Universal Journal of Agricultural Research 11(1): 56-71, 2023 http://www.hrpub.org
DOI: 10.13189/ujar.2023.110106

Sustainability Strategy for Organic Paddy Farming Business toward Global Market: Network Process Analysis Approach

Heru Irianto[1,2,*], Erlyna Wida Riptanti[1,2], Emi Widiyanti[2,3], Refa'ul Khairiyakh[1], Agung Prasetyo[4], Mujiyo[5]

[1]Department of Agribusiness, Faculty of Agriculture, Universitas Sebelas Maret, Indonesia
[2]The Center for Micro, Small, and Medium Enterprises and Cooperative Studies, Universitas Sebelas Maret, Indonesia
[3]Department of Agriculture Extension and Communication, Faculty of Agriculture, Universitas Sebelas Maret, Indonesia
[4]Department of Agribusiness, Faculty of Agriculture, Universitas Tunas Pembangunan, Indonesia
[5]Department of Soil Science, Faculty of Agriculture, Universitas Sebelas Maret, Indonesia

Received November 25, 2022; Revised January 3, 2023; Accepted January 28, 2023

Cite This Paper in the Following Citation Styles

(a): *[1] Heru Irianto, Erlyna Wida Riptanti, Emi Widiyanti, Refa'ul Khairiyakh, Agung Prasetyo, Mujiyo , "Sustainability Strategy for Organic Paddy Farming Business Toward Global Market: Network Process Analysis Approach," Universal Journal of Agricultural Research, Vol. 11, No. 1, pp. 56 - 71, 2023. DOI: 10.13189/ujar.2023.110106.*

(b): *Heru Irianto, Erlyna Wida Riptanti, Emi Widiyanti, Refa'ul Khairiyakh, Agung Prasetyo, Mujiyo (2023). Sustainability Strategy for Organic Paddy Farming Business Toward Global Market: Network Process Analysis Approach. Universal Journal of Agricultural Research, 11(1), 56 - 71. DOI: 10.13189/ujar.2023.110106.*

Abstract Go Organic was launched by the Indonesian Government in 2010; nevertheless, its progress has encountered issues and constraints. Farming products, especially organic paddy, have been unable to satisfy export demand since organically certified agricultural land has not yet reached its goal. This study aims to investigate the sustainability strategy of organic paddy farming in the global market. The exploratory investigation was undertaken in Ngawi Regency of East Java. The study surveyed 90 organic/converted rice producers as respondents. Data analysis was performed by Multi-Dimensional Scaling (MDS), which was followed by Network Process Analysis (NPA). MDS was utilized to assess the sustainability of the five dimensions: environmental, economic, social, institutional, and technological. Meanwhile, NPA was conducted based on the MDS analysis findings to identify the essential methods for sustainability improvement. The research unveiled that the environmental, economic, social, and institutional dimensions were quite sustainable. However, the technological dimension was less sustainable. Multidimensionally, organic paddy farming was quite sustainable. Based on the identified priority strategy, increasing the availability of organic matter and organisms in the soil would improve the sustainability of organic paddy farming. It was accomplished by incorporating straw, livestock manure, fermented farming waste, azolla, earthworms, eels, and organic pesticides into the soil, increasing the long-term quality and quantity of organic paddy farming.

Keywords Go Organic, Environmental, Economic, Institutional

1. Introduction

Indonesia is the fourth most populous country in the world, behind China, India, and the United States. The Indonesian population exceeded 276 million at the end of 2021 [1], with an annual growth rate of 1.25% [2]. The enormous population and ever-increasing growth rate raise food needs. Food is a basic necessity of every human being, ingested to supply the body with nutrients necessary to support life [3]. Following the law, the right to food is a

fundamental human right protected by the 1945 Constitution of the Republic of Indonesia. This right is separated into two categories: freedom from hunger and access to sufficient food that meets acceptable quality requirements [4].

The staple foods of the people of Indonesia are rice, maize, cassava, and sago. As the primary food producing industry, agriculture aims to increase output to fulfill the community's demands. Since 1970, the "Green Revolution" by chemical fertilizers and pesticides has made these efforts possible. Due to the program's emphasis on maximizing outcomes and the efficiency of farming inputs among farmers [5], Indonesia achieved rice self-sufficiency in 1984. However, the "Green Revolution" has detrimental effects on environmental, social, and health concerns [6]. The long-term impact of using chemical fertilizers and pesticides is how environmental sustainability remains sustainable in the future [7] because it harms the environment. Continuous use of chemical fertilizers degrades soil fertility and reduces crop yield [8]. On the other hand, people are beginning to comprehend the significance of organic food consumption for a healthy lifestyle [9]. In the end, it affects agriculture in Indonesia through the use of organic inputs or organic farming.

Traditional conservation-focused agriculture is combined with current farming technology to form an organic farming approach. This approach stresses crop rotation, natural pest control, crop and livestock diversity, and improving the soil using animal compost and green manure [10]. Organic paddy agriculture utilizes non-genetically modified paddy seedlings and does not employ radiation technologies [11]. Since 2010, the "Go Organic" initiative has provided government assistance for the success of organic agriculture in Indonesia, in addition to the efforts of the community [12]. The community's support and excitement for a healthy lifestyle and environmental preservation have increased the market for organic products, especially staple foods. Rice is the primary source of energy not just for the people of Indonesia but also for more than half of the global population [13]. According to David and Ardiansyah [14], organic rice is the second most frequently purchased product by consumers.

Organic rice offers benefits over ordinary rice [15] because it lacks chemical residues, has tastier flavors and textures, and retains its nutritional value, which positively affects health. Organic paddy production in Indonesia has grown annually. In addition to home use, the commodity is exported. Indonesia exported 252 tons of organic rice in 2019, a 171-ton increase from 2016 [16]. Currently, France is the leading importer with 51.5 tons, followed by the United States with 50 tons and Malaysia with 45.3 tons. Italy, Singapore, Germany, Hong Kong, Belgium, and Australia are also importers [17]. Organic paddy production is expanding in Indonesia and other paddy producing countries, such as Thailand and Vietnam. Thailand's domestic sales have increased by 7% over the past decade, but the country has not yet reached the worldwide average of 1.5% certified organic land concerning other arable areas [18]. The acceleration of the organic farming expansion is demonstrated by a 28% rise in organic paddy production in 2017 and a total area of 9,990 ha [19] of organic paddy land. With 9.3 million ha of paddy growing land, Vietnam is the world's leading rice producer. Although Vietnam is the largest rice producer in Asia, it is not on the list of countries that produce organic rice [20].

Indonesia has significant potential as an exporter of organic rice due to its large potential land area compared to other producing countries [17]. Ngawi Regency, comprising 14 sub-districts, is a region that grows implemented environmentally friendly or organic paddy and houses the national rice barn (Figure 1).

The expansive and productive terrain enables expanded organic paddy production. This endeavor is difficult because farmers encounter obstacles, such as a small percentage of certified organic agricultural land and the high risk of organic paddy production [21-22]. According to the Ministry of Agriculture [23], certifying agricultural land, particularly paddy production, boosts the product's added value and competitiveness [24]. Uncertified paddy growing land poses a marketing challenge for farmers, particularly when completing the export standards for organic rice products. Meanwhile, the organic farming system must be maintained and enhanced to fulfill market demands and export potential.

This study aims to develop a strategic sustainability of organic paddy farming towards global market. This study examined the sustainability of organic paddy farming. It is the basis for identifying the most critical indicators of organic paddy farming when building a development strategy.

