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Research Article

SUSTAINABILITY STRATEGY OF INTEGRATED ORGANIC FARMING BASED ON CIRCULAR ECONOMY IN REALIZING SUSTAINABLE AGRICULTURE AND FOOD SYSTEM

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Abstract
It becomes a dilemma when on the one hand to meet market needs, people massively utilize the environment and on the other hand it causes damage, especially in agriculture. There needs to be an appropriate problem approach to overcome this. The purpose of this research is to develop a strategy model for implementing integrated organic farming based on circular agriculture. This research uses quantitative methods with sequential exploratory design. This design begins with quantitative research first, then qualitative with the aim of completing the discussion with Analytical Hierarchy Process (AHP) analysis. The economic dimension has the greatest weight with a value of 0.381. This indicates that in realizing organic farming integrated with Circular Economy, the first thing that needs to be focused on is the economic dimension by making production cost efficiency (Rank 1; GW 0.118). The results bring innovation in the world of research and novelty as a form of environmentally friendly production cycle and reduces waste and is useful for reducing carbon dioxide emissions. Not only that, organic farming by adopting a circular economic system can also create added value to production. Such as compost and biogas energy. The implications in this study can realize policy recommendations for food security, farmer empowerment, and global sustainability.

Keywords: Analytical Hierarchy Process, Circular Economy, Food Security, Organic Farming, Sustainable

INTRODUCTION

Central Java Province is a province that has been named as a national food supplier. Based on its astronomical position, Central Java has high rainfall and humidity ranging from 1,024 - 3,624 mm for rainfall and 69-83 percent humidity (Afiatin et al., 2023; Yaqot et al., 2023; Yang et al., 2023; Melinda, Feizi, & Monfared, 2024). Apart from having sufficient rainfall, Central Java also has fertile land. According to data from BPS, Central Java has the first-ranked agricultural sector GRDP contribution nationally in 2023 and is the third largest rice producer in Indonesia with a production value of 9,084,107.53 tons (BPS Indonesia, 2024). However, the contribution of GRDP in the agricultural sector in Central Java Province has decreased every year. Fluctuations that tend to decrease in rice productivity as one of the agricultural sectors in Central Java are the cause of the decline in the contribution of GRDP in the agricultural sector in Central Java.

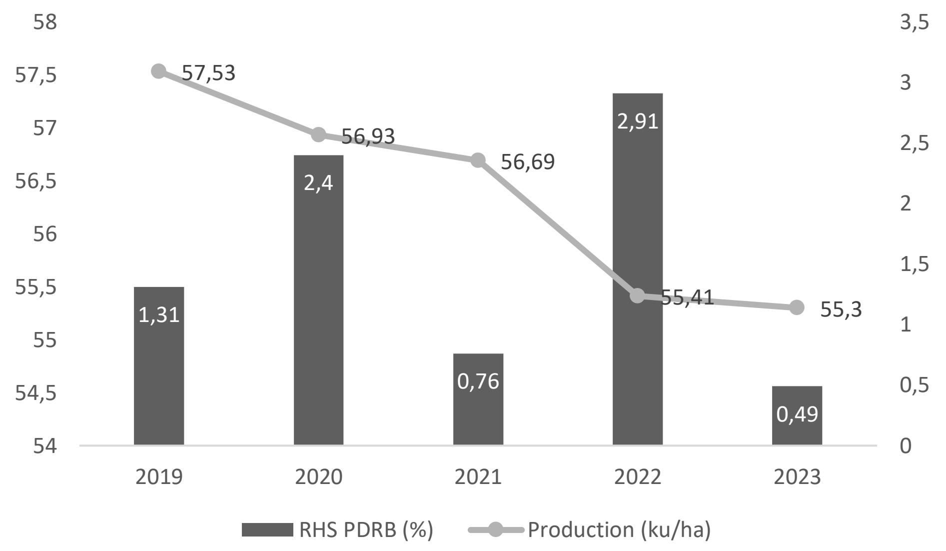

Figure 1. Contribution of GRDP of Agriculture Sector and Rice Productivity in 2019-2023
Note: RHS is the right side
Source: BPS Central Java, 2024

Data from the Central Java Provincial Agriculture and Food Crops Office states that the conversion of food land in Central Java is 300 to 400 hectares per year. This land is converted into industry, offices, business areas, housing and others. The agricultural sector is still considered less profitable in terms of income so that many people convert the land they own into buildings that are more profitable in terms of profit. If this is left unchecked, there will be 10 to 20 hectares of food shortages in the Central Java region.

