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THRIVING FIELDS: A STUDY ON THE SUSTAINABLE PRACTICES OF ORGANIC RICE FARMING IN SLEMAN REGENCY

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ABSTRACT

Organic farming is an environmentally friendly agricultural strategy that relies on natural inputs for the output. Organic farming's sustainability can be examined from a variety of perspectives, including institution, ecological, economic, social, and technology. This research aims to determine the sustainable practices of organic rice farming in Sleman Regency and determine the sensitive attributes which have effects on sustainability. The method of this research is descriptive analysis with a quantitative approach. The total number of respondents is 49 organic rice farmers in Sleman Regency. All of the respondents were selected by simple random sampling. The methods of collecting data are observation, in-depth interview, and documentation. The data analysis uses Multidimensional-Scaling Rapid for Appraisal (MDS-RAPS) technique which release Rap-Score value and Root Mean Square (RMS) value on Leverage Analysis. Rap-Score value is used to determine sustainability index status. RMS value is used to determine sensitive attributes that affects the sustainability. Each dimension of sustainability has different index, those are ecological (81,57); economic (78,47); institution (78,36); social (77,11); and technology (62,58). The average sustainability index from all dimensions is 75,62 which means that the sustainable practice of organic rice farming in Sleman Regency is very sustainable. The result of RMS value on Leverage Analysis show that, those are 21 sensitive attributes from five dimensions were obtained that effect on sustainability. So, the strategies are still needed to increase the value of sustainability. The strategies that can be made to improve the sustainability index is improving the performance of sensitive attributes in each dimension.

Keywords: *sustainability, multidimension, organic agriculture, Sleman Regency*

INTRODUCTION

Agriculture is a strategic sector which has a significant impact on the Indonesian economy. This condition is reflected in the contribution of the agricultural sector to the Gross Domestic Product (GDP) in 2022, that is 12.40% and becomes the top second rank in terms of its contribution to the GDP, after the processing industry as the first rank (BPS, 2023). Agriculture also supports national development within their roles to provide raw material for industries, provide job vacancy, provide food, and foreign exchange contributors (Marpaung et al., 2021). Considering the important role of the agricultural sector to the national development process, the agricultural activities must be done by maintaining the environment aspect in order to be sustainable in the future.

Agricultural development should be done in balance so it can be sustainable. To achieve the target, we must focus to increase the yield and maintain the environment balance, quality product, and product safety. (Yuriansyah et al., 2020). Agricultural cultivation which considers environmental sustainability is commonly known as the organic agriculture system. Based on Agriculture Ministry Regulation No 64 in 2013, the organic agriculture system is the holistic production management system to increase and develop the healthy agroecosystem, including biodiversity, biology cycle, and soil biology activities.

As stated by International Federation of Organic Agriculture Movement (IFOAM), organic agriculture can be defined as a whole farming activity, from production process to natural yield processing, and is environmentally friendly without using chemical matter. The aim is to maintain soil health, the ecosystem, and human beings (IFOAM, 2008). There are four principles in organic agriculture, those are health, ecology, equity, and protection (IFOAM, 2020).

The Indonesian government took a role to support the acceleration of the organic agriculture transformation system by launching the “Go

Organic 2010" program started in 2001. This program aims to make Indonesia a global player in terms of organic food producer and exporter. The strategic moves to achieve this target are introducing the organic system, facilitating the program, empowering farmers, and formulating policy about organic rice and horticulture (Ditjen BPPHP Deptan, 2005). The "Go Organic 2010" program has succeeded in introducing organic agriculture to society. This success is indicated by the increasing number of organic farmers in 2017 (Indonesia Organic Alliance, 2019).

The development of organic agriculture in Indonesia in the period 2011 to 2021 is fluctuating. In the period 2016 to 2018, the growth of organic agriculture is relatively significant due to the increasing organic awareness of farmers. But in 2018, there was a decline in organic land area because some operators did not extend the organic certification. The development of organic land area can be seen in Picture 1.