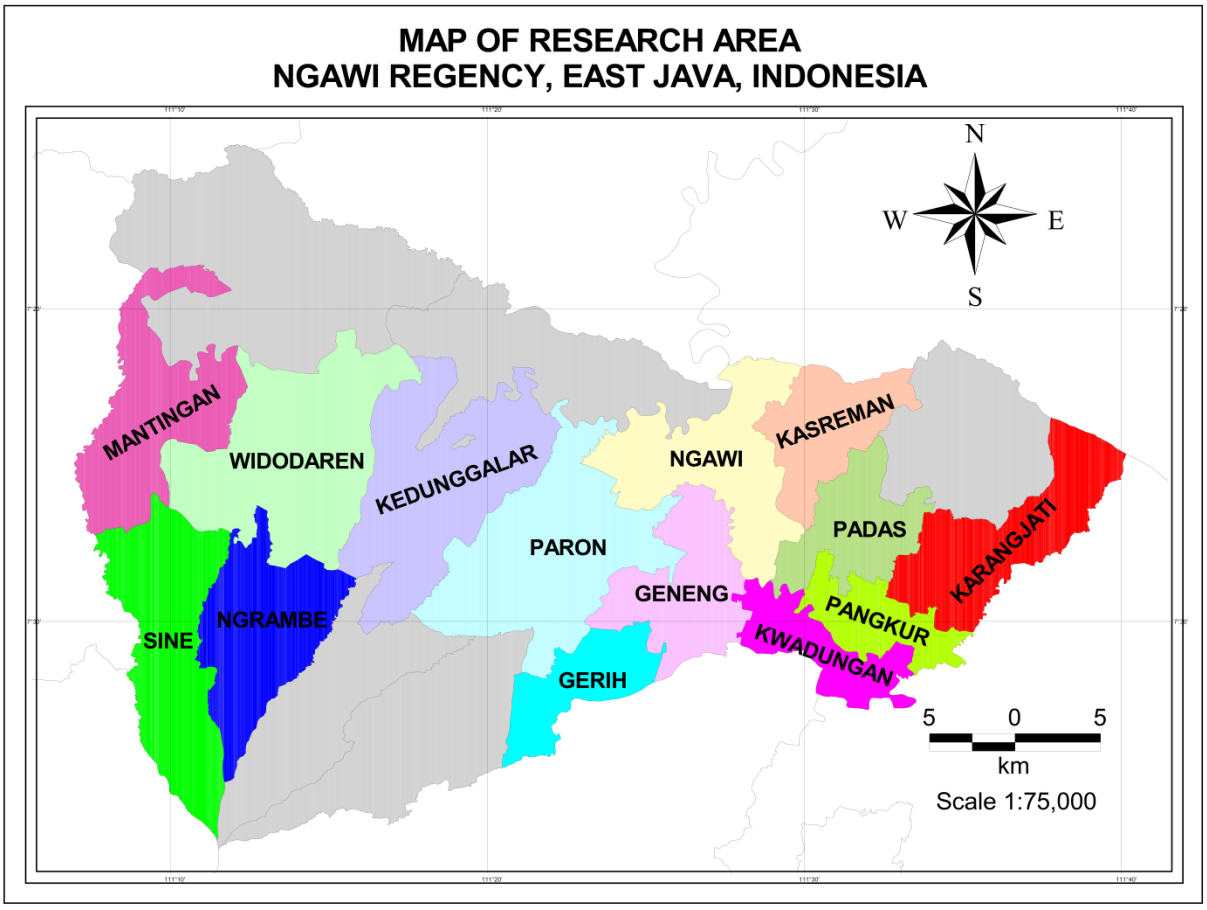


Figure 1. Sub-Districts That Have Implemented Environmentally Friendly or Organic Farming Systems

2. Materials and Methods

The study employed descriptive and quantitative methods [25]. The investigation was conducted in Ngawi Regency, East Java, Indonesia, from July to September 2022. Since Ngawi Regency is one of the nation's paddy barns and has been conducting the "Go Organic" initiative since 2010, it was determined purposively for the research location. However, a relatively tiny percentage of agricultural land is currently certified organic. Out of 19 sub-districts of Ngawi Regency, 14 have switched to environmentally friendly and organic agriculture (Figure 1).

The population under study consisted of paddy farmers practicing organic or environmentally friendly farming. Respondents were selected using snowball sampling [25]. Ninety farmers were surveyed to examine the sustainability level of organic paddy farming. In addition to farmers as respondents, the study included key informants from the Department of Agriculture of Ngawi Regency, the Department of Industry and Trade of Ngawi Regency, the Agricultural Extension Center, the Head of Farmers Group, and the Organic Farmer Association of Ngawi Regency. The information received from key informants was utilized to establish organic paddy farming's sustainability strategy.

The required data comprised both main and secondary information. Data were gathered through direct field observation, interviews, documentation, literature reviews, and focus group discussions [26]. Data triangulation was also employed.

Data analysis was divided into two stages. The first stage of analysis determined the sustainability status of organic paddy farming using Multi-Dimensional Scaling (MDS). The analysis technique applied Rapid Appraisal for Organic Paddy Farming (RAP-ORFARM), modified from RAPFISH [27]. Sustainability measurement requires reference levels, indicators, and comparison methods. The indicators adopted were adapted to the conditions of organic paddy farmers in Ngawi Regency. This research utilized five dimensions: environmental, economic, social, institutional, and technological. Each dimension consisted of attributes with scoring criteria (Table 1). The environmental dimension comprised nine attributes, the economic dimension encompassed eight attributes, the social dimension consisted of eight attributes, the institutional dimension entailed eight attributes, and the technological dimension covered six attributes. Each attribute had a score based on related references or input from experts [27]. The sustainability status of organic farming was determined based on the index value. It is unsustainable if the index value is between 0 and 25. A

value of more than 25 to 50 means less sustainable, more than 50 to 75 indicates quite sustainable, and more than 75 to 100 denotes sustainable [25]. The increase in sustainability status seen from the key factor comes from indicators that have a Root Mean Square (RMS) value of more than half [27, 28, 29].

The second analysis stage employed the NPA to examine the priority strategies for organic paddy farming development. The key factors from the results of the first analysis stage were then analyzed using NPA [32] to determine the interactive dependence and correlation between each of the criteria used in solving complex problems through synthesis decomposition to produce the highest priority [33], as displayed in Figure 2. NPA utilizes the word cluster, each cluster having nodes that can communicate [34]. The cluster in this study comprised environmental, economic, social, institutional, technological, and alternative strategy dimensions. The nodes for each dimension of sustainability were determined by the greatest RMS value. The NPA output scores for each node, with the greatest value representing the highest priority.

Table 1. Dimensions and Attributes of Sustainability

Dimension	Attribute
Environmental	Prevention of chemical pollution, farming soil fertility, organic material/fertilizer content, soil organism content, use of organic fertilizers, use of vegetable pesticides, use of straw after harvest, water sources for irrigating paddy fields, quality control of water for irrigation, and natural control of pests and diseases
Economic	Organic paddy farming productivity, organic paddy farming profits, access to harvest sales, easy access to price information, the contribution of organic paddy farming income to household income, farmer welfare levels, sources of organic paddy farming capital, and farming insurance
Social	Formal education, non-formal education, land ownership status for organic paddy farming, experience in organic paddy farming, the culture of community cooperation in lowland paddy farming, availability of organic paddy farming infrastructure, knowledge of farmers about the advantages and disadvantages of organic farming, and community views regarding organic paddy farming
Institutional	The role of village funds, the participation of farmers in farmer groups, the existence and role of extension agencies, the frequency of extension and training activities, extension workers paying attention to and providing assistance for organic certification, the role of capital institutions, the role of marketing institutions, and the role of government in facilitating exports
Technological	Organic certificate, organic paddy farming system using superior seeds (quality, certified, and not Genetically Modified Organisms (GMO), soil processing mechanisms, spacing, fertilization at the right time and the right dose, maintenance procedures, and post-harvest procedures

Source: Modified indicators [25, 27, 29, 30, 31]

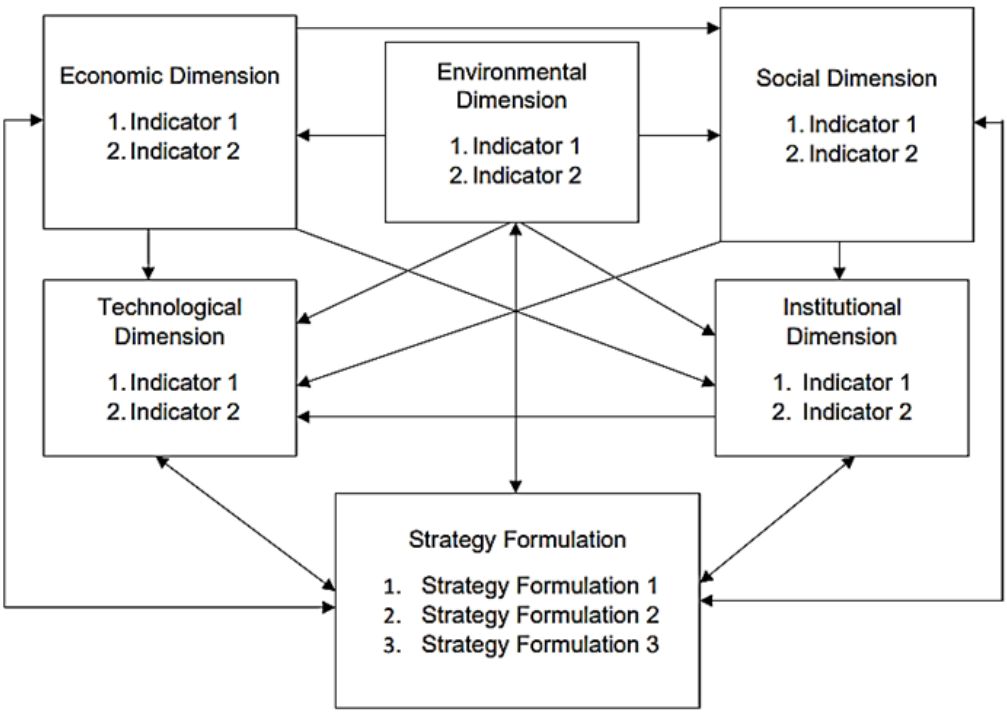


Figure 2. Network Structure

3. Result and Discussion

3.1. Sustainability Status of Organic Paddy Farming

Analysis of sustainability considered each dimension individually and the dimension as a whole. Environmental, economic, social, and institutional aspects acquired MDS values of 72.10, 66.00, 66.29, and 65.00, respectively, implying their quite sustainable state. Meanwhile, the technology dimension obtained an MDS value of 49.49, indicating less sustainability. The MDS score for the sustainability of organic paddy farming was 63.78, denoting quite sustainable.