Apart from supporting the food sector, agriculture is also one way to realize Green Economy or green economic growth (Velenturf et al., 2021; Sudibya et al., 2022; Nikolaev, 2021; Hyskaj et al., 2024; Marnasidis et al., 2024; Tambovceva, 2024). It becomes a dilemma when on the one hand to meet market needs, people massively utilize the environment and on the other hand it causes damage (Susanti, 2019; Valencia et al., 2023; Endra & Villaflor, 2024; Simamora et al., 2024). In recent decades, much of agriculture has been focused on how to achieve high yields, short life cycles, uniformity, disease and pest resistance (McGuire, 2017; Nugroho et al., 2022; Ali, 2024). The technology used for fertilization is by using chemicals. This has caused serious ecological impacts and disturbances such as the extinction of local varieties, pest explosion, and pollution of soil and waters (Lizana et al., 2024). The explosion of chemicals such as pesticides has killed various organisms and natural enemies of pests. Spraying pesticides will make pests immune and multiply quickly (Marsh et al., 2022; Craparo et al., 2023).

The use of these chemicals changes the mindset and behavior of farmers (Corvellec et al., 2022; Afiatin et al., 2023; Enaime, 2023; Gamage et al., 2023; Budiyoko et al., 2024). Without various herbicide products, pesticides and various chemical fertilizers, the land is mythologized as unproductive (Ali and Ali, 2023; David et al., 2024; Firmansyah et al., 2024). The industrialization of agriculture ultimately pushes farmers as part of a giant industrial machine, in the product value chain, and no longer an actor as a source of land use wisdom. Based on Figure 2, the use of inorganic fertilizers is still the majority used by Central Java farmers with a percentage of 78.05%. Inorganic fertilizers used consist of urea, ZA, and NPK. Meanwhile, households that use organic fertilizers such as manure and compost are only 7.39 percent of the total number of paddy rice households. This shows that serious efforts from the government to encourage the use of organic fertilizers by households in paddy rice cultivation are urgently needed. The use of inorganic fertilizers will only have an impact on increasing productivity if the use is right according to the recommended dose or dose. Using too little or too much fertilizer will not result in an increase in productivity, but rather a decrease in productivity.

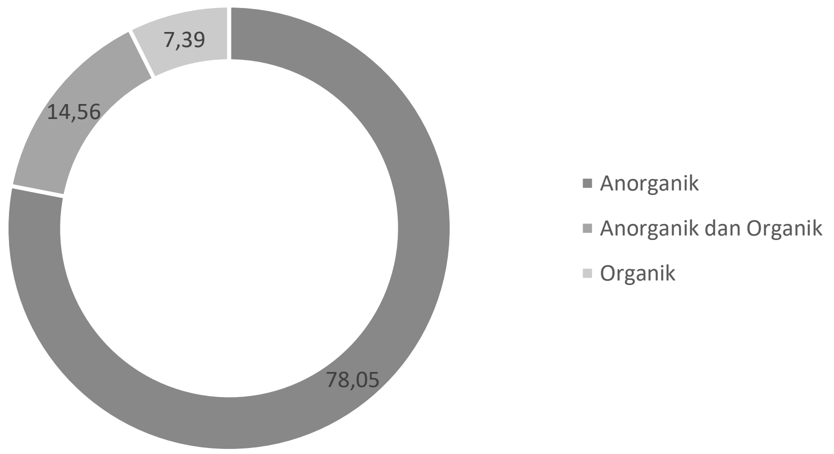

Figure 2. Percentage of Rice Paddy Households by Type of Fertilizer in 2017 (%)
Source: Structure of Rice Crop Business Costs (SOUT) Central Java, 2017

Addressing environmental issues and healthier agricultural productivity has led to a more holistic and integrated concept of organic farming based on Circular Economy, which aims to produce an environmentally friendly agricultural system, thereby reducing greenhouse gas emissions, increasing food security, and reducing dependence on external resources. Circular economy is an alternative economic model that aims to minimize waste and preserve the value of resources in a sustainable manner. The development of circular economy is an effort to improve community food security and sustainable food availability in the future (Kusumowardani et al., 2022; Hasibuan et al., 2024).