Figure 1. Organic farming land area in Indonesia

Source: Indonesia Organic Alliance (2019)

This situation has a bad impact on the sustainability of organic farming in Indonesia. Therefore, it is critical to discuss the sustainability condition of organic farming in Indonesia, especially where organic farming has been implemented. In addition, it should analyze the aspects that may impact the sustainability of organic farming so it will be evaluated in the next policy making process.

METHOD

The basic method in this research is descriptive analysis with quantitative approach. Sugiyono (2013) states that descriptive analysis is a method to collect or compile the data and display it to describe the existing situation. Meanwhile, quantitative approach is a research approach that uses data of calculation, measurement, and numeric to analyze and make conclusions (Musianto, 2002). Those methods were to assess the sustainability status of organic rice farming and sensitive attributes that affect sustainability.

This research was conducted in 2023. The sampling location was purposive sampling in three villages of Sleman Regency, that were Widodomartani Village, Ngemplak District; Sumberharjo Village, Prambanan District; and Jogotirto Village, Berbah District. Those three villages were chosen as research locations because it has produced organic rice and got an organic certificate from Seloliman Organic Certification Institute (LeSOS). The organic rice was produced by members of three farmer groups, namely Mekar, Makmur, and Sido Rukun.

The population in this research were 65 farmers who implemented organic rice farming in Sleman Regency and members of three farmer groups. Gay et al. (2009) state that the minimum sample of small population is 20%. Based on that, this research used quota sampling to select respondents. The respondents were 75% of the population from each farmers group, that are 49 respondents. Then, the farmers were carried out as simple random sampling. This research used primary and secondary data. Primary data were obtained from observation and interview with respondents. Meanwhile, secondary data were obtained from stakeholder's publications such as Indonesia Organic Alliance and BPS Sleman.

The data was analyzed using Multidimensional-Scaling (MDS) technique. MDS is a concept that uses perceptual mapping technique to represent data on similarities or dissimilarities (Pratiwi & Noeryanti, 2020). MDS approach is used to analyze multivariate variables. This research is included in MDS non-metric because it uses ordinal data or categorical scales. The tool used for analyzing multidimensional data is MDS-RAPS.

Multidimensional-Scaling and Rapid Appraisal for Sustainability (MDS-RAPS) is a tool to analyze sustainability. The tool was introduced by Tony J. Pitcher, a fisheries scientist from University of British Columbia since 1999 with the first name was Rapfish (Yusuf et al., 2021). MDS-RAPS is a modification of Rapfish with attributes that have been adapted to assess sustainability. There are several principles of MDS-RAPS, such as use categorical scales (nominal/ordinal data), have bad and good scores, use 6-12 attributes, and

the score can represent about best or worst possibility (Pitcher et al., 1998).

MDS-RAPS uses a perceptual mapping concept depending on Euclidean Distance between one dimension and others (Ristianingrum et al., 2016). Based on the MDS concept, attributes in each dimension will be mapped in Euclidean distance. Then, the object which has the same characteristics is considered to have similarities and have shortest distance. But, objects which have different characteristics are considered as dissimilarities and have the longest distance. So, the difference between objects can be measured in "perception distance" and the result can be seen as a sustainability index.

Based on Fauzi & Anna (2002), MDS technique for Euclidean distance uses the following formula:

$$d = \sqrt{|x1 - x2|^2 + |y1 - y2| + \ldots} \quad \ldots\ldots\ldots\ldots(1)$$

Where:
d = distance
x, y = attributes

Configuration and ordination from an object or dot in MDS-RAPS then will be approximated with the regression on Euclidean distance (Dij) from i to j with the domain (Dij) in this equation:

$$Dij = a + bDij + e \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where:
Dij = euclidean distance from dot i to j
a = constant
b = regression coefficient
aij = euclidean value from dot i to j

The sustainability assessment by MDS-RAPS has a selfvalidation system robust. So that, when data was processed, the system could show the level of validation. MDS-RAPS uses the ALSCAL algorithm to regress the equations. The ASCAL algorithm can optimation square distance (Dij) to domain (Oij). Kanvagh & Picther (2004) state that the principle of ASCAL algorithm is to make an iteration of the regression process and make an intercept to get the smallest error value. The iteration process will be stopped when the S-Stress value was less than 0,25.