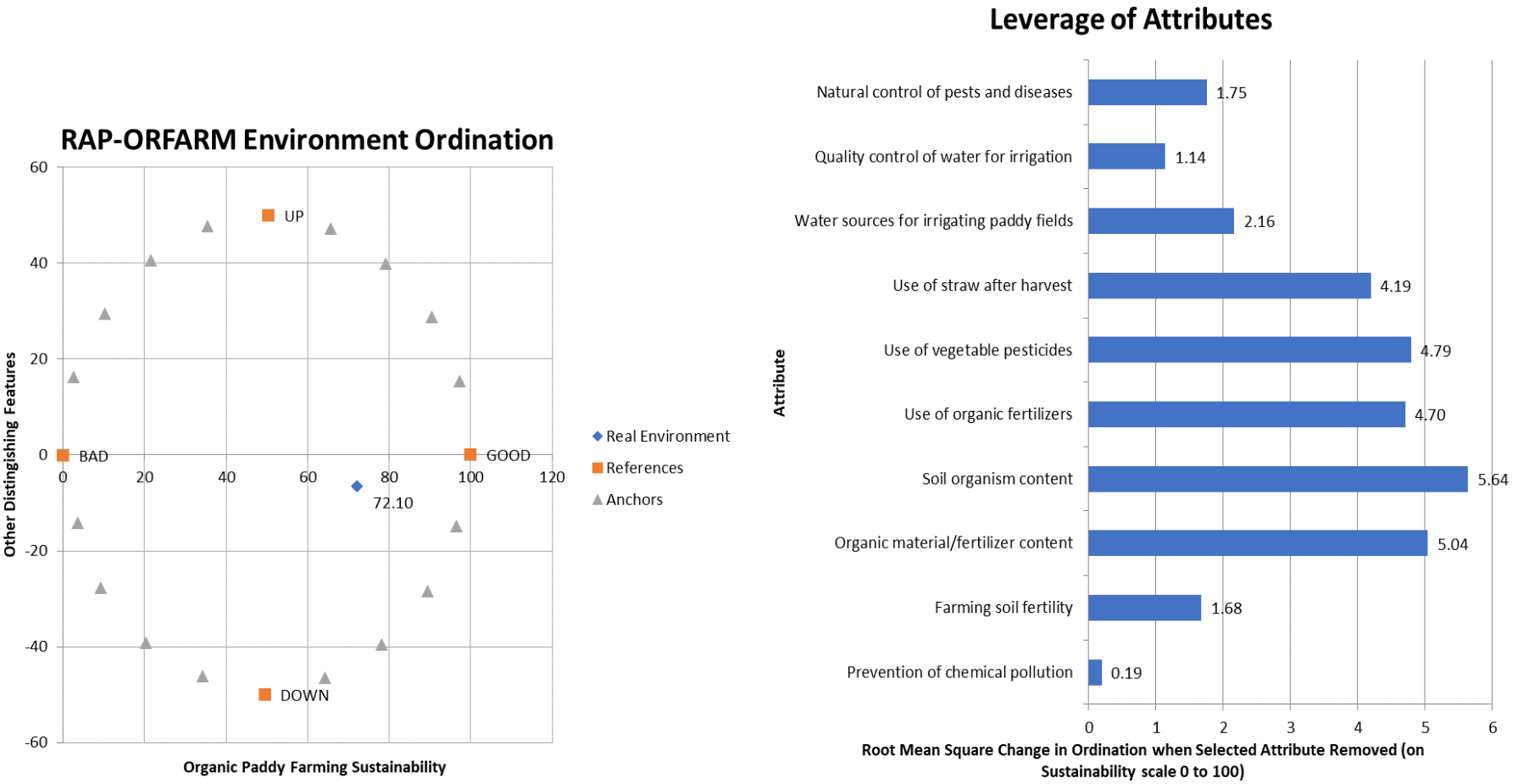
The first diagram depicts the environmental sustainability of organic paddy farming. The content of soil organisms and organic matter in the soil, with RMS values of 5.64 and 5.04, respectively, was responsive to sustainability improvement. The amount of organic matter and organisms in the soil is crucial in preserving agricultural land fertility and environmental quality [35]. This endeavor is achieved by utilizing organic materials such as manure, compost, earthworms, azolla, eels, and organic pesticides [36]. Compared to conventional farming, the first usage of organic inputs will result in reduced production. It is due to the soil's acclimatization to accepting inorganic materials, which necessitates an adjustment period until it reaches its maximal production [37].

In Ngawi Regency, organic farming has yet to use organic inputs completely. In reality, organic farming is an environmentally friendly farming approach. Farmers have begun transitioning from conventional to environmentally friendly agriculture by decreasing their use of inorganic inputs and increasing their use of organic inputs. To reduce chemical contamination, however, farmers have utilized the same irrigation water as conventional farmers without filters. According to Sivaranjani and Rakshit [38], water, as an essential component, must be controlled to prevent contamination with dangerous substances.

The second diagram illustrates the economic sustainability of organic paddy farming. The majority of the crops sold by farmers were harvested dry paddy. The market price for organic and ordinary paddy was the same because the farming system was undergoing conversion and has yet to be certified organic. Even if the price is the same, organic paddy farmers earn more profit owing to decreased expenses. Typically, farmers utilized their funds to plant organic paddy. According to Prasetya et al. [39], one of the variables in the organic paddy business is personal capital. If the funding originates from credit or loans, farming will be dangerous if the investment fails.

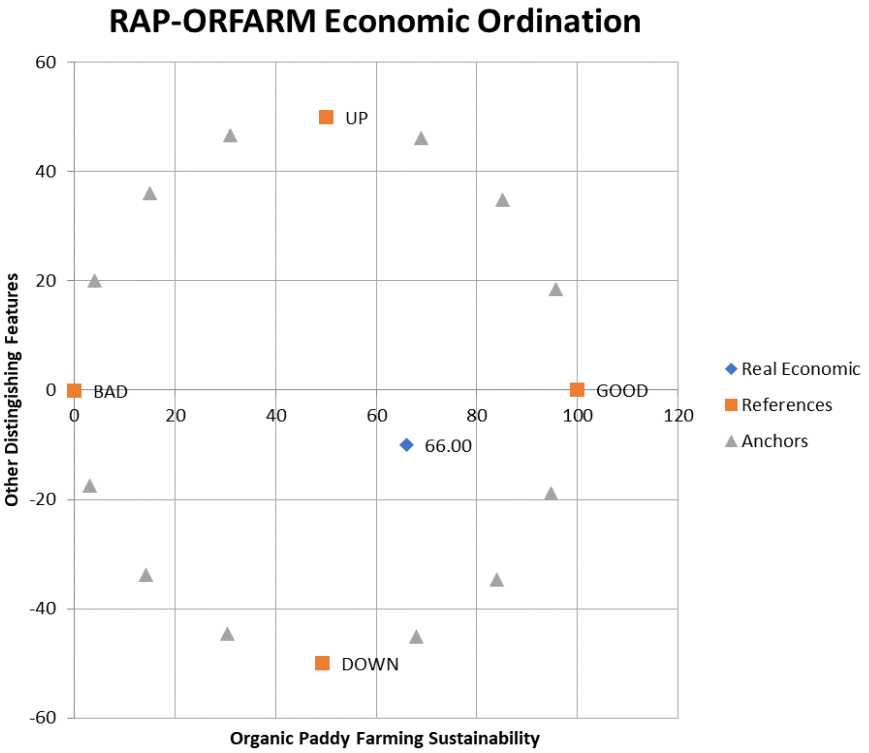
With RMS values of 6.64 and 6.00, respectively, the leverage analysis revealed that the ease of access to price information and the degree of farmer welfare were the most important factors for enhancing economic sustainability. Farmers were more likely to select organic paddy production due to the ease of access to price information and the rising degree of farmer welfare [40]. Because farmers directly sold paddy to intermediaries, it was generally straightforward to collect price information [41]. The higher selling price of organic paddy than conventional paddy could boost farmers' income and well-being.