The circular economy concept emerged as a paradigm that emphasizes the efficient and responsible use of resources or materials. This concept emphasizes efforts to recycle and reuse waste or leftover materials as resources, so that these materials can be used longer (Indreswari et al., 2021; Azis & Clefoto, 2024; Dovgal et al., 2024; Ghazouani et al., 2024; Wirnayanti et al., 2024). For waste management performance, the application of circular economy is considered very important. A circular economy is an economic system in which waste from one process is not directly disposed of, but becomes a resource for other means. The application of circular economy is mostly found in the food agribusiness sector, as the problems that circular economy tries to solve are inherent and have systemic relevance (Nattassha et al., 2020; Setiyani et al., 2024).

Agriculture with a sustainable circular economy model according to Uzlifatil (2023) is oriented towards three dimensions, namely: the economic dimension, the environmental dimension, and the social dimension. These three dimensions are described as a pillar. Moch and Dila (2022) explained that to maintain food security with the circular economy concept, there are two dimensions of sustainability, namely technology and regulation. The purpose of this research is to develop a strategic model for the implementation of integrated organic farming based on circular agriculture. This research has high urgency because it discusses the circular economy in organic farming with the principle of sustainability. So that it brings innovation in the world of research and novelty as a form of environmentally friendly production cycle and reduces waste and is useful for reducing carbon dioxide emissions. Not only that, organic farming by adopting a circular economic system can also create added value to production. Such as compost and biogas energy. The implications in this study can realize policy recommendations for food security, farmer empowerment, and global sustainability.

RESEARCH METHOD

This research uses a quantitative method with a sequential exploratory design. This design begins with quantitative research first, then qualitative with the aim of completing the discussion. The consideration is that the combination of quantitative and qualitative approaches will produce a more comprehensive and holistic understanding because it uses two approaches.

The data used in this research is primary data. In this research, the data collection methods include observation, field survey with questionnaires, and FGDs. The keyperson who will be involved in the FGD consists of farmers, government, academicians, research institutes, and Semarang Regency Agriculture Office. A total of 12 keypersons will be involved with the location of the area that has abundant agricultural potential, namely in Semarang Regency.

Tabel 1. Respondent Characteristics

Characteristics	Indicators	Number	Percentage
Sex	Man	8	67
	Woman	4	33
Age	21-30	2	17
	31-40	2	17
	41-45	3	25
	> 45	5	42
Education	SMP	1	8
	SMA	4	33
	S1	3	25
	S2	2	17
	S3	2	17
Occupation	Farmer	5	42
	Government	2	17
	Academics	2	17
	Research Institute	2	17
	Semarang Regency Agriculture Office	1	8

Source: Data Processed, 2024

Respondents in this study were dominated by men with a percentage of 67% and most respondents were over 45 years old (42%). Most respondents had a high school education (33%) considering that most respondents in this study worked as farmers (42%). Respondents with a bachelor's degree were 25%, masters were 17%, and doctoral education was 17%. In addition to farmers, respondents in this study also consisted of government (17%), academics (17%), research institutions (17%), and Semarang Regency Agriculture Office (8%).

The analysis method used is Analytical Hierarchy Process (AHP). AHP is known as a comprehensive decision-making that considers both qualitative and quantitative methods (Kirchherr, 2023). AHP produces priorities and objectives from various options based on several criteria with comparisons on each element. The comparison is formed in the form of a matrix. The matrix is filled by selecting numbers that describe the relative importance of one element over another. The scale used is from one to nine. Through AHP, several strategies will be produced to develop a strategy model for implementing integrated organic agriculture based on circular agriculture.

