Profitability analysis and rice check measurement of rice cultivation in Daerah Istimewa Yogyakarta

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Abstract. Population growth drives food demand, which requires increased production to offset up. Furthermore, the principle of sustainability must be implemented through organic farming practices to ensure that future food needs are met. However, many farmers still tend to practice conventional farming. This study aims to determine the profitability and technical sustainability level in organic, non-organic, and semi-organic rice cultivation systems in the Daerah Istimewa Yogyakarta Province. The sample was 90 farmers representing the three cultivation systems. Profitability analysis and Rice Check measurement were employed to answer the research aims. The results showed that the R/C ratio in the organic cultivation system had a better performance of 1.50 compared to the other systems of 1.36 (semi-organic) and 1.20 (non-organic). Furthermore, the three cultivation systems had higher profitability than the deposit interest rate (2.5%), which was 91.99% (organic), 74.46% (non-organic), and 70.66% (semi-organic). Rice check analysis showed that organic rice had the highest average score of 73.59% (sustainable), non-organic rice with a score of 59.27% (intermediate sustainable), and semi-organic rice with 56.39% (intermediate sustainable). This research was expected to be a reference for farmers in developing organic farming and how to conduct more efficient cultivation practices with Rice Check.

1 Introduction

Food is a fundamental need for humans to survive. However, the possibility of food production capacity is lower than the increase in food demand [1], which has become a challenge for society and the government. The rapid rate of population growth drives an increase in food demand.

Malthus predicted that one day, the rate of population growth that follows the measuring series (1, 2, 4, 8, 16, etc.) will not be able to be fulfilled by the rate of food supply that follows

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the counting series (1, 2, 3, 4, etc.), resulting in aglobal hangerover since there is lacks of food supply [2].

The global food crisis is attributable not only to population growth but also to factors such as conflict, escalating fertilizer costs, and climate change [3]. It is imperative to make coordinated endeavors to address these issues to mitigate the escalation of the food crisis.

Climate change is currently a major constraint in agriculture. The increase in greenhouse gases (GHG) is one of the main factors that continues to cause climate change. Agricultural activities contribute approximately 10% of atmospheric GHG production [4]. Using inorganic fertilizers is one source of increased GHG in the agricultural sector because they have higher emissions than organic fertilizers [5]. This impact has led to the development of many sustainable agriculture concepts that are more environmentally friendly, have a higher level of adaptation, allow recycling and recovery of nutrients, and allow efficient use of resources [6]. One of the sustainable steps farmers or producers can take is to recommend implementing organic farming practices.

According to the Food and Agriculture Organization [7], organic farming is a holistic management system that promotes and enhances environmental farming systems approaches, including biodiversity, biological cycles, and soil biological activity. The most recent survey conducted by the Research Institute of Organic Agriculture FiBL indicates that organic farming is experiencing global expansion, with an increase in both organic farmland and sales, reaching unprecedented levels [8]. FiBL also informed that the global organic farmland area in 2023 will reach 76.4 million hectares. Oceania has the largest organic farmland, accounting for 36 million hectares (47%), and Europe has 17.8 million hectares (23%). Latin America has 9.9 million hectares (13%), followed by Asia at 6.5 million hectares (8.5%), North America at 3.5 million hectares (4.6%), and Africa at 2.7 million hectares (3.5%) [8].

Organic farming has emerged in Indonesia due to increasing consumer awareness of the need to consume safe and healthy products. Organic food and beverages in Indonesia continue to expand, with a value growth of 7.9% in 2021, reaching a value of USD 16.2 million. Organic food sales consist almost entirely of organic rice, and the category recorded value growth of 8.7% in 2021 to reach USD 14.7 million [9] [10].

As an agricultural country, Indonesia has great potential to become an international organic producer. On the other hand, the total area of organic farmland in Indonesia still needs to be increased, and the number of certified organic farmers in Indonesia is still relatively small since many farmers still preference for conventional farming. Most farmers are not confident if they do not use pesticides, so they seem "dependent" on pesticides or chemicals [11]. Some farmers who have realized the negative impact of excessive chemical use have encouraged various community groups or individuals to start inviting a return to chemical-free agriculture or organic farming in recent years. Organic farming is thought to possess the capacity to produce higher and more nourishing products [12].

Organic farming promotes sustainable agriculture by preserving biodiversity and refraining from eliminating natural predators of pests and diseases [13]. Cost is a significant factor in organic farming. While organic farming may not yield as much as non-organic farming, it lowers expenses by eliminating the need to purchase costly inorganic pesticides and fertilizers. Farmers are expected to continue earning a profit by decreasing the cost of purchasing chemical materials while producing healthier and more environmentally friendly products. Non-organic farming will eventually cause serious problems since the continuous use of inorganic fertilizers harms the soil, such as a decrease in the content of organic matter and the activity of soil microorganisms, the soil becomes compacted, and damage occurs. This is essential for the emergence of sustainable agriculture as an implementation of the concept of sustainable development [14]. Sustainable agriculture not only provides benefits for the earth but also for the good of mankind and the sustainability of farming, known as the 3P benefits (people, planet, profit) [15].