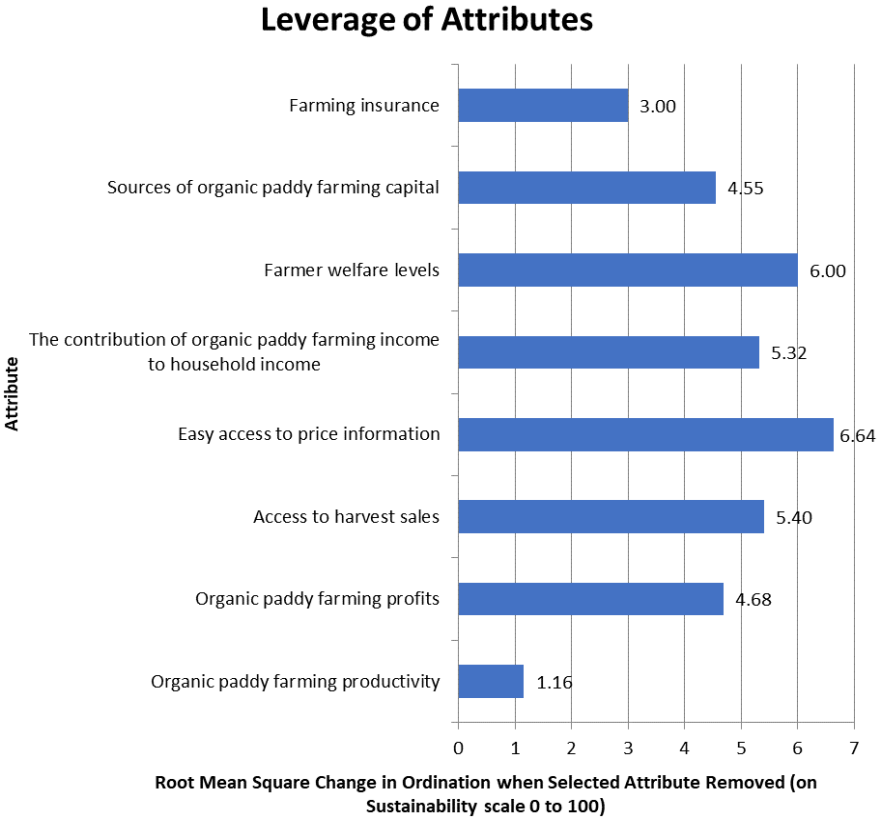
Diagram 3 exhibits the social sustainability of organic paddy farming. The practice of organic paddy farming is inseparable from the knowledge of farmers adopting environmentally friendly farming principles. In the past, organic paddy farmers were conventional paddy farmers who had farmed paddy for decades. Changing farmers' perspectives from conventional to organic requires substantial motivation [42]. Government, non-government organizations (NGOs), and farmer groups conduct counseling, training, demonstration plots, and field schools to promote organic farming knowledge. The awareness to move to organic is a result of farmers' desire to attain healthy products, maintain rich soil, and minimize expenditure on fertilizers and pesticides [43] owing to lower government subsidies.