Table 2. Pairwise Comparison Scale

Score	Information
1	Both factors are equal
3	One factor is more important than the others
5	One factor is essential than other factors
7	One factor is most important than other factors
9	One factor is absolutely more important than the other factors
2,4,6,8	Intermediate values, between two adjacent consideration values

Source : Khalil et al., 2024

The first thing to do in AHP analysis is the normalization process, namely the row operation by dividing the aij matrix value by the total matrix value in one column (n) and the column operation to get the weighting value (wi).

$$w_i = \sum_{i=1}^{n} a_{ij} / n \qquad \text{(1)}$$

Wi: weighting value; aij/n: row normalization matrix.

The second way is to calculate the eigenvalue (λ) and maximum eigenvalue (λmax).

$$\lambda_i = \sum_{i=1}^{n} a_{ij} / w_i \qquad \text{(2)}$$

$$\lambda_{max} = \sum_{i=1}^{n} (a_{ij} / w_i)/n \qquad \text{(3)}$$

The next step is to test its consistency using the consistency index (CI).

$$CI = \frac{(\lambda_{max} - n)}{(n - 1)} \qquad \text{(4)}$$

λmax : eigen value maximum; n : the number of matrix.

The last thing to do is to calculate the Consistency Ratio (CR). Saaty (2008) sets a CR value ≤ 10% for acceptable consistency data standards and if CR > 10% then the data is inconsistent so that data collection is repeated for pairwise comparisons and priority ranking is based on the highest weighted score. The formula used is (Liu et al., 2016):

$$CR = \frac{CI}{RI} \qquad \text{(5)}$$

CR : Consistency Ratio; CI : Consistency Index; RI : Random Consistency Index

In determining the priority strategy, the following steps are required in the Analytical Hierarchy Process (AHP) method:

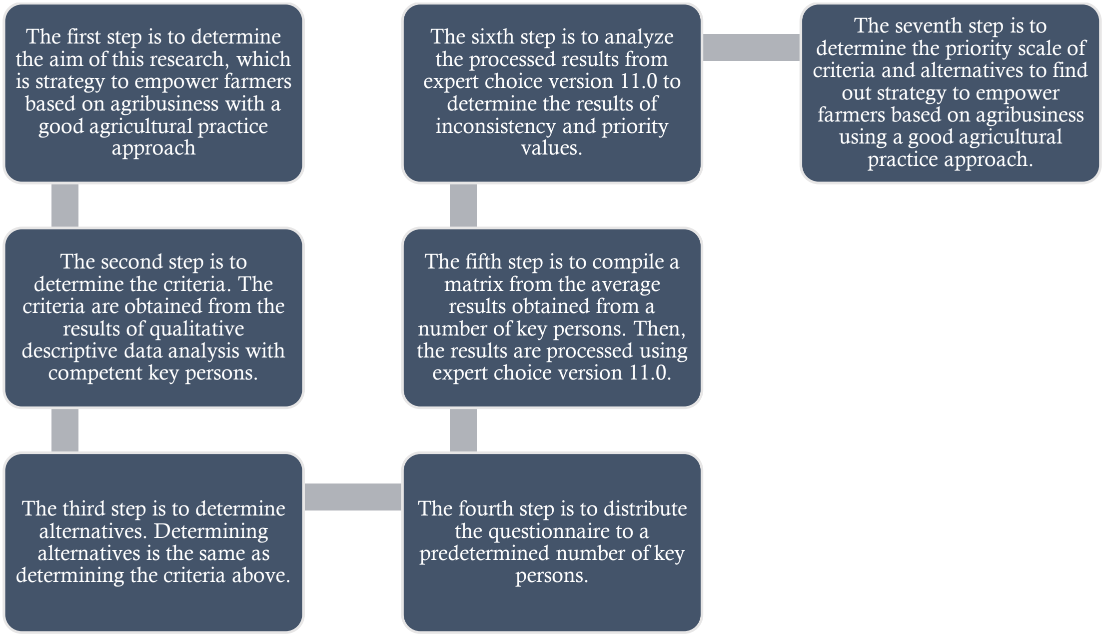

Figure 3. AHP Analysis Stages

Indicators in AHP analysis consist of economic, social, and environmental dimensions sourced from Uzlifatil's research (2023) and research conducted by Moch and Dila (2022) consisting of technology and regulation can be seen in the table 3.