Analyzing the sustainability of organic farming practices through various dimensions among farmers becomes one of the actions needed to respond to the above phenomenon. An analysis of the sustainability of organic farming practices can be seen by measuring technical sustainability with the Rice Check method. Rice Check is similar to the rice standard operating procedure (SOP). The difference is that Rice Check only consists of essential components that support rice cultivation. According to Wahab et al. [16], Rice Check contains a list of "essential" technology components that are the main requirements for achieving optimal and maximum rice productivity. Rice Check users are expected to understand rice SOPs emphasizing cultivation control with standard techniques. Rice Check is a checklist of the best technical components farmers need. Farmers are expected to adopt the best technology and maximize rice productivity by adopting and applying rice checks.

Daerah Istimewa Yogyakarta has a diverse topography ranging from coastal sand, dry land, rice fields, and mountainous areas [17]. This condition causes differences in rice cultivation, especially in high and low areas. For example, most areas of Bantul Regency are dominated by non-organic rice cultivation, and some farmer groups cultivate organic rice, while in Sleman Regency, rice is cultivated semi-organically. The difference in each rice farming cultivation variety is a very interesting topic regarding income, profitability, and sustainability.

This study aims to determine the level of farming profitability and technical sustainability of three various rice cultivation methods from a technical point of view using the Rice Check method. Sustainability research conducted by Purba et al. [18], Taylor et al. [19], Terano et al. [20], and Van Thanh and Yapwattanaphun [21] studied the sustainability of farming as measured using rice check. Furthermore, the rice check measurement model used is different according to the conditions of each country and the differences in Good Agricultural Practices (GAP) in each country. The novelty of this research is how to measure sustainability using the Rice Check method which has not been done much research, especially in Indonesia. The Rice Check model used has also been modified according to the results of observations to facilitate data collection to farmers but is still guided by the Rice Check made by the Ministry of Agriculture.

2 Research methods

2.1 Study Location

The location was chosen purposefully according to the research objectives. The Daerah Istimewa Yogyakarta Province was chosen because there are various techniques of rice cultivation: organic, non-organic, and semi-organic. Specifically, the research was conducted in Sleman Regency and Bantul Regency, with details as shown in Table 1.

Table 1. Details of Research Location on Profitability and Rice Check measurement in rice cultivation in Daerah Istimewa Yogyakarta

No.	Village	Regency	Type of Rice
1.	Gilangharjo	Bantul	Organic
2.	Candibinangun	Sleman	Semi-organic
3.	Bangunjiwo	Bantul	Non-organic

Gilangharjo Village was selected since it has an organic rice certificate, Candibinangun Village is known for cultivating semi-organic rice, and Bangunjiwo Village was chosen since there are farmer groups that regularly cultivate non-organic rice. Fig. 1. Shows the maps of research location.

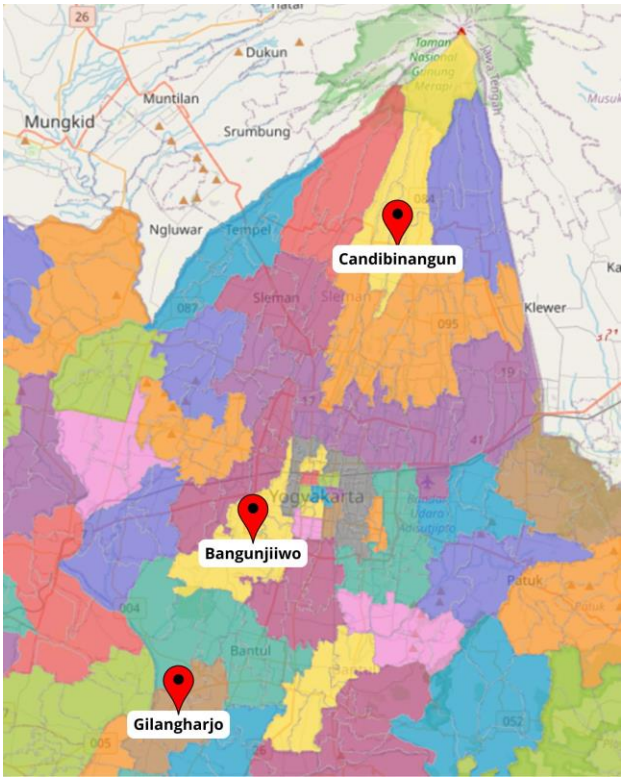

Fig. 1. Research Locations Spread across 3 Villages in Yogyakarta

2.2 Data Collection

Non-probability sampling was employed, particularly quota sampling [25]. This technique involves non-uniform sampling, where each element or member of the population is not given an equal chance of being selected as a sample. Quota sampling is an approach that involves selecting participants based on a desired amount or quota, as described by Firmansyah and Dede [22]. A sample size of 30 farmers was selected from each village to participate in the survey.

