Organic and Conventional Rice Farming Feasibility in Central Java, Indonesia: A Resources Productivity Approach

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Abstract. Organic farming for sustainable agriculture still needs proof and various efforts in achievement. The research objective was comparing the income and profits of organic rice and rice conventions and to determine the feasibility of organic rice farming and rice conventions in Karanganyar District, Kebumen Regency, Central Java. The data used are primary data of rice farming data in two season planting. Sampling in this study used the census method in which all members of the population were used as respondents, namely as many as 25 organic farmers and proportional random sampling where the respondents were equalized as many as 25 conventional farmers. The results showed that: 1) Organic rice farming has higher income and profits when compared to conventional income and profits. 2) Based on the feasibility analysis of organic rice farming, it is more feasible than conventional rice, which can be seen from the ratio of R/C, land productivity, capital productivity, labor productivity. The farmers should run the rice organic farm to increase their income and sustainable agriculture.

1 Introduction

Agriculture involves the use of biological resources by humans to produce food, raw materials for industry, and energy sources, while also managing the environment. In Indonesia, rice remains a key agricultural commodity, serving as the primary food source for 2.5 billion people worldwide. For many farmers, rice cultivation is their main livelihood [1]. So that crop failure can result in widespread social turmoil. Therefore, rice is a strategic commodity in various countries, and more than half of the world's population emphasizes rice as a source of carbohydrates for most Indonesian people, rice in addition to functioning as a staple food is also a source of livelihood.

One of the rice centers in Central Java province is in the Kebumen district area. The success of Kebumen Regency in increasing production is quite encouraging because it is constantly increasing. Based on BPS data, Kebumen Regency in 2019 is an area with a harvest area of 2302.9, 15th out of 26 sub-districts. Most of the rice production in Kebumen

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Regency is in rice fields, both conventionally and organically. Conventional farming practices can lead to land degradation and a decline in total factor productivity, which, in the long term, may result in higher production costs and lower crop yields. While the use of pesticides and irrigation tends to be insufficient, fertilizers and labor are often overutilized [2]. Adopting an organic rice farming system can provide significant benefits by boosting production and enhancing the local agricultural ecosystem. This approach promotes more sustainable farming practices that contribute to healthier soil and a balanced environment [3].

Organic rice in Karanganyar District is intensive in 2015 to produce rice with good quality. The use of organic fertilizers has been running but has not been certified because it is still on a small scale and requires a long process, so it is currently still in the certification process. The Agriculture Service has carried out supervision and has allowed it to operate so that it is currently still running. However, organic rice farming has not developed widely, while conventional rice farming is still dominant in the region.

Overview of conventional rice farming using chemical fertilizers and pesticides. This business requires higher input costs for the use of fertilizer than organic rice, but the price of conventional rice production is lower than the price of organic rice production. Conventional rice farmers think that their production is more profitable than organic rice because the labor input in the application of conventional rice farming fertilizer is not as much as in organic rice farming. This is because of the direct impact of global change [4].

Evidence suggests that, on average, crop yields under organic farming are lower compared to those achieved through conventional farming methods. Despite this, organic farming offers other benefits, such as improved soil health and reduced environmental impact [5]. The development of organic agriculture in Poland has grown rapidly, both in terms of the number of farms and the area under cultivation. Interestingly, the average size of organic farms in Poland is larger than that of conventional farms [6]. Meanwhile, studies in China report that the elemental content of conventional rice is found at a higher level due to the abundant application of synthetic fertilizers, this is unlike organic agricultural rice, which preferentially uses animal manure and compost [7]. Technically, there are differences in soil fertility, with the highest Soil Fertility Index (SFI) found in organic rice fields (0.69), followed by semi-organic fields (0.62), and the lowest in conventional fields (0.59). Additionally, organic farming demonstrated the most favorable conditions for soil biota [3].

The results of the study prove that it is scientifically available to make organic farming a solid tool to solve several challenges. However, organic farming systems must be further developed to fulfill their potential [8]. Organic farming is considered more efficient and effective in reducing greenhouse gas emissions compared to conventional agriculture. This is largely because it relies less on chemical fertilizers and fossil fuels, leading to a lower carbon footprint [9].

Organic vegetable farming provides more decent income and profits than conventional vegetable farming [10]. Economically higher yields with organic farming, the benefit-cost ratio for all crops is higher despite higher production costs in other treatments [11]. In terms of fish production and economics, organic farming systems prove to be the best techniques available [12].