Table 3. Research Indicators

Objective	Source	Dimension	Attributes
Model of Integrated Organic Agriculture Implementation Strategy Based on Circular Agriculture	Uzlifatil (2023)	Economy	Production cost efficiency
			Farmer profit
			Added value and profit
			Market stability
		Social	Community Empowerment
			Farmer Participation
			Social Stability
			Cultural Preservation
		Environment	Waste Management
			Conservation of Natural Resources
			Ecosystem Sustainability
			Biodiversity
			Environmental Health
	Moch dan Dila (2022)	Technology	Innovation and Research
			Adoption of Eco-Friendly Technology
			Infrastructure Availability
		Policies and Regulations	Policy and Regulation Government
			Environmental Regulation
			Partnership and Collaboration

Source: Uzlifatil (2023) and Moch and Dila (2022)

RESULTS AND DISCUSSION

AHP analysis in this study uses Expert Choice 11 software which is useful for determining the Local and Global Weights of each dimension factor as well as sensitivity analysis of the strategy model for implementing integrated organic agriculture based on Circular Agriculture. The second software used is MAXQDA 24 which functions to map the most prioritized dimensional factors and see intersections between dimensions so as to make the model more comprehensive. Based on Table 4. the economic dimension has the greatest weight with a value of 0.381. This indicates that in realizing organic farming integrated with Circular Economy, the first thing that needs to be focused on is the economic dimension by making production cost efficiency (Rank 1; GW 0.118).

Table 4. Local and Global Weights of the Circular Economy-Based Integrated Organic Agriculture Implementation Strategy Model

Dimension	Local Weights	Global Weights	Factors/Attributes	Local Weights	Global Weights	Rank
Economy	0,381	0,381	Production cost efficiency	0,309	0,118	1
			Farmer profit	0,285	0,108	2
			Added value and profit	0,196	0,075	4
			Market stability	0,211	0,080	3
Social	0,215	0,215	Community Empowerment	0,309	0,066	5
			Farmer Participation	0,285	0,061	6
			Social Stability	0,196	0,042	10
			Cultural Preservation	0,211	0,045	7
Environment	0,140	0,140	Waste Management	0,437	0,061	9
			Conservation of Natural Resources	0,209	0,209	14
			Ecosystem Sustainability	0,137	0,019	16
			Biodiversity	0,104	0,015	18
			Environmental Health	0,113	0,016	17
Technology	0,145	0,145	Innovation and Research	0,329	0,048	11
			Adoption of Eco-Friendly Technology	0,370	0,054	8
			Infrastructure Availability	0,301	0,044	13
Policies and Regulations	0,119	0,119	Policy and Regulation Government	0,564	0,067	12
			Environmental Regulation	0,277	0,033	15
			Partnership and Collaboration	0,158	0,019	19

Notes: All calculated Consistency Ratios (CR values) are below 0.1. This means that the matrix assessment passes the consistency test, ensuring the calculated weights maintain coherence.
Source: Data Processed, 2024

Sensitivity analysis means analyzing the stability of alternative priorities by making simulated variations in the priority of network model criteria (Neves et al., 2022; Passaro et al., 2024). Sensitivity analysis is related to the question of whether the final result will always be stable if there is a change in input, either assessment or priority. Based on Figure 4. it can be explained that the priority order in the sensitivity test is the same as the previous alternative priority. This shows the stability of the assessment. From the sensitivity analysis, the following results are obtained:

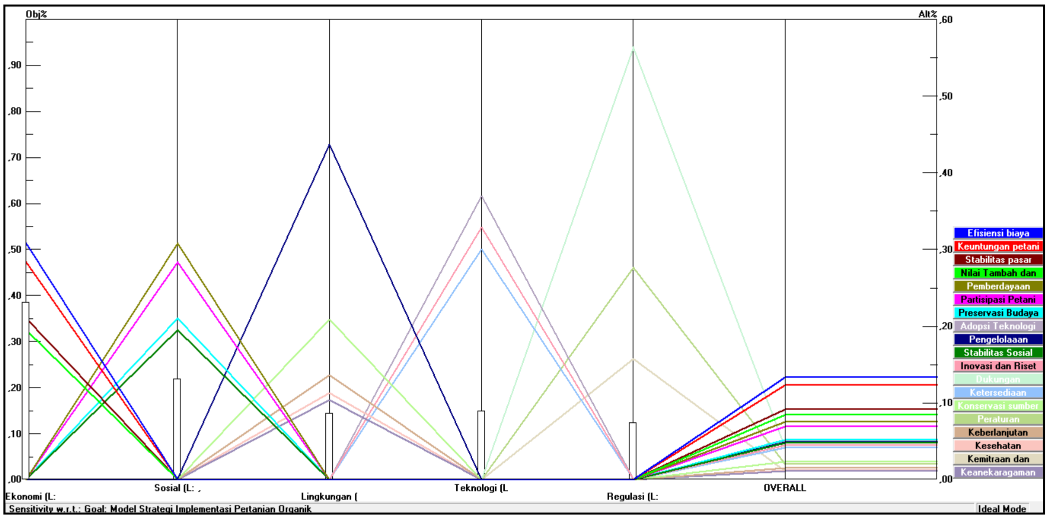

Figure 4. Sensitivity Analysis

Source: Data Processed, 2024

MAXQDA 24 software analyzes two things, the first is to map the dimensional factors of the Circular Economy-based integrated organic farming implementation strategy. The model will show which factors or attributes are most important between dimensions. Between Expert Choice 11 and MAXQDA 24 software have related results. The most important factors in the economic dimension are production cost efficiency (Rank 1; GW 0.118) and added value and profit (Rank 3; GW 0.075).