2.3 Data Analysis

2.3.1 Farming Profitability Analysis

Farming profitability was calculated by analyzing the production costs, revenue, income, and profit incurred in the three techniques of rice cultivation.

1) Revenue

Revenue was defined as the receiving and selling of goods multiplied by the unit selling price. Revenue in this study was obtained from rice production and its selling price. This is also supported by Soekartawi, Soeharjo, Dilllon, and Hardaker [23], who stated that farming revenue is the multiplication of production obtained by the selling price. This statement was written in Formula 1:

$$TR = Y \times P_y \quad (1)$$

where *TR* was total revenue (IDR), *Y* was rice production (kg), and *Py* was rice price (IDR).

2) Income

Income generated from revenue minus total explicit costs. Explicit costs are the types of costs incurred by farmers in carrying out production process activities. Implicit costs are costs that are not visible because they are not issued in the form of cash where there is no process of exchanging money or other forms of transactions.
This indicates that the income received by farmers is the total revenue minus the total explicit costs incurred in the production process, so it can be formulated as Formula 2 [24]:

$$I = TR - TC_{explicit} \quad (2)$$

where *I* was farming income, *TR* was total revenue, and $TC_{explicit}$ was total explicit cost.

3) Profit

Profits are almost the same as farming income. The difference is that in the profit analysis, all total costs incurred in farming, explicit and implicit, such as wages for family labor and own capital interest, are considered [23]. Mathematically, profit can be written as Formula 3 [24]:

$$\pi = TR - TC \quad (3)$$

where π was profit, *TR* was total revenue, and *TC* was total cost (sum of explicit and implicit costs).

4) Farming Profitability and Relative Profit

The profitability of farming is determined after determining the amount of revenue, income, and profit. Profitability was a measurement tool for the utilization of assets in a business, or the ability of a corporation to generate profits within a specific period at the sales of own capital and assets owned. The profitability was written as Formula 4:

$$Profitability: \frac{Income}{Production\ cost}\ x\ 100\% \quad (4)$$

Measurement criteria:
a) Profitability > deposit rate, meaning the business is profitable
b) Profitability < deposit rate, meaning that the business is not profitable

R/C ratio analysis was used to determine the relative profitability of the three types of paddy rice cultivation in Daerah Istimewa Yogyakarta. The R/C ratio was an analytical tool that compared revenue and total costs. Mathematically, the analysis can be written as Formula 5 [23] [24]:

$$R/C\ Ratio = \frac{TR}{TC} \quad (5)$$

where *TR* was the total revenue, and *TC* was the total cost.

Relative profit criteria:
R/C Ratio = 1 means break-even point (no profit and no loss)
R/C Ratio > 1 means rice farming is profitable
R/C Ratio < 1 means rice farming is not profitable

2.3.2 Sustainability Measurement Analysis with Rice Check

A rice check is used to assess the technical sustainability of rice farming. This analysis aimed to improve the quantity and quality of rice production while also providing recommendations and education for farmers. Rice Check is similar to rice SOP; the difference is that Rice Check only consists of important components that support rice cultivation. According to Wahab et al. [16], Rice Check contains a list of "essential" technology components that are the main requirements for achieving optimal and maximum rice productivity. By adopting and applying the Rice Check, it is expected that farmers will be able to adopt the best technology and maximize rice productivity [16]. This study selected several important components considered the most decisive for preparing the rice check. The selection of these components was determined based on the recommendations of the Ministry of Agriculture. These components include: 1) land preparation; 2) planting time; 3) varieties and seeds; 4) nursery; 5) planting; 6) fertilization; 7) care and weeding; 8) digging; 9) harvesting; and 10) post-harvesting.

The rice check in this study was developed according to the conditions of each rice cultivation variety. The practices and indicators have been modified to suit organic, semi-organic, and non-organic paddy fields. The sustainability assessment worksheet for rice farming practices was provided as a questionnaire. The sustainability index of rice farming practices refers to Taylor et al. [19]. Farmers who implement the practices based on the sustainability assessment worksheet or questionnaire will be given a score of 1. On the other hand, farmers who do not implement the practices based on the questionnaire will be given a score of 0 or negative (-1). The sustainability index value of rice farming practices was built from 0 to 100%. Therefore, to measure sustainable agricultural practices by rice farmers, a Farmer Sustainability Index (FSI) was developed based on the methodology suggested by Taylor et al. [19]. Positive values were assigned to practices believed to contribute to sustainability, and negative values to practices that reduce sustainability. A value of zero was assigned to the neutral position. In terms of easing the interpretation of FSI scores for different farmers in this study, the respective FSI scores of each unadjusted Rice Check are as follows:

a) *Rice Check* of organic farming ranges from -6 to +22
b) *Rice Check* of semi-organic ranging from -7 to +26
c) *Rice Check* of non-organic rice ranges from -6 to +22