Pitcher (1999) states that on MDS-RAPS, if the value of S-Stress close to number zero is indicated that the model is better. But, if the value of S-Stress close to number one is indicated, the model is worse and has bigger errors. The value of S-Stress acceptable on MDS-RAPS if the value is less than 0,25 or 25%.

Yusuf et al. (2021) state that the MDS-RAPS method also carried out Monte Carlo simulation. Monte Carlo simulation is used to determine the level of random errors when performing data processing. Beside of that, Monte Carlo simulation also forecasts actual value (Kavanagh & Picther, 2004). Monte Carlo analysis is conducted with 95% confidence level. Thus, the difference between the value of Rap-Score and the Monte Carlo index is acceptable if the result is less than 5%.

Based on Pitcher & Preikshot (2001), there are several stages to analyze sustainability uses tool MDS-RAPS. The first step is determination of attributes to assess sustainability. The attributes are selected based on references to previous research and be adapted to conditions in the field. This research uses 36 attributes from 5 dimensions to assess the status of sustainability.

The second step is attributes assessment using an ordinal scale between 0 (bad) and 4 (good) based on characteristics of each attribute and references to previous studies. The result of assessment on each attribute is analyzed using add-ins MDS-RAPS template to software Microsoft Excel. Then, the result of Rap-Score is compared with sustainability index categories to identify the status of sustainability. The categories of sustainability index can be seen in Table 1

Table 1. The categories of sustainability status

No	Sustainability Index	Sustainability Status
1	0,00-25,00	Unsustainable
2	25,01-50,00	Less sustainable
3	50,01-75,00	Quite sustainable
4	75,01-100	Very sustainable

Source: Ristianingrum et al. (2016)

The third step is Leverage analysis to determine sensitive attributes that affect the sustainability index.The Leverage analysis will result in Root Mean Square Square (RMS) value. The value of RMS will be used to identify the sensitivity of attributes. The sensitive attributes determination is carried out using the law of

middle values. The law of middle values explains that a sensitive attribute is an attribute that has an RMS value higher than the highest RMS value divided by two (Yusuf et al., 2021).

RESULTS AND DISCUSSION

The analysis of sustainability status on organic rice farming in Sleman Regency uses five dimensions that are ecology, social, economics, technological, and institution. The status of sustainability is seen by MDS-RAPS ordination index and is compared with criteria of sustainability on Table 1.

Ecological Dimension

The sustainability status based on ecology dimension shows environmental conditions in organic rice farming. There are six attributes to identify sustainability of ecology. The attributes are input production application (seed, fertilizer, and pesticide), pest control, harvest success rate, and land suitability. The sustainability index of ecology dimension can be seen in Figure 2.

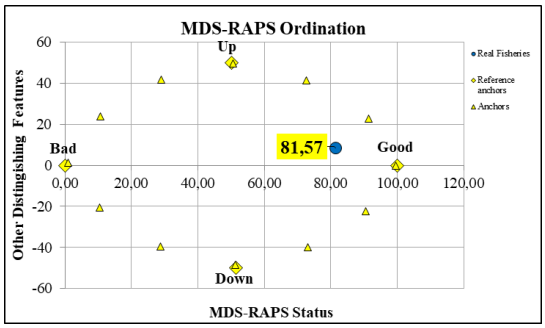

Figure 2. The index of ecology dimension
Source: MDS-RAPS Ordination (2023)

Based on figure 2, the sustainability index of dimension ecology is 81,57. Based on the categories of sustainability, that value belongs to the very sustainable. The condition shows that when viewed from ecological criteria and resources There are several sensitive attributes that affect sustainability status for ecological dimension. The sensitive attributes can be seen as a result of Leverage analysis in Figure 3.