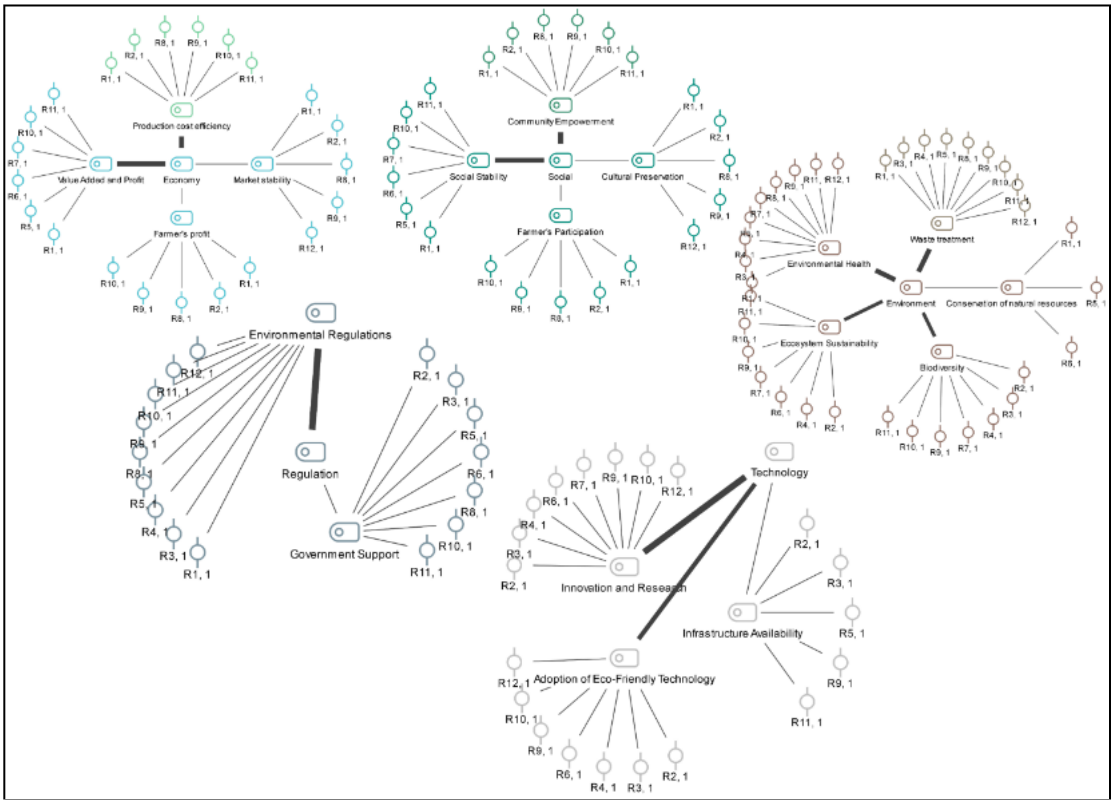

Figure 5. Most Prioritized Dimension Factor Mapping

Source: Data Processed, 2024

In addition, MAXQDA 24 shows the interconnection relationship between dimensional factors. Table 5 shows the intersection between dimensional factors, which when the color gets darker and the number gets bigger, shows the greatest intersection. The purpose of this research is to develop a strategic model for the implementation of integrated organic agriculture based on circular agriculture. So that the economic, social, technological, and regulatory dimensions will be juxtaposed with the environmental dimension to see the intersection relationship.

Table 5. Intersection of Economic and Environmental Dimension Factors

Code System	Market stability	Value Added and Profit	Farmer's profit	Production cost efficiency	Environmental Health	Biodiversity	Ecosystem Sustainability	Conservation of natural resources	Waste treatment
Economy > Market stability	0	1	3	3	4	2	2	1	4
Economy > Value Added and Profit	1	0	6	7	7	6	6	6	8
Economy > Farmer's profit	3	6	0	8	7	6	5	4	8
Economy > Production cost efficiency	3	7	8	0	8	7	6	4	9
Environment > Environmental Health	4	7	7	8	0	6	5	5	7
Environment > Biodiversity	2	6	6	7	6	0	6	3	7
Environment > Ecosystem Sustainability	2	6	5	6	5	6	0	3	6
Environment > Conservation of natural resources	1	6	4	4	5	3	3	0	5
Environment > Waste treatment	4	8	8	9	7	7	6	5	0

Source: Data Processed, 2024

Table 6 shows that community empowerment has a high intersection with environmental health and environmental health.

Table 6. Factor Intersection of Social and Environmental Dimensions

Code System	Cultural Preservation	Social Stability	Farmer's Participation	Community Empowerment	Environmental Health	Biodiversity	Ecosystem Sustainabilit
Social > Cultural Preservation	0	1	4	4	5	2	2
Social > Social Stability	1	0	2	3	4	3	4
Social > Farmer's Participation	4	2	0	5	4	3	3
Social > Community Empowerment	4	3	5	0	5	4	4
Environment > Environmental Health	5	4	4	5	0	6	5
Environment > Biodiversity	2	3	3	4	6	0	6
Environment > Ecosystem Sustainability	2	4	3	4	5	6	0
Environment > Conservation of natural resources	2	4	2	2	5	3	3
Environment > Waste treatment	5	5	5	6	7	7	6

Source: Data Processed, 2024

Table 7. shows that innovation and research have a large intersection with waste management and also have a large intersection with environmental health, biodiversity, sustainable ecosystems, and waste management.

Table 7. Factor Intersection of Technology and Environment Dimensions

Code System	Environmental Health	Biodiversity	Ecosystem Sustainability	Conservation of natural resources	Waste treatment	Infrastructure Availability	Adoption of Eco-Friendly Technology	Innovation and Research
Environment > Environmental Health	0	6	5	5	3	5	5	6
Environment > Biodiversity	6	0	6	3	7	4	5	6
Environment > Ecosystem Sustainability	5	6	0	3	6	3	5	6
Environment > Conservation of natural resources	5	3	3	0	5	3	3	4
Environment > Waste treatment	3	7	6	5	0	5	6	7
Technology > Infrastructure Availability	5	4	3	3	5	0	3	3
Technology > Adoption of Eco-Friendly Technology	5	5	5	3	6	3	0	7
Technology > Innovation and Research	6	6	6	4	7	3	7	0

Source: Data Processed, 2024

Based on table 8. Environmental regulations have the greatest intersection with waste management. In addition to waste management, environmental regulations also have the greatest intersection with environmental health.