Based on previous research, we have not found a review of the productivity of the main production factors (land, labor and capital) in the context of household-scale organic rice farming in Indonesia. Organic farming has many advantages and can be expected to be a sustainable agricultural solution with increasingly massive innovation. Therefore, this paper will discuss the extent of the feasibility of farming of the two systems on a household scale, so that the comparison of the two can be considered in the sustainable development of organic agriculture.

2 Research method

The study used a quantitative descriptive method and compared income and profits between organic and conventional rice farming. In addition, it is also used to test feasibility and to determine land, capital, and labor productivity. The research location was deliberately chosen by the purposive sampling method. The determination of samples for organic rice farming uses the census method, which is to make all farmers as research samples so that the number of samples is equal to the number of populations, which is as many as 25 people belonging to five farmer groups union. Meanwhile, the determination of the number of samples of conventional rice farmers was taken by 25 farmers by proportional random sampling from the five farmer groups union.

2.1 Farming Analysis

Data from rice farming is analyzed to assess costs, revenues, income, profits, and feasibility, using T-tests to compare organic and conventional farming methods. Farming costs are categorized into explicit and implicit costs. The explicit costs mean the actual expenses incurred by farmers, such as production input costs, tool depreciation, hired labor, and other payable expenses. Implicit costs, on the other hand, are not directly paid by farmers and include expenses like the rental value of owned land, family labor, and interest in self-financed capital. Since these resources are already available to the farmers, they do not need to pay for land rent, family wages, or interest in their own capital. The total cost of farming is formulated as follows:

$$TC = TEC + TIC \tag{1}$$

Information, *TC* was total cost (IDR); *TEC* was total explicit cost (IDR); and *TIC* total implicit cost (IDR)

The benefits of rice farming can be reviewed from revenue, income and profit. Revenue as the value of agricultural production is the total sales value of rice farming production every harvest season. Meanwhile, net revenue is farmers' income after reduced explicit costs. Farming profits are derived from net revenue after reduced explicit and implicit costs. The formulation of rice farming benefits is as follows:

$$NR = TR - TEC \tag{2}$$
$$TR = P \times Q \tag{3}$$
$$\pi = TR - TC \tag{4}$$

Information, *TR* was total revenue (IDR); *P* was price of product (IDR/kg); *Q* was quantity of product (kg); *NR* was net revenue (IDR); π was profit (IDR); and *TC* was total cost (IDR)

2.2 Farm Feasibility Analysis

2.2.1 Revenue Cost Ratio (R/C)

The R/C is a method used to measure the feasibility of a farm by looking at the comparison between revenue and costs. The formulation of the Revenue Cost Ratio is as follows:

$$R/C = \frac{TR}{TC)} \tag{5}$$

Information, TR was total revenue (IDR); TC was total cost (Explicit and implicit (IDR))

Conditions:
If the R/C > 1, the rice farming that is carried out is profitable, so it is worth cultivating.
If the R/C ≤ 1, the rice farming that is run suffers losses, then it is not feasible to run.

2.2.2 Land Productivity

Land productivity is the ability of land to obtain income. The formulation is presented as follows:

$$\textit{Land productivity: } \frac{NR-FLC-OCI}{Land\ (m^2)} \tag{6}$$

Information:
Land Productivity = IDR/m^2
NR = Net Revenue (IDR)
FLC = Family Labor Cost (IDR)
OCI = Own Capita Interest (IDR)

Conditions:
If the land productivity > land leases, then rice farming is worth pursuing.
If the land productivity ≤ land leases, then rice cultivation is not feasible.

2.2.3 Labor Productivity

Labor productivity is the ability of workers to produce production per Full Time Equivalen (FTE) of family labor. The formulation is presented as follows:

$$\text{Labor productivity} = \frac{NR-ROL-OCI}{FL} \tag{7}$$

Information:
Labor productivity = IDR/FTE
NR = Net Revenue (IDR)
ROL = Rent of Own Land (IDR/m^2/season)
FL = Family Labor (FTE)

Conditions:
If labor productivity > the applicable daily labor wage of rice farming, then rice farming is worth pursuing.
If labor productivity ≤ the applicable daily labor wage of rice farming, then rice farming is not feasible to be cultivated.

2.2.4 Capital Productivity

Capital productivity is the value of receipts from every value of capital used in rice farming in a certain peoride. The formulation is presented as follows:

$$\textit{Capital productivity} = \frac{NR-ROL-FLC}{TEC} \times 100\% \tag{8}$$

Information:
Capital productivity: %
NR = Net Revenue (IDR)
ROL = Rent of Own Land (IDR/m^2/season)
FLC = Family Labour Cost (IDR)
TEC =Total Explicit Cost (IDR)

Conditions:
If capital productivity > the interest rate of the lending bank, then rice farming is feasible.
If capital productivity ≤ the loan interest rate, then rice farming is not feasible to run.