Source: MDS Analysis Output, 2022

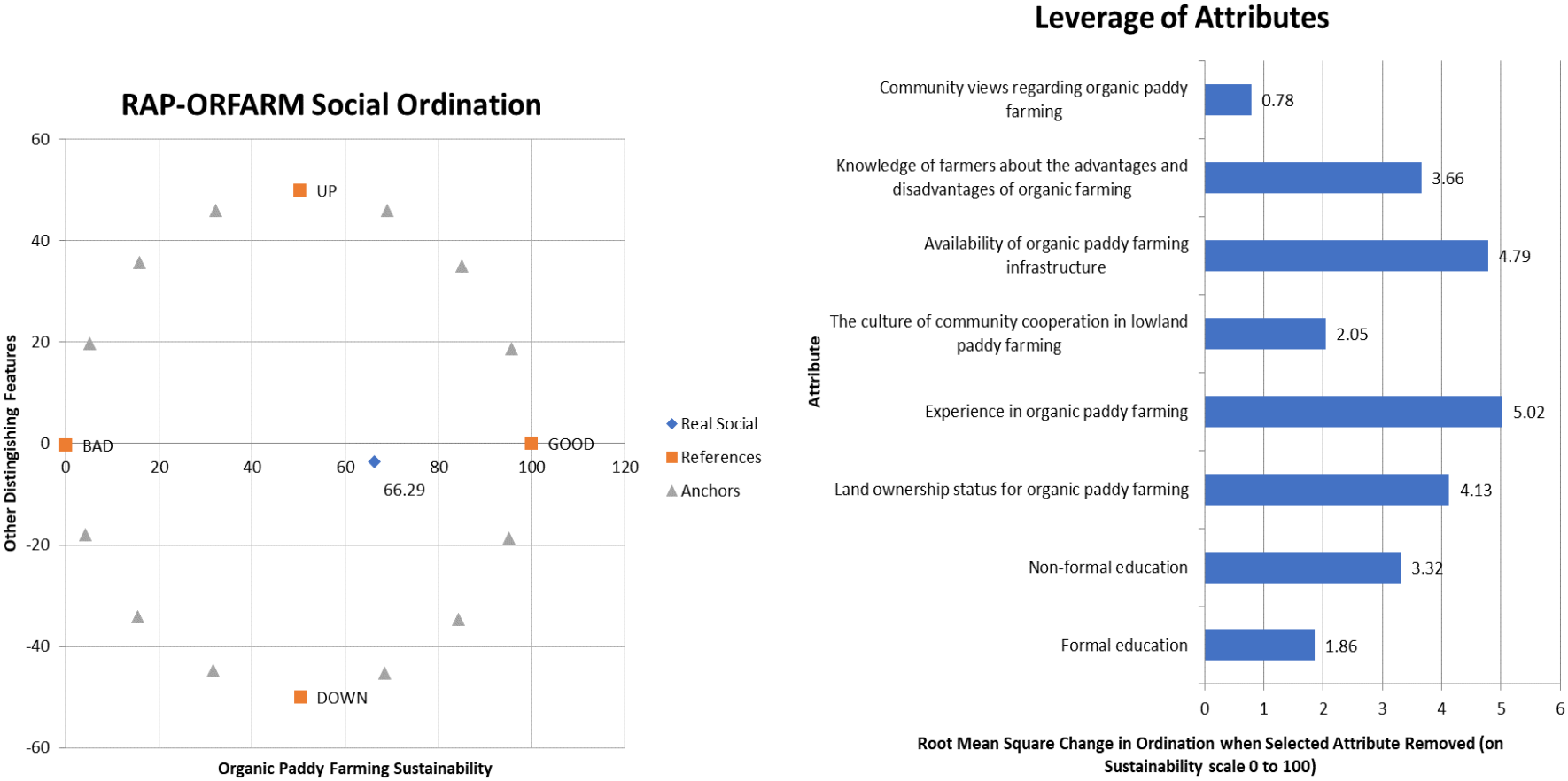
Diagram 1. Environmental Dimension





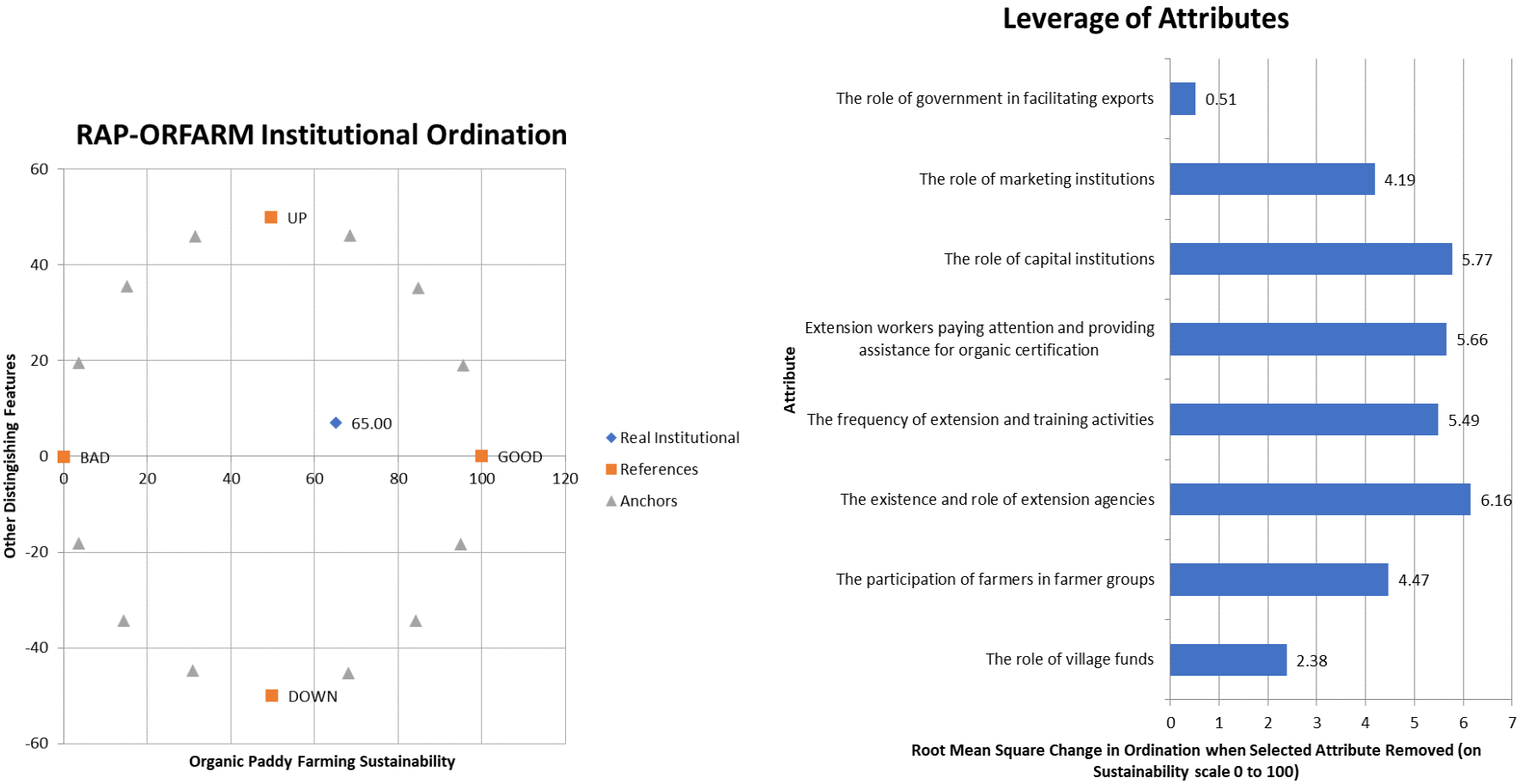
Source: MDS Analysis Output, 2022

Diagram 2. Economic Dimension



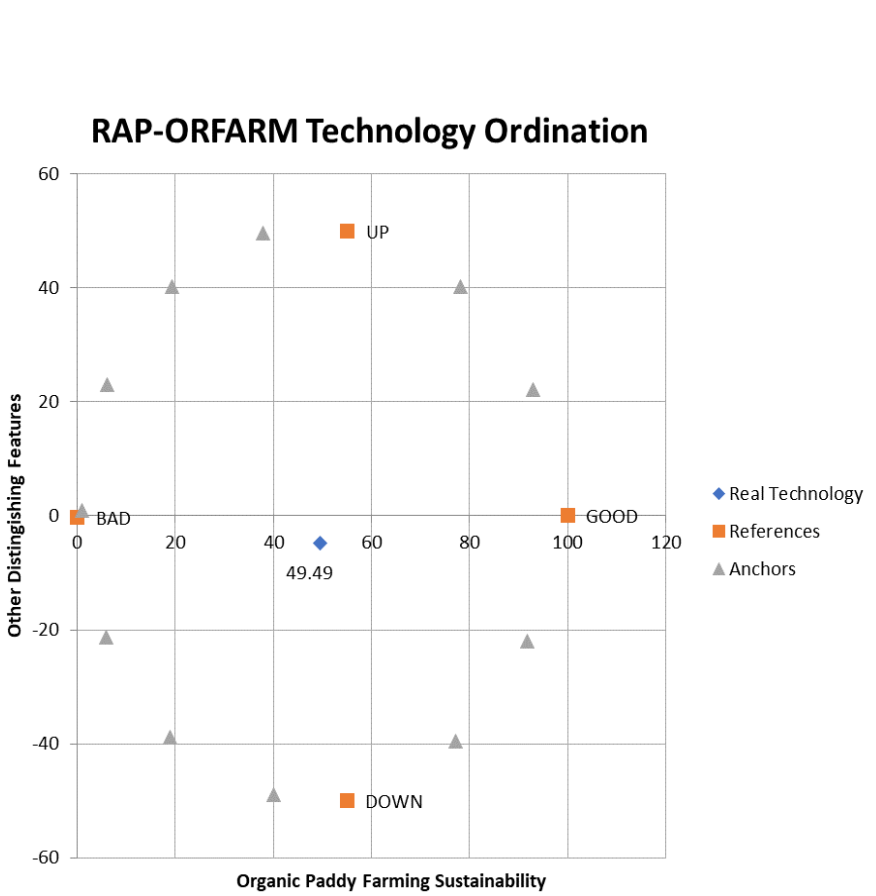
Source: MDS Analysis Output, 2022

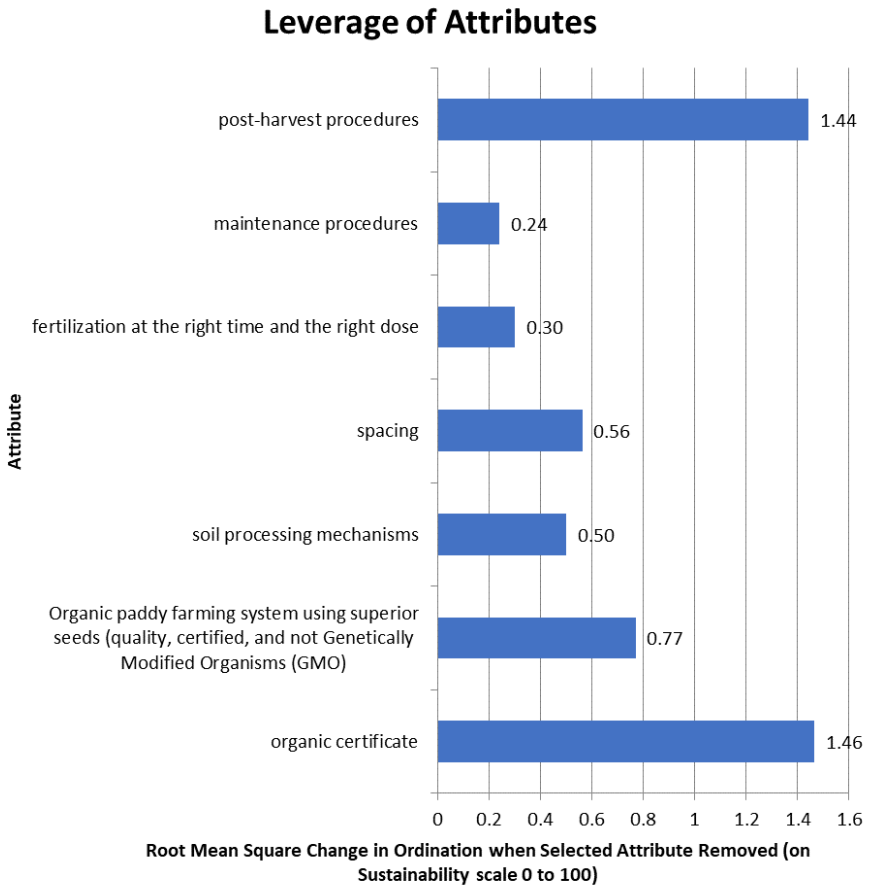
Diagram 3. Social Dimension



Source: MDS Analysis Output, 2022

Diagram 4. Institutional Dimension





Source: MDS Analysis Output, 2022

Diagram 5. Technological Dimension

With RMS values of 5.02 and 4.79, respectively, the leverage analysis disclosed that the experience of organic paddy farming and the availability of organic paddy farming infrastructure were sensitive variables for enhancing the social sustainability status. The more experience in organic paddy farming a farmer has, the greater the farmer's mastery of the skills, ability to overcome obstacles, and responsiveness to new technology is. Infrastructure for organic paddy farming consists of the facilities required to develop organic paddy farming [6]. Organic paddy farming requires production and production shops that provide organic production facilities, suitable irrigation channels, farming roads, harvest, post-harvest technologies, and marketing networks.