Table 2. Sustainability Index of Rice Check on Different Techniques of Rice Cultivation in Daerah Istimewa Yogyakarta

Sustainability Index Value (%)	**Sustainability Category**
>70.01	Sustainable
60.1 – 70.0	Somewhat sustainable
50.1 – 60.0	Intermediate sustainable
40.1 – 50.0	Possibly quite unsustainable
20.1 – 40.0	Possibly unsustainable
< 20.0	Possibly very unsustainable

Source: [19]

Each score was adjusted to be placed within the range of 0 to 100, as shown in Formula 5 [19]:

$$Adjusted\ FSI\ score = \frac{(Unadjusted\ score - minimum\ score)}{(maximum\ score - minimum\ score)} x\ 100 \quad (6)$$

Afterward, each Rice Check FSI score was determined and classified based on the sustainability index. Table 2 shows the six sustainability index categories for rice farming.

FSI is used to measure the sustainability value, after obtaining the results, the results can be determined based on the sustainability index category.

2.3.3 ANOVA Test

ANOVA was a statistical analysis to assess the differences in means between groups, which may refer to groups or treatment types. This statistical test is similar to the independent t-test, but ANOVA has the advantage of testing for differences in more than two groups. The independent sample t-test could only test the mean difference between the two groups [22] [25]. The ANOVA test was used to assess whether there was a difference in means between groups. The calculated F value will be compared to the value in the F table. If the calculated F value was higher than the value in the F table, it was concluded to accept H1 and reject H0. It means that there was a significant difference in means across all groups. The ANOVA test in this study was used to measure the difference in the value of the Rice Check analysis results. The basis for decision-making in ANOVA Analysis is:

1. If the significance value (Sig) > 0.05, then the means are equal
2. If the significance value (Sig) < 0.05, then the averages are different 2

3 Results and discussion

3.1 Profitability Analysis

3.1.2 Rice Farming Input Utilization

The utilization of inputs in organic, non-organic, and semi-organic rice farming has its characteristics and will affect production. Table 3 shows the average use of rice farming inputs in various cultivation techniques with a land conversion of 1,000 m^2.

Table 3. Average production input use of rice farming businesses in Yogyakarta Special Region

Description	Unit	Input Average per 1000m^2		
		Organic	Non-organic	Semi-organic
Seeds	Kg	5.19	7.98	5.77
Manure	Kg	223.10	130.80	63.36
Biogas	Kg	9.78	-	-
Empon - Empon	Kg	0.25	10.76	0.04
Organic waste	Kg	12.67	0.02	1.71
NPK	Kg	-	15.40	13.52
KCL	Kg	-	1.18	1.13
ZA	Kg	-	-	0.50
Urea	Kg	-	14.98	16.91
SP-36	Kg	-	0.24	0.45
Organic Solid Pesticides	Kg	0.32	0.15	-
Inorganic Solid Pesticides	Kg	-	0.03	0.03
Organic Liquid Pesticides	Liter	0.16	0.01	0.01
Inorganic Liquid Pesticides	Liter	-	0.05	0.13
Family labor	HKO	10.04	10.92	8.83
Nonfamily labor	HKO	5.73	5.06	7.09

In terms of manure, the input was used in significant amounts in organic rice farming, while in non-organic and semi-organic systems, the amounts were lower. This finding was supported by the fact that many organic rice farmers have livestock that can be used as

fertilizer. One notable distinction among the three cultivation methods is that organic rice farming involves farmers utilizing livestock dung-derived biogas waste. Another difference is using inorganic fertilizer inputs such as NPK, KCL, ZA, Urea, and SP-36, which were more dominant in non-organic and semi-organic rice farming systems. The use of solid and liquid pesticides, both organic and inorganic, is also evident in the data, with significant variations in use between the three cultivation techniques.

3.1.2 Total Cost

Total costs were the total costs incurred by farmers during the farming process. Total costs consist of explicit and implicit costs. Explicit costs refer to the actual expenses farmers incur during the farming process. Implicit costs are not apparent expenses, as they do not involve exchanging money or other tangible transactions [23]. Table 4 shows the total cost of rice farming in three cultivation techniques.