Comparison of the yield values of organic rice farming with conventional using the T-test formulated in the hypothesis as follows:
Ho: Organic ≤ μ Conventional μ: there is no difference between the income and profits of organic rice farming and conventional rice.
Ha: Organic > μ Conventional μ: there is a difference between income, profit, organic farming and conventional rice.

The T-test value is formulated as follows:

$$T\text{-}test = \frac{\bar{x}_1 - \bar{x}_2}{S\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}} \quad (9)$$

Information:
X_1 = Income or profit from organic rice farming.
X_2 = Income or profit of conventional rice ushatani.
$\bar{X}_1$ = Average income or profit of organic rice farming.
$\bar{X}_2$ = Average income or profit of conventional farming.
n_1 = number of samples of organic rice farmers.
n_2 = number of samples of conventional rice farmers
S = Standard deviation or variance

The calculation of the S value uses the following formula:

$$S = \sqrt{\frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{n_1 + n_2 - 2}} \quad (10)$$

Information:
n_1 = Number of organic samples
n_2 = Number of convention samples
S_1 = Standard deviation for organic
S_2 = Standard deviation for conventional

Each standard deviation can be calculated using the following formula:

$$S_1^2 = \frac{\Sigma X_1^2 - (\frac{\Sigma x_1)^2}{n_1})}{n_1 - 1} \quad ; \quad S_2^2 = \frac{\Sigma X_2^2 - (\frac{\Sigma x_2)^2}{n_2})}{n_2 - 1} \quad (11)$$

T-table value α = 5% with df (Degree of freedom) = n_1+n_2-2

The conclusion of the analysis results is based on the following provisions:
T-test > t-table, Ho was rejected, and Ha was accepted, meaning that there was a real difference between the income and profit of organic rice farming and conventional rice farming.
T-test ≤ t-table, Ho is accepted, and Ha is rejected, meaning that there is no real difference between the income and profits of organic rice farming and conventional rice farming.

3 Results and discussion

3.1 Income and Profit of Farming

In analyzing rice farming, it is important to consider farming costs, production, income, and profitability. Farming costs refer to the total expenses incurred during the production process for inputs and services expressed in rupiah. These total costs consist of explicit and implicit costs, as detailed in Table 1. The analysis shows that the total cost of organic rice farming is

lower than that of conventional rice farming across two planting seasons. Organic farmers spent IDR 8,058,834, while conventional farmers incurred IDR 8,797,826. The higher costs in conventional farming are mainly due to the greater expense on fertilizers and pesticides, which are more costly compared to the natural, low-cost alternatives used by organic farmers.

Table 1. Organic and Conventional Rice Farming Analysis at a Scale of 200 m^2

Description	Organic		Conventional	
	Season-1	Season-2	Season-1	Season-2
Explicit Cost (IDR)	1,362,660	1,362,660	1,746,219	1,746,219
Implicit Cost (IDR)	2,666,757	2,666,757	2,652,694	2,652,694
Total Cost (IDR)	0	8,058,834	0	8,797,826
Production (Kg)	1,247	1,148	1,523	1,371
Price (IDR/Kg)	6,320	6,755	5,148	5,655
Revenue (IDR)	7,884,050	7,774,789	7,839,986	7,753,280
Income (IDR)	6,521,389	6,412,128	6,093,767	6,007,061
Profit (IDR)	3,854,633	3,745,372	3,441,073	3,354,367

Revenue is the result obtained by farmers in carrying out farming. Revenue is the sales value of rice farming products. Organic rice farming production is lower than conventional. This is because organic rice farming is still in the early stages of land conversion and needs longer adjustments. However, the price of organic rice production is higher than conventional so there is no significant difference between both of them. In detail, the production, price, and farming revenue are presented in Table 1.

The weighted average price of organic rice is IDR. 6,320 in the first season and IDR. 6,755 for the second planting season. In conventional rice farming, the weighted average price for the first planting season is IDR 5,148 and for the second planting season is IDR 5,655. The price difference between organic and conventional rice affects farmers' income, as organic rice typically commands a higher market price. As a result, organic farming can lead to higher income for farmers compared to conventional methods. By adopting organic practices, farmers can take advantage of these price premiums and increase their overall earnings from rice production [13]. Thus, organic rice farming offers the potential for high income, driven by premium pricing and the growing demand for organic products [14].