Diagram 4 portrays the institutional dimension of organic paddy farming. Support from many stakeholders, such as the government, extension agents, farmer groups, and financial institutions, is crucial for farmers to engage in organic paddy farming. Institutions significantly influence farmer technology transfer, acceptance, knowledge, skills, marketing, and capital requirements [27]. Strong institutions empower farmer groups and farmers to withstand farming risks [44].

Leverage analysis showed that the sensitive determinants of improving sustainable status on the institutional dimension were the existence and role of extension agencies and the involvement of capital institutions, with RMS values of 6.16 and 5.77, respectively. The existence and function of sub-district-level extension agencies offer periodic dissemination, counseling, training, and demonstration plots. The production of organic fertilizers, local micro-organisms, and organic pesticides are the fundamentals that organic farmers must master [6]. Production expenses are minimized by utilizing local resources accessible in the farmer's area, such as straw waste, cow manure, various spice, and majapahit fruit [14]. On the other hand, capital institutions play a role in enhancing the management of organic paddy farming by providing financing at reasonable interest rates.

Diagram 5 demonstrates the less sustainable dimension of organic paddy farming technology. Organic farming begins with using seeds, land management, irrigation, fertilization, pest control, harvesting, and post-harvest care. Organic land must be certified as being managed following environmentally friendly principles. The standards for organic certification are complex, and the associated fees are enormous. The government has disseminated information on organic land certification and financing aid through Field Extension Officers. However, only a few farmers have organically certified their paddy fields. According to research findings, it is difficult for farmers to utilize Standard Operating Procedures (SOP) to acquire organic certification [45]. Respondent farmers were still at the stage of one to three plantings on transformed land. In addition, the conversion area has been limited to planting with traditional land, resulting in relatively high water pollution and inorganic inputs. The water supply is sourced from the same irrigation water, causing relatively high chemical contamination [43,46].

Leverage analysis showed that the sensitive attributes of the technological dimension were organic certification and post-harvest processes, with RMS values of 1.46 and 1.44, respectively. The fact that just a limited portion of land has been organically certified implies that the certification standards still need to be met [45]. Farmers have been urged to implement SOPs for organic farming system technologies to satisfy certification standards, as well as organic paddy post-harvest processing. There was no contamination from conventional paddy throughout the harvesting, drying, and milling processes.

The findings of the Monte Carlo analysis with the 95% confidence level indicate no significant difference between the Monte Carlo and MDS results, signifying the accurate study results and the negligible error rate [26]. Therefore, the research results in each dimension could be utilized to design a sustainability strategy [25].

Table 2. Differences in RAP-ORFARM Analysis and Monte Carlo Values

Sustainability Dimension	MDS	Monte Carlo	Difference
Environmental	72.10	71.12	0.98
Economic	66.00	65.69	0.31
Social	66.29	65.57	0.72
Institutional	65.00	64.41	0.59
Technological	49.49	49.29	0.20

Source: Sustainability Analysis Output, 2022

3.2. Organic Paddy Farming Strategy toward Global Market

Based on the RMS value of each dimension, essential criteria for enhancing the sustainability status were determined. These critical elements serve as the basis for constructing the strategy. The major informants concurred and devised three plans: enhancing soil processing procedures and spacing, boosting the availability of organic matter and soil organisms, and improving organic certification. In contrast, up to two crucial indicators were selected from each dimension, followed by creating a network structure and formulating the strategy. Using NPA, this network structure was examined (Figure 2).

Table 3 presents the findings of the NPA's environmental dimension study. Soil organic matter content with a value of 0.5583 emerged as the most priority strategy to enhance sustainability based on environmental criteria.

Table 3. Weight of Environmental Dimension Criteria

Environmental	Normalized by Cluster	Limiting
Soil organic matter content	0.5583	0.0556
Soil organism content	0.3746	0.0373

Source: NPA Output, 2022

The organic matter content of Ngawi Regency's paddy fields was less than 2%. Organic matter must be applied to farming soil to boost land fertility. Straw waste, manure, and fermented farming waste are inexpensive products common in a farmer's area. These materials have been applied to farming soil at roughly 10 tons per ha every growing season [47]. The greater soil organic matter content will enhance soil structure, preserve soil fertility, promote microbial diversity, and maximize crop yields in quantity and quality [48].

As displayed in Table 4, the level of farmer well-being belongs to the economic dimension's top priority plan, with a score of 0.5371. Although organic farming can contribute to the betterment of the environment and human health, the welfare of farmers is of the utmost importance to sustain their passion and motivation to engage in organic paddy farming [45].

Table 4. Weight of Economic Dimension Criteria

Economic	Normalized by Cluster	Limiting
Easy access to price information	0.4226	0.0287
Farmer welfare level	0.5371	0.0365

Source: NPA Output, 2022

The welfare of farmers is an indicator of the effectiveness of the organic farming system. Farmers' capability and ability to farm organic paddy can be improved by enhancing their welfare. The benefits of organic farming can only be realized after at least ten planting seasons. Farmers begin to profit when the selling price of paddy is greater than traditionally produced paddy, the cost of production inputs begins to rise, and their farming management skills improve [49]. The application for organic paddy certification can only be submitted after ten planting seasons using an organic farming system [45].

As depicted in Table 5, valued at 0.4941, experience in organic paddy farming is a priority strategy for enhancing the sustainability of organic paddy farming. Counseling, training, field schools, demonstration plots, and comparative studies augment this experience. Additionally, the accessibility of knowledge sources on how to expand organically can also be gathered and evaluated independently of YouTube or internet news. Farmers can create and implement technologies to enhance the performance of organic farming systems based on their expertise. The relationship between a farmer's experience and knowledge of the farming business's technical aspects is tight. According to Panpakdee et al. [50], farmers with expertise in environmentally friendly agriculture will find it easier to practice organic farming.

Table 5. Weight of Social Dimension Criteria

Social	Normalized by Cluster	Limiting
Availability of organic paddy infrastructure	0.4402	0.0298
Organic paddy farming experience	0.4941	0.0335

Source: NPA Output, 2022

Increased farming expertise can help organic paddy farmers overcome issues and hurdles. Failures faced by farmers become experiences from which they might learn. The better farmers' knowledge is, the greater their experience will be [50].

Table 6 presents that the existence and function of extension agencies have the highest priority on the institutional dimension, with a score of 0.5950. The farming extension is an endeavor to alter the behavior of farmers to enhance their quality of life and well-being. The sub-district-level farming extension institutes serve as a conduit for transmitting information, dissemination, and innovation to farmers. Several farmers find implementing organic paddy farming challenging since they must alter their traditional farming practices to organic farming [51]. According to Bakker et al. [52], altering farmers' routines is difficult because farmers want reliable parties to guarantee their survival if they are obliged to adopt a new pattern of behaviors. Extension agents will bolster farmers' trust in their ability to engage in organic paddy farming with superior knowledge and communication skills who actively support them.

Table 6. Weight of Institutional Dimension Criteria

Institutional	Normalized by Cluster	Limiting
Existence and role of extension agencies	0.5950	0.0434
The role of capital institutions	0.3591	0.0262

Source: NPA Output, 2022

Field Extension Officers provide constant assistance to farmers and instruction in producing organic fertilizers, organic insecticides, integrated pest management, and environmentally-friendly farming field schools. Extension workers' capacity is bolstered by including Field Extension Officers in training in the most recent technologies, distributing the latest research findings, and using equipment in organic farming systems [53].

As detailed in Table 7, the approach with the highest

priority for enhancing the sustainability of organic paddy production in the technological dimension is organic certification, with a value of 0.4973. Implementing organic farming requires a legal document in the form of a certificate recognized by the governing body [45]. It is still an impediment for most farmers due to the difficult method involved. Conditions in the field revealed that organic paddy farming, both converted and environmentally friendly, did not comply with the SOP, particularly with irrigation water and planting distances between organic and conventional paddy plants.

Table 7. Weight of Technological Dimension Criteria

Technological	Normalized by Cluster	Limiting
Organic certification	0.4973	0.1482
Post-harvest procedures (grain drying)	0.4419	0.1317

Source: NPA Output, 2022

Organic paddy certification costs have been considered expensive by farmers, ranging from 30-35 million rupiah per farmer group. Small farmers have strongly opposed organic certification finance [45]. To incentivize farmers to engage in organic farming, the government has annually facilitated organic certification through the Regency Agriculture Office for farmer groups. Cooperation with third parties in organic certification, such as with marketers or exporters, is also crucial for accelerating the growth of organic certification. It necessitates the facilitation of such collaboration by regional governments. Commodity-based financial policy support is very important to increase the financial capacity of farmers in the sustainability of their farming towards global markets [54].

