmers

Household income is the total income of all farmer households’ members in a particular period. The value of the household income of organic and non-organic rice farmers per year are shown in Table 2.

The results show that the organic farmers’ household income was higher than non-organic. The rice farming income here was calculated on the land area of 0.33 ha to avoid bias. The non-rice farming consists of some commodities: onion, pepper, corn, teak, peanut, rubber, turmeric, mustard greens, and cassava. Off-farm income came from the activities of laborers, small traders, wood craftsman, and other work (crackers production, parking attendant, and housemaid), as well as other off-farm sources such as scholarships, a donation, and remittance.

| Source of Income                  | Organic rice farmers | Non-organic rice farmers |
|-----------------------------------|----------------------|-------------------------|
| On-farm (IDR)                     |                      |                         |
| 1. Rice farming                   | 8,839,392            | 5,596,557               |
| 2. Non-rice farming               | 3,198,368            | 2,169,149               |
| 3. Livestock                      | 2,863,250            | 1,144,000               |
| 4. Farm worker                    | 963,000              | 606,000                 |
| 5. Land renting out               | 912,500              | 80,000                  |
| 6. Farming tools renting out      | 1,000,000            | 240,000                 |
| Off-farm (IDR)                    |                      |                         |
| 1. Laborer                        | 4,500,000            | 5,160,000               |
| 2. Small trader                   | 1,140,000            | 3,080,000               |
| 3. Wood craftsman                 | 3,940,000            | 1,480,000               |
| 4. Other work                     | 1,800,000            | 2,352,000               |
| 5. Other off-farm source          | 680,000              | 784,400                 |
| ∑                                 | 29,836,510           | 22,692,106              |

Source: Primary Data (2020)

There are differences between the main income source of organic and non-organic rice farmers, whereby organic farmers got a higher income from on-farm, whereas non-organic farmers got a higher income from off-farm. The off-farm income made a large contribution to the household income. The farmer activities outside the farming sector related to insufficient income and the long waiting time between the harvest, as well the high risks and uncertainty of the agricultural sector [16].

3.4. Household welfare of organic and non-organic rice farmers

Household welfare relates to basic needs, including the quantity and quality of foods, clothes, residence, health, education, and employment [17]. The value of the Rice Farmer Exchange Rate and Food Expenditure Share of Organic and Non-Organic are shown in Table 3.
Table 3. Rice farmer exchange rate and food expenditure share of organic and non-organic

| Description                              | Organic Rice Farmers | Non-Organic Rice Farmers |
|------------------------------------------|----------------------|--------------------------|
| Rice FER (%)                             | 109.00               | 89.68                    |
| 1. Rice farming revenue (IDR ha⁻¹ per year) | 58,356,579           | 40,951,235               |
| 2. Farmer’s payment (IDR per year)       | 53,536,949           | 45,664,304               |
| a. Rice production cost (IDR ha⁻¹ per year) | 27,552,596           | 24,204,164               |
| b. Household consumption (IDR per year)  | 25,984,353           | 21,460,140               |
| FES (%)                                  | 49.95                | 56.13                    |
| 1. Food (IDR per year)                   | 12,979,660           | 12,045,050               |
| 2. Non-food (IDR per year)               | 13,004,693           | 9,415,090                |
| 3. Total Expenditure (IDR per year)      | 25,984,353           | 21,460,140               |

Source: Primary Data (2020)

Based on the Rice FER, the organic farmers get a score of 109% and are categorized as prosperous, which indicates that the revenue of rice production was higher than the farmers’ payment. Meanwhile the non-organic farmers are categorized as unprosperous, with a value of 89.68%.

Based on the FES, the organic farmers’ households are categorized as prosperous, with a value of 49.95%, which indicates that the food expenditure is not higher than non-food expenditure. Meanwhile, the non-organic farmers are categorized as unprosperous, with a value of 56.13%.

3.5. Comparative analysis of farm income, the household income of farmers, and household welfare of organic and non-organic farmers

The comparative analysis of organic and non-organic farmers was done by the Independent Sample t-test, and the critical value of t (58) is 1.672 (α=0.05, one tail). A comparative test of the rice farming income produced a t-count > t-table (2.093 > 1.672), so H₀ was rejected and H₁ was accepted, which means that the organic rice farming income was higher than the non-organic income. A comparative test of household income produced a t-count > t-table (1.958 > 1.672), so H₀ was rejected and H₁ was accepted, which means that the organic rice farmers’ household income is higher than the non-organic equivalent. A comparative test of the rice FER produce t-count > t-table (2.684 > 1.672), so H₀ was rejected and H₁ was accepted, which means that the rice FER of organic farmers was larger than non-organic. This indicates that, based on the rice FER, the welfare of organic farmers’ households was higher than non-organic ones. A comparative test of FES produced a t-count < t-table (-3.962 > 1.672), so H₀ was accepted and H₁ was rejected, which means that the FES of organic rice farmers’ households is not significantly different from the non-organic equivalent. This indicates that, based on the FES, there is no significant difference between the welfare of organic rice farmers’ households and that of non-organic households.

4. Conclusions

Organic rice farming income is higher than its non-organic equivalent; approximately IDR 10,267,994.00 ha⁻¹ for organic, compared to IDR 5,582,356.00 Ha⁻¹ of non-organic. Meanwhile, the household income of organic rice farmers is higher than that of non-organic farmers, approximately IDR 29,836,510.00 for the former and IDR 22,692,106.00 for the latter. Based on a comparative test of Rice FER, the welfare of organic rice farmers’ households is higher than for non-organic ones. Meanwhile, based on the comparative test of the FES, there is no significant difference between the welfare of organic rice farmers’ households and that of non-organic ones.
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