Table 4. The average cost of rice farming per planting season in Daerah Istimewa Yogyakarta

Description	Average cost/1000m^2		
	Organic (IDR)	**Non-organic (IDR)**	**Semi-organic (IDR)**
Explicit cost			
Seeds	69,866	70,316	75,681
Fertilizer	566,994	745,125	473,044
Pesticide	27,148	20,415	14,738
Nonfamily labor	580,935	864,648	666,783
Others cost	435,613	538,607	354,516
Equipment Depreciation	100,023	134,231	71,195
Total Explicit	**1,780,578**	**2,239,112**	**1,584,763**
Implicit cost			
Family labor	779,893	852,887	1,065,154
Own land rent	1,688,145	1,203,571	1,163,226
Own capital interest	16,297	48,001	45,836
Total Implicit	**2,484,335**	**2,104,459**	**2,274,216**
Total Cost	**4,264,913**	**4,343,571**	**3,858,978**

Table 4 shows that the highest explicit costs were incurred by non-organic rice farms, amounting to IDR 2,239,112. Non-organic rice farming uses much nonfamily labor. This result was in line with some research, such as that conducted by Azis et al. [29], that showed that the total cost of semi-organic rice was IDR 3,282,823 less than non-organic rice, which amounted to IDR 4,792,901. Research conducted by Agnesti et al. [30] also showed the same results, where the total cost of non-organic rice farming was IDR 16,455,009 higher than that of semi-organic rice, IDR 12,026,030.

The difference between the three types of cultivation also lies in the total use of costs incurred for fertilizer, where non-organic rice farming has the highest total fertilizer costs of IDR 864,648. In total cost, non-organic rice farming has the highest total cost, followed by organic and semi-organic rice farming.

3.1.3 Production and Revenue

Revenue was the outcome obtained by farmers, calculated by multiplying the production quantity by the price of the produced commodity. The production addressed in this study refers to rice that has been harvested for commercial sale, excluding rice in the form of Harvested Dry Rice and Milled Dry Rice.

Table 5. Average revenue of rice farming per planting season in Daerah Istimewa Yogyakarta

Description	Average revenue per 1000m^2		
	Organic	**Non-organic**	**Semi-organic**
Production (kg)	449	402	382
Price (IDR)	14,235	12,982	13,726
Revenue (IDR)	6,390,658	5,220,561	5,238,405

Table 5 shows that organic rice farming had the highest production value, followed by non-organic and semi-organic rice farming. The average price of the three cultivation techniques had almost the same price level, IDR 12,000-14,000, according to the market price of rice in early 2023, averaging around IDR 14,201 [31]. The quantity of production and the price level determined the total revenue. Consequently, an increase in either the production quantity or the price will result in an associated increase in the total revenue. In Table 6, organic rice farming had the highest total revenue since it had quite high production and prices compared to non-organic and semi-organic rice farming. Organic rice products have an organic label or healthy rice branding to help consumers understand. This label caused the price to be relatively high since the rice was healthy. Another reason was that farmers have also used online platforms to sell organic products, such as WhatsApp.

3.1.4 Farming Profitability and Relative Profit

This study calculates the profitability and relative advantage of farming using R/C ratio analysis. This analysis determines whether a business unit experiences a loss, break-even point, or profit in production. R/C ratio analysis was also employed to test how far the cost used in rice farming can provide revenue. A higher RC ratio indicates greater farm feasibility. Farming is feasible if the R/C ratio value is higher than one or equal to one (Soekartawi, 1990).

Table 6. Analysis of Relative Profit of Rice Farming Business per Planting Season in Yogyakarta Special Region

Description	Relative profit analysis per 1000m^2		
	Organic (IDR)	**Non-organic (IDR)**	**Semi-organic (IDR)**
Revenue (A)	6,390,658	5,220,561	5,238,405
Total Explicit (B)	1,780,578	2,239,112	1,584,763
Total Implicit (C)	2,484,335	2,104,459	2,274,216
Income (D) (A-B)	4,610,080	2,981,449	3.653,643
Total cost (E) (B+C)	4,264,913	4,343,571	3,858,978
Profit (A-E)	2,125,745	876,990	1,379,427
R/C ratio (A/E)	**1.50**	**1.20**	**1.36**
Profitability (D/E) x100 (%)	**91.99**	**74.46**	**70.66**

Table 6 analyzes the relative profitability of farming per 1000m^2 for three farming systems: organic, non-organic, and semi-organic. Based on the analysis, organic farming has the highest revenue, profit, and R/C ratios compared to semi-organic and non-organic farming. The high R/C ratio value in organic rice compared to non-organic and semi-organic rice is in line with the research of Sholihah et al. [32], where the R/C ratio value of organic and conventional rice farming was 4.73 and 3.99, respectively. Another study by Saikhu et al. [33] found that organic rice had a higher R/C ratio of 10.59 compared to inorganic rice of 4.67.

The R/C ratio value of 1.50 in organic rice farming can be interpreted as every IDR 1,000 resulting in revenue of IDR 1,500. The three techniques of rice cultivation had a value of R/C> 1, which illustrates that rice farming in various techniques of cultivation was feasible.

Based on the results, the profitability of the three cultivation techniques was higher than the deposit interest rate (2.5%), so all three were profitable. Organic rice farming had the highest level of profitability at 91.99%. In second place, non-organic rice farming recorded a profitability rate of 74.46%. Semi-organic farming, a combination of organic and non-organic methods, has the lowest profitability rate at 70.66%.