As presented in Table 8, increasing the availability of organic matter and soil organisms has become the strategy with the highest priority (0.3973). The second and third priorities are to improve the method of tillage and infrequent planting, and to expand organic certification, respectively. Organic farming is inseparable from the organic matter level of the soil [55]. After decades of chemical inputs to agricultural land, the condition of the soil has degraded [56]. On the other hand, organic farming rejects using chemical inputs and non-environmentally friendly instruments. Priority number one in applying organic paddy farming is to enhance the soil by increasing the availability of organic matter and organisms.

Table 8. Weight of Strategy Formulation

Strategy Formulation	Normalized by Cluster	Limiting
Improving the technique of tillage and plant spacing	0.2824	0.1112
Increasing the availability of organic matter and soil organisms	0.3973	0.1565
Improving organic certification	0.2546	0.1003

Source: NPA Output, 2022

According to Seilsepour and Rashidi [57], soil requires essential nutrients such as organic carbon, phosphorous, potassium, and nitrogen, all of which are derived from organic matter. Farmers have regularly added straw, animal manure, fermented farming waste, azzola, earthworms, and eels to boost the amount of organic matter and organisms in the soil [58]. This endeavor would be complex for farmers in the short term, but the regular use of organic materials and organisms would result in long-term environmental and financial advantages [59].

Soil is an environmental factor playing a crucial function [60]. As a planting medium, soil serves as a repository for organic matter that promotes plant development [61]. Increased availability of organic matter and soil organisms as fundamental capital boosts the worldwide market viability of organic paddy farming.

4. Conclusions

The analysis disclosed quite sustainable environmental, economic, social, and institutional dimensions but the less sustainable technological dimension of organic paddy farming. In other words, the sustainability of organic paddy production has been quite sustainable across several dimensions. Improving soil processing processes and spacing, increasing the availability of organic matter and soil organisms, and improving organic certification are strategies for enhancing the sustainability of organic paddy farming. Priority is placed on increasing the availability of organic matter and soil organisms in the implemented strategy. It aims to promote fertility and environmental quality to boost productivity.

Acknowledgements

The research team would like to deliver gratitude to Reismaya and Annita for their assistance in data collecting in the research area. The team also would like to thank the Rector of Universitas Sebelas Maret for granting competitive funding through a joint university grant program.

REFERENCES

[1] World Bank Open Data. Total population, The World Bank, online available from https://data.worldbank.org/indicator/SP.POP.TOTL

[2] Badan Pusat Statistik, Laju pertumbuhan penduduk, Available from https://www.bps.go.id/indicator/12/1976/1/laju-pertumbuhan-penduduk.html

[3] U. Maman, A. Nata, D. Hejazziey, Y Razak, A. U. Ismail, A. D. Humaerah, Muksin, I. R. Zarkasi, B. E. Samiono. Initiating model of agricultural development based on

local wisdom: The case of risk mitigation of organic rice farming in Indonesia, Univers. J. Agric. Res, Vol. 10, No. 5, 449-463, 2022. DOI: 10.13189/ujar.2022.100501.

[4] E. W. Kimani-murage, D. Osogo, and J. Harrington. Covid-19 and human right to food: Lived experiences of the urban poor in Kenya with the impacts of government's response measures, a participatory qualitative study, BMC Public Health, Vol. 22, 1–27, 2021.

[5] J. Boafo and K. Lyons. The Rhetoric and farmers' lived realities of the green revolution in Africa: Case study of the Brong Ahafo Region in Ghana, J. Asian Afr. Stud., Vol. 57, No. 3, 406–423, 2022.

[6] T. Karyani, F. Arifin, H. Hapsari, and E. Supriyadi. Organic rice farming for sustainable development in the Nurani Sejahtera Famers Group, IOP Conf. Ser. Earth Environ. Sci., Vol. 306, No. 1, 1-11, 2019.

[7] M. Hauser and M. Lindtner. Organic agriculture in post-war Uganda: Emergence of pioneer-led niches between 1986 and 1993, Renew. Agric. Food Syst., Vol. 32, No. 2, 169–178, 2017.

[8] S. Supriyadi, I. L. P. Vera, and P. Purwanto. Soil quality at rice fields with organic, semi-organic and inorganic management in Wonogiri Regency, Indonesia, Caraka Tani J. Sustain. Agric., Vol. 36, No. 2, 259-269, 2021.

[9] Soroka, A. K. Mazurek-kusiak, and J. Trafialek. Organic food in the diet of residents of the visegrad group (V4) countries — Reasons for and barriers to its purchasing, Nutrients, Vol. 13, 2021.

[10] L. N. Puteri and M. F. Makki. Kabupaten Hulu Sungai Utara comparative analysis of organic and inorganic rice farming in the Swampy Land in Sub-District of Babirik, IOSR Journal of Agriculture and Veterinary Science, Vol. 13, No. 7, 16–20, 2002.

[11] Y. Sari, E. Rasmikayati, B. R. Saefudin, T. Karyani, and S. N. Wiyono. Willingness to pay organic rice consumers and factors related to consumer willingness to pay more, Forum Agribisnis, Vol. 10, No. 1, 46–57, 2020.

[12] S. Sujianto, E. Gunawan, S. Saptana, S. Syahyuti, V. Darwis, A. Ashari, M. Syukur, E. Ariningsih, H. P. Saliem, S. Mardianto, and M. Marhendro. Farmers' perception, awareness, and constraints of organic rice farming in Indonesia, Open Agric., Vol. 7, No. 1, 284–299, 2022.

[13] S. Muthukumaran, P. Geetha, and E. Ramaraj. Multi-objective optimization with artificial neural network based robust paddy yield prediction model, Intell. Autom. Soft Comput., Vol. 35, No. 1, 215–230, 2023.

[14] W. David and Ardiansyah. Organic agriculture in Indonesia: Challenges and opportunities, Org. Agric., Vol. 7, No. 3, 329–338, 2017.

[15] D. U. Siswanti, Maryani, F. Y. Rachmawati, A. Niken, R. V. Agustin, and N. Wulansari. Grain quality of rice (Oryza sativa l.) 'menthik wangi' of organic farming yields, Hayati J. Biosci., Vol. 28, No. 2, 105–109, 2021.

[16] E. Paryanto, R. P. Dewanti, H. Ningsih, R. Indreswari, and A. Agustina. Analisis model bisnis beras organik dengan menggunakan pendekatan model bisnis kanvas (Studi Kasus di Koperasi APPOLI Kabupaten Boyolali), Indonesian Journal of Economy, Business, Entrepreneuship and Finance, Vol. 1, No. 3, 200–213, 2021.

[17] H. P. Saliem, S. H. Susilowati, E. Ariningsih, A. Agustian, and Muksin. Supporting organic rice exports: The success story of West Java organic rice exports, IOP Conf. Ser. Earth Environ. Sci., Vol. 672, No. 1, 2021.

[18] Asean Access. Agriculture sector brief Indonesia, 2020.

[19] N. Panpluem, A. Mustafa, X. Huang, S. Wang, and C. Yin. Measuring the technical efficiency of certified organic rice producing farms in Yasothon Province: Northeast Thailand, Sustain., Vol. 11, No. 24, 2019.

[20] M. P. Suharyono. The development of organic farming in Vietnam, J. Kaji. Wil., Vol. 9, No. 1, 20-32, 2018.

[21] V. I. Mutiara, R. Hariance, and A. S. Utami. Incentive program towards sustainability of organic rice certification in Limapuluh Kota Regency, West Sumatra, Indonesia, IOP Conf. Ser. Earth Environ. Sci., Vol. 741, No. 1, 2021.

[22] L. Y. Devi, Irham, Subejo, E. Anatasari, A. Nurhayati, and A. Wahyu Widada. Key drivers of organic rice productivity in Sleman and Magelang Regencies, IOP Conf. Ser. Earth Environ. Sci., Vol. 746, No. 1, 2021.

[23] H. Sembiring. Petunjuk teknis fasilitasi sertifikasi pertanian organik, Kementerian Pertanian, 2016.

[24] H. Sakolwitayanon, P. Soni, and J. Damien. Attributes determining consumer preference for organic rice in Bangkok, Thailand, Br. Food J., Vol. 120, No. 9, 2017–2032, 2018.

[25] E. W. Riptanti, H. Irianto and Mujiyo. Strategy to improve the sustainability of 'porang' (Amorphophallus muelleri Blume) farming in support of the triple export movement policy in Indonesia, Open Agriculture, Vol. 7, 566–580, 2022.

[26] H. Irianto, Mujiyo, A. Qonita, A. Sulistyo and E. W. Riptanti. The development of jarak towo cassava as a high economical raw material in sustainability-based food processing industry, AIMS Agriculture and Food, Vol. 6, No. 1, 125-141, 2021.