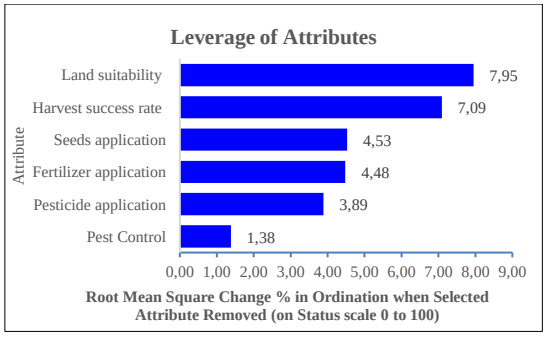

Figure 3. Leverage analysis of ecological
Source: MDS-RAPS analysis (2023)

Based on Figure 3, we know that from six attributes, there are four most sensitive attributes of ecological dimension that affect organic rice farming sustainability in Sleman Regency. The sensitive attributes are (1) Land suitability (RMS = 7,95); (2) Harvest success rate (RMS = 7,09); (3) Seed application (RMS = 4,53); and (4) Fertilizer application (RMS = 4,48).

Land suitability for organic rice farming is the most sensitive attribute on ecological sustainability because the unsuitability of land can have a negative impact on physical and economic conditions (Pradana et al., 2013). Based on physical condition, if the land is unsuitable, it can cause land damage. Meanwhile, based on economic conditions, if the land is unsuitable, it has a negative impact on reducing land productivity and has potentially to cause economic losses.

Land conditions in Sleman Regency are quite suitable for organic rice farming. It's because in recent years there has been an obstacle to dry and crack land because the drought season is too long. Land condition also has an impact on harvest success rate. Organic farmers have not had crop failure. But in the last few years, the production is low because climate change has had an effect on land conditions. So that needs some strategies to maintain water irrigation and adapt to climate change.

Seed application has effect on sustainability agriculture because seed contains genetic material that will have effect on production result. Chan (2021) states that as good as anything environmental conditions, soil, and nutrients, if they use the bad and low quality of seed, the quantity and quality of production also will be bad. Most organic farmers in Sleman Regency used certified organic seeds. Organic seeds have better quality and are more environmentally friendly (Priadi et al., 2007).

Fertilizer application has an effect on sustainability agriculture because it can increase the macro and micro nutrients (Fathoni et al., 2020). If the application of fertilizer is balanced, it will increase the quality and quality of agricultural production. Organic farmers in Sleman Regency used organic fertilizer from manure and liquid fertilizer. Organic fertilizer has a good impact on the environment. Then, the application of organic fertilizer can improve the soil quality such as soil permeability, soil porous structure, soil fertility, water absorption capacity, and cation content (Roidah, 2013).

Economic Dimension

The sustainability status based on economic dimension shows efficiency of production and economic carrying capacity of

organic rice farming in Sleman Regency. There are eight attributes to identify sustainability of economic dimension: organic farming land area, marketing access, capital access, contribution of farming income, ease of obtaining seeds and fertilizer, selling price, and feasibility of organic farming. The sustainability index of economic dimension can be seen in Figure 4.

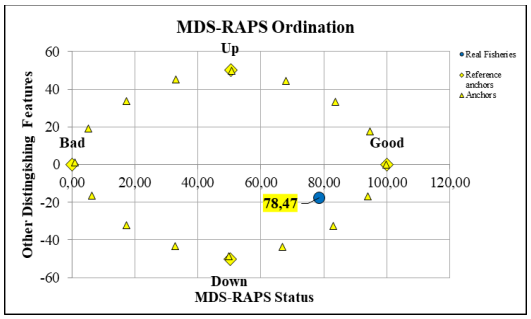

Figure 4. The index of economic dimension
Source: MDS-RAPS Ordination (2023)

Based on figure 4, the sustainability index of economic dimension is 78,47. Based on the categories of sustainability, that value belongs to the very sustainable. There are several sensitive attributes that affect sustainability status for economic dimension. The sensitive attributes can be seen as a result of Leverage in Figure 5.