There was an increase in production prices in the second planting season, but the amount of production decreased. This is because in the second planting season, the availability of irrigation water is less because it has entered the dry season. The use of vegetable materials such as manure, compost, and organic fertilizer made by farmers also affects in terms of determining prices because by using vegetable materials the production produced will be healthier than the production products that in the farming process still use chemicals.

Income is the total income from a farm minus the total explicit cost. The organic and conventional rice farm income is presented in table 1. The income of organic rice farming is higher than the income of conventional rice, organic rice farming is IDR. 6,521,389 and for the income of conventional rice farming of IDR. 6,093,767, this income is for the first planting season. The income of the second planting season for organic and conventional rice farmers has decreased in income, namely for organic rice farmers of IDR. 6,412,128 while conventional rice farmers amounted to IDR. 6,007,061. The highest income production is in organic rice. This indicates that organic farming has the potential to improve family income [15] and play a role in achieving the welfare of farming families [16]. The results showed that there was a significant difference in income between organic and conventional rice farming. The benefits of organic and conventional rice farms are net revenues after reducing by total explicit costs and implicit costs. The advantages of organic and conventional rice farms can be seen in table 1. The profits of organic rice farms are higher than the profits of conventional rice farms. The profit from organic rice farms is IDR. 3,854,633 while the profit

from conventional rice farm is IDR. 3,441,073 for the first planting season. In the second planting season, there was a decrease between organic rice farms of IDR. 3,745,372 and conventional rice of IDR. 3,354,367. The amount of profit is influenced by the production results and production costs incurred by farmers, the less costs incurred, the greater the profits will be obtained. These results are in line with research conducted [17] which revealed that in terms of profitability or profits, organic farming is more significant when compared to conventional agriculture. The results of the comparative T-test showed that there was a significant difference in profits in organic rice farming and conventional rice.

3.2 Farming Feasibility

The feasibility of organic and conventional rice farming in Karanganyar District can be assessed through the Revenue Cost Ratio (R/C), as well as land, labor, and capital productivity.

3.2.1 Revenue Cost Ratio (R/C)

The R/C is a method used to measure the feasibility of a farm by using revenue divided by total explicit and implicit costs. Organic and conventional rice farming in Karanganyar District is presented in table 2. Based on the R/C value, organic rice farming and conventional rice farming are feasible. This R/C value at the time of 1 planting season, in the second planting season the results show that it is feasible to run between organic rice farming and conventional rice. The R/C value of organic rice farming in the first planting season was 1.98 greater than that of conventional rice farming of 1.78. In the second planting season, the R/C value of organic rice decreased by 1.93 for conventional rice R/C to 1.76, but both are still worth cultivating. Integrated and community-based organic farming management will provide economic and environmental feasibility so that it has sustainable potential [18].

Table 2. Feasibility Analysis of Organic and Conventional Rice Farm at a Business Scale of 200m^2

Description	**Organic**		**Conventional**	
	Season-1	**Season-2**	**Season-1**	**Season-2**
Revenue (IDR)	7,884,050	7,774,789	7,839,986	7,753,280
Total Cost (IDR)	4,029,417	4,029,417	4,398,913	4,398,913
R/C	1.96	1.93	1.78	1.76
Income (IDR)	6,521,389	6,412,128	6,093,767	6,007,061
Family Labor Cost (IDR)	639,504	639,504	617,770	617,770
Own Capita Interest (%)	27,253	27,253	34,924	34,924
Land (m^2)	2,000	2,000	2,000	2,000
Land Productivity (IDR/m^2)	2,927	2,873	2,721	2.677
Rent of Own Land (IDR/m^2/season)	2,000,000	2,000,000	2,000,000	2,000,000
Family Labor (FTE)	639,504	639,504	617,770	617,770
Total Explicit Cost (IDR)	1,362,660	1,362,660	1,746,219	1,746,219
Capital Productivity (%)	285	277	199	194
Rent of Own Land (IDR/m^2/season)	2,000,000	2,000,000	2,000,000	2,000,000
Own Capita Interest (%)	27,253	27,253	34,924	34,924
Family Labor (FTE)	7.99	7.99	7.72	7.72
Labor Productivity (IDR/FTE)	562,203	548,535	525,612	514,384

3.2.2 Land Productivity

Land productivity is the ability of land to obtain income. Land productivity is said to be feasible if the land productivity is higher than the prevailing land rent in the area. Land productivity in organic and conventional rice farming in Karanganyar District is presented in table 2. The average productivity value of organic rice farming land in the first planting season was IDR. 2,927/m^2/season with the applicable land rent at the research location of IDR. 2,000,000 per season. This means that every m2 of land used for organic rice farming will generate an income of IDR. 2,927 m^2 greater than the applicable land rent in Karanganyar District. In the second planting season, it decreased to IDR. 2,873/m^2/season with the applicable land rent at the research site of IDR. 2,000,000 per season. This means that every m^2 of land used for organic rice farming will generate income of IDR. 2,873 m^2 greater than the applicable land rent in Karanganyar District. In the first and second planting seasons, land productivity is greater than land rent, so organic rice farming is worth pursuing when viewed from land productivity.