3.2 Average Rice Check Analysis

The average rice check score shows which farms had the highest average rice check score. The average score of Rice Check in this study can be seen in Fig. 2, in which sequentially, organic rice had a high average score of 73.59% (sustainable), non-organic rice had a score of 59.27% (intermediate sustainable), and semi-organic at 56.39% (intermediate sustainable). Based on this figure, the sustainable check of organic rice farming is better than the other two types of cultivation techniques, namely non-organic and semi-organic. These results were based on the hypothesis that there were differences in the value of the sustainability index of rice farming practices based on the results of the Rice Check analysis. The difference in the value of the rice check was also analyzed statistically using a different ANOVA test using SPSS in Table 7.

Table 7. Multiple Comparisons of Rice Check

Dependent Variable: Rice check				
Tukey HSD				
(I) type of cultivation	**(J) type of cultivation**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**
Organic	non-organic	14.31452*	3.40672	.000
	semi-organic	17.19800*	3.49678	.000
non-organic	Organic	-14.31452*	3.40672	.000
	semi-organic	2.88348	3.49678	.689
semi-organic	Organic	-17.19800*	3.49678	.000
	non-organic	-2.88348	3.49678	.689

*The mean difference is significant at the 0.05 level.

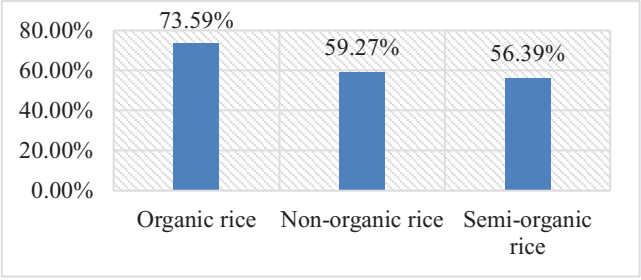

Fig. 2. Average Score of Rice Check.

Non-organic and semi-organic rice had the same significance value. In contrast, if organic rice was compared with non-organic or semi-organic rice, there was a difference, which means there was a considerable difference between organic rice and non-organic and semi-organic rice.

Table 8 illustrates the analysis results and the distribution of rice check values for rice farming in three categories: organic, non-organic, and semi-organic. These results were classified into six value ranges, ranging from more than 70.01 to less than 20.0. From the data, it can be concluded that the majority of organic rice farms, 61.29%, belong to the sustainable category, with index values above 70.01. On the other hand, only 22.58% of non-

organic rice farms and 7.14% of semi-organic farms meet the sustainable criteria. The Somewhat sustainable category dominates in non-organic rice farming at 29.03% and semi-organic at 39.29%, while in the intermediate sustainable category, organic has a share of 3.23%.

Table 8 shows that organic rice has the highest sustainability index score, indicating that many organic rice farms follow the GAP guidelines in Check Rice, especially those of the Ministry of Agriculture. By adopting Rice Check, farms have understood rice cultivation's standard operating procedures (SOPs), emphasizing cultivation governance using standard technology. By adopting and implementing Rice Check, farmers demonstrate that they have adopted the best technology available, so rice productivity is expected to reach the best level [16].

Table 8. Results of Analysis and Distribution of Rice Check Values of Rice Farming Businesses

Index score		Organic		Non-organic		Semi-organic	
		Amount	Percentage (%)	Amount	Percentage (%)	Amount	Percentage (%)
>70.1	Sustainable	19	61.29	7	22.58	2	7.14
60.1 – 70.0	Somewhat sustainable	9	29.03	9	29.03	11	39.29
50.1 – 60.0	Intermediate sustainable	1	3.23	5	16.13	8	28.57
40.1 – 50.0	Possibly quite unsustainable	2	6.45	7	22.58	4	14.29
20.1 – 40.0	Possibly unsustainable	0	0	3	9.68	3	10.71
< 20.0	Possibly very unsustainable	0	0	0	0	0	0

The results of non-organic and semi-organic rice farming based on Table 8 still need evaluation when using SOPs. According to the SOP guidelines, farmers were encouraged to pay more attention to good and correct rice farming processes. Local extension workers also need to play an active role in training farmers to use SOPs for rice farming. It was recommended that non-organic and semi-organic rice farms switch to using the organic farming system. Non- and semi-organic farms can still increase the value of rice checks if farmers evaluate the cultivation process, such as by paying more attention to the use of production inputs, especially natural ingredients.