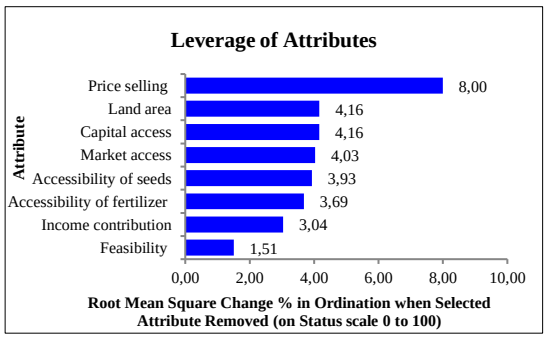

Figure 5. Leverage analysis of economic
Source: MDS-RAPS analysis (2023)

Based on Figure 5, we know that from eight attributes, there are four most sensitive attributes of economic dimension that affect organic rice farming sustainability in Sleman Regency. The sensitive attributes are: (1) Selling price product (RMS=8,00); (2) Organic land area (RMS=4,16); (3) Capital access (RMS=4,16); and (4) marketing access (RMS= 4,03).

Selling price products become a most sensitive attribute on economic dimension because it can affect farmer income. If the farmers get a low selling price for their product, it will make their income low (Saputra, 2020). If their income is low, the possibility of farmers will look for another job which is more profitable and leave agricultural activities. That condition can threaten the sustainability of agriculture. The selling price of organic rice products is stable but relatively low because most of the farmers sell their product in Dried Milled Grain (GKG) without processing. So, they need assistance in product processing to increase selling prices.

Organic land area is one of the sensitive attributes because it has an effect on quantity of product. The wider agricultural land will produce a greater quantity of production (Pradnyawati & Cipta, 2021). Tunas et al., (2023) state that the wider amount of agricultural land will affect rice farmers income. The organic land area in Sleman Regency is relatively low because they have less than 0,25 ha. So, it needs some strategies to increase organic land area in Sleman Regency.

Capital access is one of the important factors for agriculture because the capital is needed to provide input production like seed, fertilizer, pesticides, labor force, machine, infrastructure, and technology (Mariati et al., 2022). Most organic rice farmers in Sleman Regency use their own money to provide operational production. Market access is also important to sustainability access. Easy market access can make it easier for farmers to sell their product.

Social Dimension

The sustainability status based on social dimension shows the supporting capacity of a farmer's social environment such as motivation, family support, and community support. This dimension uses seven attributes. The sustainability index of social dimension can be seen in Figure 6.

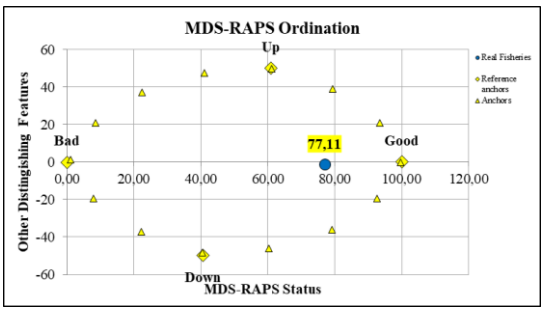

Figure 6. The index of social dimension
Source: MDS-RAPS Ordination (2023)

Based on figure 6, the sustainability index of social dimension is 77,11. Based on the categories of sustainability, that value belongs to the very sustainable. There are several sensitive attributes that affect sustainability status for social dimensions. The sensitive attributes can be seen as a result of Leverage analysis in Figure 7.

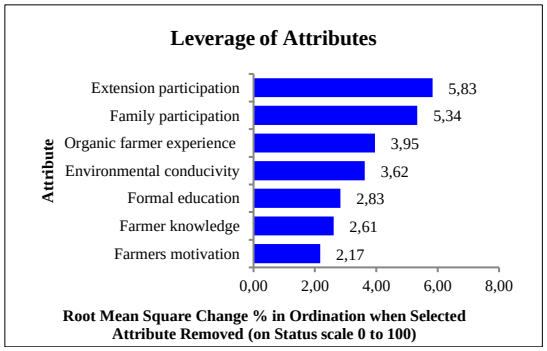

Figure 7. Leverage analysis of social
Source: MDS-RAPS analysis (2023)

Based on the Figure 7, we know that from seven attributes there are four sensitive attributes that affect social sustainability. There are (1) Agricultural extension participation (RMS=5,83); (2) Family participation (RMS=5,34); (3) Organic farming experience (RMS=3,95); and (4) Environmental conductivity (RMS=3,62).