The productivity of conventional rice farming land in the first planting season of IDR. 2,721 per m2 is lower than that of organic rice farming because the income of organic rice farming is higher. The valid land rent in Karanganyar District is the same, which is IDR. 2,000,000 per 2000/m^2 per season. This means that every m^2 of land used for conventional rice farming will generate an income of IDR. 2,721 per m^2, greater than the applicable land rent in Karanganyar District. In the second planting season, IDR. 2,677 per m^2 is lower than organic rice farming because the income of organic rice farming is higher. The valid land rent in Karanganyar District is the same, which is IDR. 2,000,000 per 2000/m^2 per season. This means that every m^2 of land used for conventional rice farming will generate an income of IDR. 2,677 per m^2, greater than the prevailing land rent in Karanganyar District. The difference in land productivity is due to different income results between the first and second planting seasons. In the first and second planting seasons, land productivity is greater than land rent, so conventional rice farming is worth working on when viewed from land productivity. Results from organic farming demonstrated a significant improvement in crop productivity after three years of interventions, including crop rotation and manure application on agricultural land [19].

3.2.3 Capita Productivity

Capital productivity is the investment of a business to obtain income. Capital productivity can be said to be feasible if the resulting capital productivity can be greater than the loan interest rate. Capital productivity from organic rice farming and conventional rice farming is presented in table 7. Capital productivity applies per planting season, in the first planting season organic rice farming capital productivity obtains 285% and in the second planting season obtains 277% while the loan interest at Bank BRI per 4 months is 2% for one planting season. This means that if organic farmers will develop organic rice farming and have to borrow from financial institutions, then farmers are able to return the loans and interest that apply to financial institutions, because the capital productivity of organic farmers is higher than the applicable loan interest rate.

Capital productivity in conventional rice farming in the first planting season is 199% and the second planting season is 194% with a BRI Bank loan interest rate of 2% per 4 months for one planting season. This means that if conventional farmers will develop conventional rice farming, farmers will be able to return loans and applicable interest at financial institutions because the capital productivity of conventional farmers is higher than the applicable loan interest rates. This shows that organic rice farming is economically profitable and has the potential to be developed towards sustainability [20].

3.2.4 Capital Productivity

Labor productivity is the ability of every labor outpouring to generate income. Farming is declared feasible to be pursued, if the value of labor productivity is higher than the prevailing wage at the research site. Table 2 shows that organic rice farming in Karanganyar District has labor productivity in the first planting season of IDR. 562,203/FTE, which means that every organic farmer prefers to run organic rice farming compared to working in other places that have a wage in Karanganyar District of IDR. 80,000/FTE. Conventional rice farming in Karanganyar District has a labor productivity of IDR. 525.612/FTE, which means that every conventional rice farmer prefers to run conventional rice farming rather than working elsewhere. In the second planting season, the productivity of organic labor is IDR. 548,535/FTE and for conventional is IDR. 514,384/FTE. From these results, it can be said that organic and conventional rice farming is feasible to run when viewed from labor productivity, this is because the labor productivity of organic and conventional rice farming is higher than the prevailing wage in Karanganyar District of IDR. 80,000/FTE. Based on the analysis, organic agriculture has the potential, in the long term, to achieve significantly greater progress in total factor productivity compared to conventional farming [21].

4 Conclusion and recommendation

Research on organic and conventional rice farming in Karanganyar District concluded that organic rice farming yields higher income and profits compared to conventional methods. The feasibility analysis also shows that organic rice farming is more viable, as evidenced by the R/C ratio, land, capital, and labor productivity.

Organic rice farming needs to be further developed because it has high profits, and by continuing to provide counseling education on the reduction of chemicals such as excessive use of fertilizers and pesticides. Emphasizing that farmers try to use natural materials to return to environmentally friendly use. To increase income and profits, further studies are needed on the quality of water/irrigation, land and seeds to increase productivity and accelerate the transition to organic agriculture.

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