3.2.1 Rice Check Organic Rice

Among the six sustainability criteria analyzed in the rice bill analysis, organic rice was primarily characterized by the "sustainable" category. Fig. 3 presents the number of farmers from the rice farming sustainability analysis based on the Rice Check index value, which was divided into six categories. A total of 19 farmers from organic rice farms in the >70.01 category was considered "Sustainable," while nine farmers with values of 60.1-70.0 were categorized as "Somewhat sustainable." Only one farmer entered the 50.1-60.0 category and was considered "Intermediate Sustainable." In contrast, two farmers in the total sample were each distributed in the "Possibly Quite Unsustainable" category (40.1 - 50.0). None of the samples fell into the categories of "possibly unsustainable" (20.1- 40.0). and "< 20.0" or "Possibly Very Unsustainable." Thus, most rice farms were in the high index value category, indicating the adoption of sustainable agricultural practices.

The large number of organic rice farmers with Rice Check scores in the sustainability category is supported by several factors, such as farmer groups encouraging farmers to discipline each other in implementing organic farming. An organic organization, PAMOR Indonesia, also supervises them. PAMOR Indonesia is an organic farming participatory assurance system that involves farmers or producers, traders, consumers, NGOs, and the government in assessing the system's quality by organic standards.

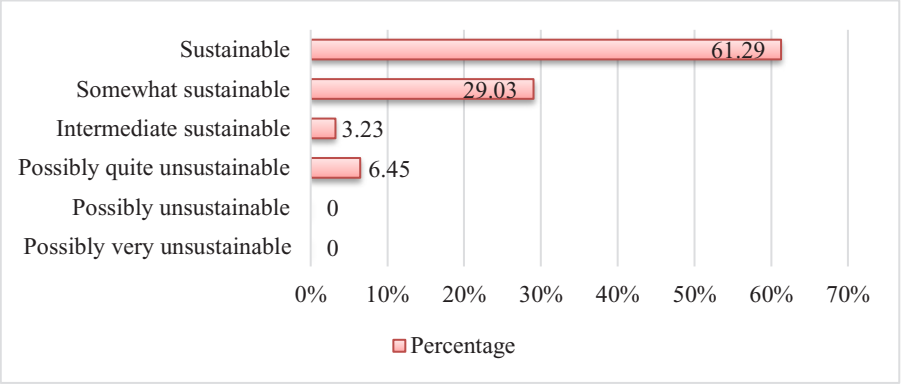

Fig. 3. Rice Check Organic Rice.

The main actors in organic quality system assurance in PAMOR Indonesia were the producers, who were responsible for evaluating and formally declaring that organic farming practices met the requirements of organic standards. The aim is to provide organic assurance to local and national markets, focusing on farmer groups [34]. In 2004, participatory assurance methods were used to guarantee the integrity of organic products. With the existence of PAMOR, organic rice farmers in Pandak, Bantul Regency, are more disciplined in implementing GAP so that they have a high Rice Check value. Research conducted by Van Thanh and Yapwattanaphun [21] on the Application of Sustainable Agricultural Practices by Banana Farmers in the Highlands of Vietnam using SPAs analysis (Vietnamese version of Rice Check) showed that out of 300 farmers, 92 were in the category of sufficient sustainability related to harvest and post-harvest systems, utilization of local wisdom, livestock management in fields, crop rotation, and weed control.

3.2.2 Rice Check Non-Organic Rice

Non-organic rice farming has quite varied rice check results. Fig. 4 shows the results of the analysis of the sustainability of rice farming based on the Rice Check index value, which is divided into six categories. Seven farmers, or 22.58% of rice farms, were classified as "Sustainable," while nine farmers, or 29.03%, fell into the category of "Somewhat sustainable." "Intermediate sustainable" included five farmers, while the categories of 'Possibly Quite Unsustainable' and 'Possibly Unsustainable' included 7 and 3 farmers, respectively. None of the samples fell into the “Possibly Very Unsustainable.” Thus, the distribution of rice farming sustainability was relatively even across the various index value categories. The main reason for the large number of farmers who fall into the Somewhat sustainable category is that many have entered old age, so some do not pay much attention to the GAP of rice farming. Furthermore, non-organic rice farmers also use many chemicals in fertilizers and pesticides, so they do not follow the Rice Check indicator, which prioritizes using organic materials. This result was in line with Purba et al. [18], which state that the average sustainability index of rice farming in tidal marshlands is 25.53%. This means that rice farming practices are possibly unsustainable. This happens because some farmers carry

out sustainable agricultural practices but only easy ones, such as pulling weeds by hand, timing fertilizer application, and others.