Participation of Agricultural extension is most of sensitive attribute that effect on social sustainability because the attribute has relate to farmer knowledge. If the famer's knowledge is deep, they can adapt to problems that occur in the field. Farmers Who take part in training or extension activities can increase the production although they use same inputs (Kuntariningsih & Mariyono, 2013). Most of the Farmers in Sleman Regency took knowledge about organic rice farming before they practice in field.

Family participation is one of the sensitive attributes because family participation in farming activities can replace the main farmer if his physical condition is weak. Beside that the family participation in agricultural activities can reduce expenses of labor (Suratman, 2015). The average number of family participation is two. Participation of farmer children is low because they choose to look for work in the city. So, it needs some strategies to increase participation of farmer families.

Organic farming experience is important to sustainability because it has an impact on farmers' skills. Most of the farmers have organic farming experience more than five years and include quite experienced. The farmers who have more experience are potentially able to maintain their agriculture (Wulansari, 2023). Conduciveness of the social environment also has an impact on sustainability because it has an effect on productivity and farmers spirit (Krismayanti & Mayasari). Farmers who live in low-conflict will have more spirit and live in harmony. In this location, there has never been any conflict between organic farmers, even if they help each other.

Technological Dimension

The sustainability status based on technological dimension shows farmers technology adoption, infrastructure conditions, and access received by farmers. This dimension uses six attributes. The sustainability index of technological dimension can be seen in Figure 8.

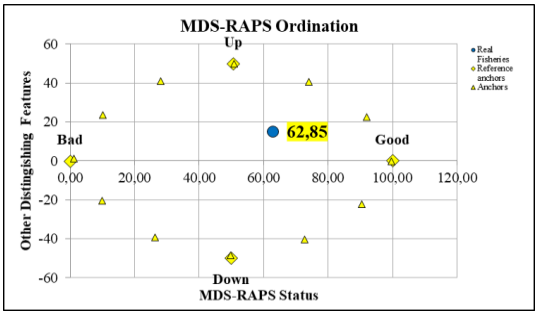

Figure 8. The index of technological dimension
Source: MDS-RAPS Ordination (2023)

Based on figure 8, the sustainability index of technological dimension is 62,85. Based on the categories of sustainability, that value belongs to quite sustainable. There are several sensitive attributes that affect sustainability status for social dimensions. The sensitive attributes can be seen as a result of Leverage analysis in Figure 9.

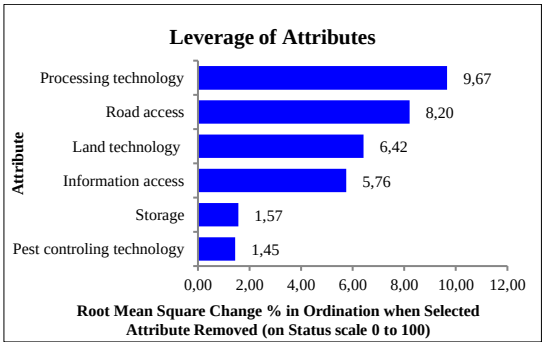

Figure 9. Leverage analysis of technological
Source: MDS-RAPS analysis (2023)

Based on the Figure 9, we know that from six attributes there are four sensitive attributes that affect technological sustainability. There are (1) Product processing technology (RMS=9,67); (2) Road access (RMS=8,20); (3) Land processing technology (RMS=6,42); and (4) Information access (RMS=5,76).

Wulansari (2023) said that product processing has a sensitive effect on sustainability agriculture. Processing product is important to extend saving product, increase quality of product, and reduce production losses. Then processing products can increase product selling. In the research location, most of the farmers have not processed their products because they have limited cost and production facilities. Beside of that, land processing is also sensitive to sustainability. The

good processing of land can improve aeration and drainage which support plant growth (Habiby, 2013). So, they need support to provide processing facilities for production and land.

Road access and information access are also sensitive attributes on sustainability. Road access has an impact on distribution, transportation, and communication. The road conditions there are paved. Meanwhile, information access can impact on farmers' knowledge about agriculture such as production technique, climate, technology, product processing, market, supply, and demand (Harmoko & Darmansyah, 2016). Farmers have received enough information from instructors, government, and other farmers. So, the road and information access have been good and need maintenance.