[27] E. W. Riptanti, M. Masyhuri, I. Irham, and A. Suryantini. The improvement of dryland farming sustainable management in food-insecure areas in East Nusa Tenggara, Indonesia, Bulg. J. Agric. Sci., Vol. 27, No. 5, 829–837, 2021.

[28] T. J. Pitcher and D. Preikshot. Rapfish: A rapid appraisal technique to evaluate the sustainability status of fisheries, Fisheries Research, Vol. 49, No. 3, 2001.

[29] Firmansyah, B. Pramudya, S. Budiharsono, and I. Firmansyah. Sustainability status of rice fields in the rice production center of Citarum Watershed, AAB Bioflux, Vol. 8, No. 1, 13-25, 2016.

[30] S. Maulidah and A. Wahib Muhaimin. Sustainable business models: Challenges on potato agro-industry SMEs, IOP Conf. Ser. Earth Environ. Sci., Vol. 709, No. 1, 2021.

[31] F. A. Diaz-Gonzalez, J. Vuelvas, C. A. Correa, V. E. Vallejo, and D. Patino. Machine learning and remote sensing techniques applied to estimate soil indicators – Review, Ecol. Indic., Vol. 135, 1-12, 2022.

[32] J. Navarro, J. V. Mart ín and V. Yepes, Analytic network process-based sustainability life cycle assessment of concrete bridges in coastal regions, Sustain., Vol. 14, No. 17, 2022.

[33] M. Usak, M. Y. Hsieh, and Y. K. Chan. A concretizing research on making higher-education sustainability count, Sustain., Vol. 13, No. 5, 1–14, 2021.

[34] L. E. Quezada, D. E. Aguilera, P. I. Palominos, and A. M. Oddershede. An ANP model to generate performance indicators for manufacturing firms under a balanced scorecard approach, EMJ - Eng. Manag. J., Vol. 34, No. 1, 70–84, 2022.

[35] Farshidi, F. Sadatebrahimi, and A. B. Talebi. The role of soil organisms on soil stability; (A review), International Journal of Current Life Sciences, Vol. 4, No. 11, 10328-10334, 2014.

[36] S. Ding, B. Wang, Y. Feng, H. Fu, and Y. Feng. Livestock manure-derived hydrochar improved rice paddy soil nutrients as a cleaner soil conditioner in contrast to raw material, J. Clean. Prod., Vol. 372, 1-13, 2022.

[37] S. Nurhidayati, A. Hudoyo, and D. Haryono. Comparison of productivity, cost of production and income of the organic and non-organic rice farming in Pringsewu Regency, Journal of Food Systems and Agribusiness, Vol. 5, No. 2, 146–155, 2021.

[38] S. Sivaranjani and A. Rakshit. Organic farming in protecting water quality, Springer Nature Switzerland, Switzerland, 2019.

[39] M. H. Prasetya, D. D. N. Zebua, and Yuliawati. Identifikasi potensi produk organik di Kecamatan Kebonpedes. Agrivet: Journal of Agricultural Sciences and Veteriner, Vol. 9, No. 1, 227-236, 2021.

[40] I. Ambali, F. J. Areal, and N. Georgantzis. Improved rice technology adoption: The role of spatially-dependent risk preference, Agric., Vol. 11, No. 8, 1–13, 2021.

[41] M. C. Mutoko, L. Hein, and C. A. Shisanya. Farm diversity, resource use efficiency and sustainable land management in the western highlands of Kenya, J. Rural Stud., Vol. 36, 108–120, 2014.

[42] T. Dalmiyatun, B. T. Eddy, W. Sumekar, D. Mardiningsih. Motivation of farmers to cultivate organic rice in Central Java, International Symposium on Food and Agro-Biodiversity, Vol. 102, 1-6, 2018.

[43] Ž. Dolijanović, S. R. Nikolić, J. Subić, Z. Jovović, J. Oljača, and J. Bačić. Organic spelt production systems: Productive and financial performance in three orographic regions, Ital. J. Agron., Vol. 17, No. 2, 1-9, 2022.

[44] N. A. Khan, Z. Gong, A. A. Shah, and G. Leng. Formal institutions' role in managing catastrophic risks in agriculture in Pakistan: Implications for effective risk governance, Int. J. Disaster Risk Reduct., Vol. 65, 1-11, 2021.

[45] Charina, R. Andriani, B. Kusumo, A. H. Sadeli, and Y. Deliana. Factors affecting farmers in applying standard operational procedure (SOP) system in Bandung Barat Regency, Jurnal Penyuluhan, Vol. 14, No. 1, 68-78, 2018.

[46] V. Seufert and N. Ramankutty. Many shades of gray- the context-dependent performance of organic agriculture, Science Advance, Vol. 3, No. 3, 1-14. 2017.

[47] Y. Yan, W. Ji, B. Li, G. Wang, B. Hu, C. Zhang, A. M. Mouazen. Effects of long-term straw return and environmental factors on the spatiotemporal variability of soil organic matter in the black soil region: A case study, Agronomy, Vol. 12, 1-13, 2022.

[48] S. Phuphisith, S. H. Gheewala, and S. Sampattagul. Assessing environmentally sustainable practices of smallholder highland farmers: A case study of maize production in Northern Thailand, Clean Technol. Environ. Policy, Vol. 24, No. 4, 1159–1172, 2022.

[49] Oyama, P. Sudiarta, F. Shiotsu, and N. Sakagami. Benefits and difficulties of organic and conventional rice farming systems in Bali, Indonesia, Trop. Agric. Dev., Vol. 61, No. 2, 70–76, 2017.

[50] C. Panpakdee, B. Limnirankul, and P. Kramol. Assessing the social-ecological resilience of organic farmers in Chiang Mai Province, Thailand, For. Soc., Vol. 5, No. 2, 631–649, 2021.

[51] M. Yazdanpanah, M. T. Moghadam, T. Zobeidi, A. P. D. Turetta, L. Eufemia, and S. Sieber. What factors contribute to conversion to organic farming? Consideration of the health belief model in relation to the uptake of organic farming by Iranian farmers, J. Environ. Plan. Manag., Vol. 65, No. 5, 90–929, 2022.

[52] Bakker, J. Sok, W. Van Der Werf, and F. J. J. A. Bianchi. Kicking the habit: What makes and breaks farmers' intentions to reduce pesticide use? Ecol. Econ., Vol. 180, 1-11, 2020.

[53] O. Mohamed, S. M. A. El-seretty, T. M. Ahmed, and A. H. A. E. El-ghonemy. Training needs of agricultural extension workers in the field of organic agriculture in Matrouh Governorate, Journal of Positive School Psychology, Vol. 6, No. 2, 6272–6289, 2022.

[54] D. A. Denisova, N. G. Levanova, Z. N. Dibrova, G. K. Isakova, D. Hafizov, O. M. Lizina. Indicators of state financial support for capital reproduction in the agricultural economic sector: The European Union and Russia, Univers. J. Agric. Res, Vol. 9, No. 5, 176-183, 2021. DOI: 10.13189/ujar.2021.090504.

[55] S. Purohit. Organic farming for maintaining soil health, Agriculture & Food: E-Newsletter, Vol. 2. No. 8, 787-788, 2020.

[56] W. Lin, M. Lin, H. Zhou, H. Wu, Z. Li, and W. Lin. The effects of chemical and organic fertilizer usage on rhizosphere soil in tea orchards, PLoS One, Vol. 14, No. 5, 1–16, 2019.

[57] Seilsepour and M. Rashidi. Modeling of soil available phosphorus based on soil organic carbon, Am. J. Agric. Environ. Sci., Vol. 3, No. 5, 1–5, 2008.

[58] Arora and A. Kaur. Azolla pinnata, aspergillus terreus and eisenia fetida for enhancing agronomic value of paddy straw, Sci. Rep., Vol. 9, No. 1, 1–11, 2019.

[59] R. Hijabeek, A. A. Pronk, M. K. Ittersum, H. F. M. Tenberge, J. Bijttebier, and A. Verhagen. What drives farmers to increase soil organic matter? Insights from the Netherlands, Soil Use and Management, Vol. 34, 85–100, 2018.

[60] D. Hou, N. S. Bolan, D. C. W. Tsang, M. B. Kirkham, and D. O'Connor. Sustainable Soil use and management: An interdisciplinary and systematic approach, Sci. Total Environ., Vol. 729, 1-12, 2020.

[61] E. Schoonover and J. F. Crim. An introduction to soil concepts and the role of soils in watershed management, J. Contemp. Water Res. Educ., Vol. 154, No. 1, 21–47, 2015.