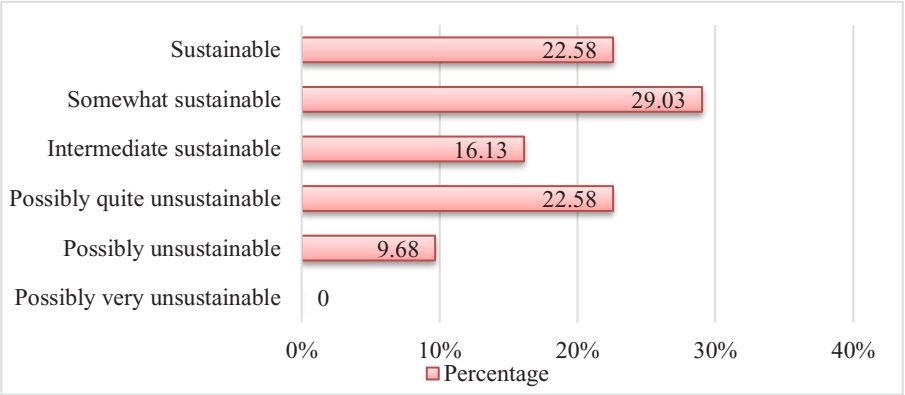

Fig 4. Rice Check of Non-organic Rice.

3.2.3 Rice Check Semi-Organic Rice

The Somewhat sustainable category of semi-organic farming showed significant results. However, semi-organic farmers still need to increase the use of GAP so that many farmers fall into the sustainable category. Fig. 5 reflects the results of the analysis of the sustainability of semi-organic farming based on the Rice Check index value, which is divided into six categories. Two rice farmers (7.14%) are classified as “Sustainable”, while eleven farmers (39.29%) fall into the category of "Somewhat sustainable." "Intermediate Sustainable” includes eight farmers (28.57%), and four farmers (14.29%) are categorized as ”Possible Quite Unsustainable”. Three farmers (10.71%) have a sustainability level that falls into the "Possibly Unsustainable." There were no farmers in the “Possibly Very Unsustainable” category. Compared to organic rice farming, semi-organic farming had the majority of farmers in the fairly sustainable category.

This finding was supported by several factors, one of which was the role of extension workers. There was a well-known extension worker who played a role in semi-organic farmer groups, namely Mr. Frans, who often monitored and assisted farmers in rice cultivation to comply with GAP. Starting as a fisheries extension agent, he was now the most sought-after expert. After being appointed as an extension worker, he focused on fisheries. Mr. Frans learned about agriculture while training at the Sukamandi Fisheries Center in West Java. At the beginning of his efforts to use the semi-organic system, the community often scorned him as they did not believe him until they saw the results [35]. Extension workers play a crucial role in assisting farmers with agricultural operations. The results of the semi-organic Rice Check were not in line with research conducted by Mohamed, Shamsudin, et al. [36] that showed that most farmers (80%) practiced moderately unsustainable rice farming with a score of less than 40.0 on a scale of 0-100. These findings indicate that most farmers lacked knowledge regarding the rice check standards, or MyGAP (the Malaysian version of Rice Check). Only 2.5% of rice farmers were in the medium sustainability range, and none were in the sufficient or sustainable range.

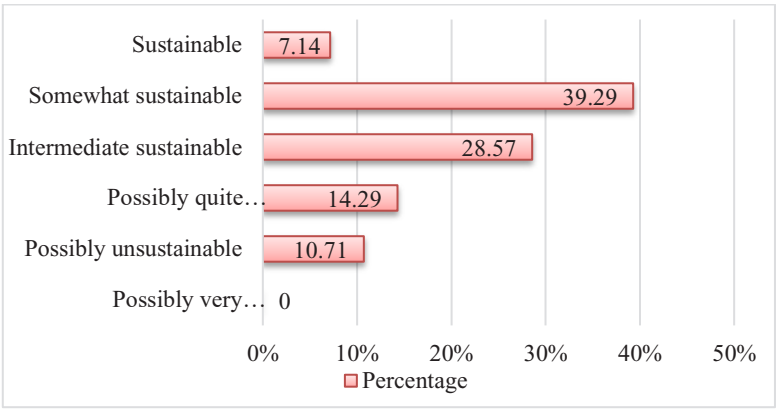

Fig. 5. Rice Check of Semi-Organic Rice.

4 Conclusion

The results of the relative profit of farming using the R/C ratio showed that organic rice farming performed better at a value of 1.50. Based on the results, the three cultivation techniques had higher profitability than the deposit interest rate (2.5%), so the three cultivation techniques were profitable. Organic rice farming had an average score of 73.59% for the Rice Check, which means it is in the sustainability category. Non-organic rice farming has a score of 59.27%, indicating the Rice Check sustainability index has intermediate sustainable status. Semi-organic farming had an average Rice Check score of 56.39%, included in the intermediate sustainable category in the Rice Check analysis. Based on the results of the ANOVA test, there was a significant difference between organic rice farming and non-organic and semi-organic farming. At the same time, there was no significant difference between non-organic rice farming and semi-organic. farming Each method had different Rice Check values among the three cultivation techniques, with organic rice having the highest status.

Extension workers on non-organic and semi-organic rice farms must further improve and pay attention to how far farmers apply GAP to rice cultivation. If in the future farmers apply GAP to the maximum, non-organic and semi-organic rice farming will be more technically sustainable, especially in Rice Check analysis.

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