Institutional Dimension

The sustainability status based on institutional dimension shows the role of institutional supports as stakeholders to develop organic farming in Sleman Regency. This dimension uses seven attributes. The sustainability index of institutional dimension can be seen in Figure 10.

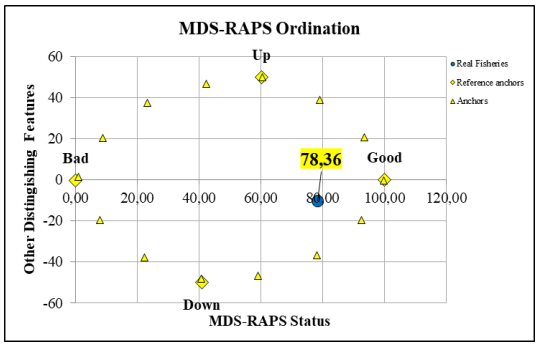

Figure 10. The index of institutional dimension
Source: MDS-RAPS Ordination (2023)

Based on figure 10, the sustainability index of institutional dimension is 78,36. Based on the categories of sustainability, that value belongs to the very sustainable. There are several sensitive attributes that affect sustainability status for institutional dimension. The sensitive attributes can be seen as a result of Leverage analysis in Figure 11.

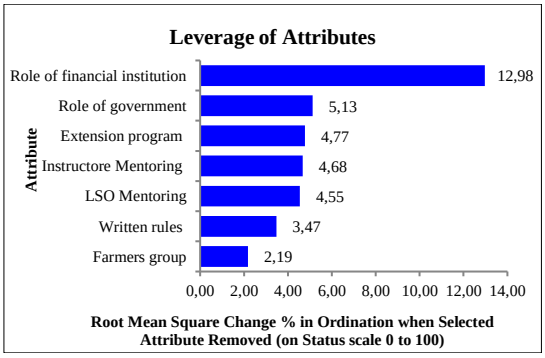

Figure 11. Leverage analysis of institutional
Source: MDS-RAPS analysis (2023)

Based on Figure 11, we know that there is one sensitive attribute on institutional dimension that is the existence of financial institutions (RMS=12,98). It has relevance as Ristianingrum et al. (2016) that financial institutions are sensitive attributes that affect organic rice farming sustainability. Financial institutions have a role to provide capital that is used to increase production, productivity, and efficiency (Louyindoula et al., 2023). Organic rice farmers in Sleman Regency still use their own capital to buy production input. They need more capital to develop their organic farming such as expanding their agricultural land and product processing.

The validation of MDS-RAPS model can identify three tests, that are S-Stress, coefficient of determination (R2), and Monte Carlo simulation. The capital result validation of MDS-RAPS can be seen in Table 2.

Table 2. The Capital Result Validation of MDS-RAPS

Dimension	S-Stress	R2	MC Index	Rap-Score Index	Rap-Score-MC
Ecology	0,145	0,94	78,78	81,57	2,79
Economic	0,136	0,95	75,62	78,47	2,85
Social	0,142	0,93	75,42	78,36	2,06
Technology	0,142	0,94	75,05	77,11	0,61
Institution	0,143	0,94	61,97	62,58	2,94

Source: Primary Analysis (2023)

Based on Table 2, we know that the data is qualified for MDS-RAPS validation. The value of S-Stress on all dimensions has score less than 0,25 thats meaning the data error is low and still tolerable. Then the value of all determination coefficient are almost one. So we know that the data have high trust. Then the difference between Rap-score and Monte Carlo less than 5%. Its meaning that sustainability analyze has well done. Beside of that, the result show in quantitatively, the error is low, analysis is stable, and data input error can be avoided (Picther, 1999).

CONCLUSIONS

We conclude that the sustainability status of organic rice farming in Sleman Regency is very sustainable. There are 21 sensitive attributes that effect on sustainability. The strategies are still needed to increase the value of sustainability index and maintain sustainability status. The strategies that can be made to improve the sustainability index is improving the performance of sensitive attributes in each dimension.

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