Table 8. Intersection of Regulatory and Environmental Dimension Factors

Code System	Environmental Health	Biodiversity	Ecosystem Sustainability	Conservation of natural resources	Waste treatment	Environmental Regulations	Government Support
Environment > Environmental Health	0	6	5	5	10	8	5
Environment > Biodiversity	6	0	6	3	7	5	4
Environment > Ecosystem Sustainability	5	6	0	3	6	4	4
Environment > Conservation of natural resources	5	3	3	0	5	3	4
Environment > Waste treatment	10	7	6	5	0	9	6
Regulation > Environmental Regulations	8	5	4	3	9	0	5
Regulation > Government Support	5	4	4	4	6	5	0

Source: Data Processed, 2024

The concept of circular economy is the natural regeneration of the system starting from the production process, to produce comprehensive systemic changes in economic activities (Henneron et al., 2015; Reganold et al., 2016; Amicarelli et al., 2024). The circular economy concept can build the resilience of a product that is produced for a long time. The circular economy concept can create better businesses and economic activities that are beneficial to the environment and social aspects of society (Crovella et al., 2024; Glockow et al., 2024).

Table 4 illustrates the results of calculating local and global weights for dimensions, factors or attributes that can influence the implementation of circular economy-based organic farming. Economy is the most important dimension for organic farming in Semarang Regency (GW 0.381). Within the economic dimension, production cost efficiency (Rank 1, GW 0.118) emerged as the most important factor far beyond the other factors. Figure 5 also explains that production cost efficiency and added value and profit (Rank 4; GW 0.075) play an important role in the circular economy of organic farming. To create a circular economy on organic farming requires production cost efficiency. Cost efficiency can be achieved by making maximum use of existing resources. During the post-harvest process, agricultural waste can be reused for animal feed, fuel (biogas), and can also be used as planting media. Vice versa, for farmers who have livestock, livestock manure can be used as organic fertilizer. Organic fertilizers derived from livestock manure, such as goats or cows, have a diverse nutrient content and are beneficial for soil fertility (Dagevos et al., 2021; Indreswari et al., 2021; Arista et al., 2022).

Table 5. shows that production cost efficiency has a large intersection with waste management (Rank 9; GW 0.061). As explained, proper waste management will create high production cost efficiency. Waste that can be processed is not only waste from livestock. Waste management can start from people's households. One cup of brewed coffee that can be consumed by the community produces about 20% coffee grounds and usually this coffee grounds becomes waste in landfills. Coffee grounds waste contains alkaloids, tannins and polyphenolics which are toxic compounds and can pollute the environment because the material is difficult to degrade biologically (Suchek et al., 2021; Burg et al., 2023). However, coffee grounds still have benefits because they contain Nitrogen, Phosphorus, and Potassium (NFK) compounds that can fertilize the soil. One of the uses of coffee grounds waste is as Liquid Organic Fertilizer (POC) (Castillo et al., 2024). The utilization of this waste not only helps reduce the amount of waste generated by the coffee industry, but also provides multiple benefits for plant growth by applying the waste to product principle and supporting the economy. This is in line with Indonesia's Sustainable Development Goals (SDGs) towards 2030.

For example, banana peels contain magnesium, sodium, phosphorus, and sulfur that can be used as organic fertilizer. Making organic fertilizer with banana peels can produce solid and liquid fertilizers. Based on the analysis of solid and liquid organic fertilizers when using kepok banana peel as conducted by Kounani (2024), it is known that the nutrient content contained in the solid fertilizer of kepok banana peel is 6.19% C-organic; N-total 1.34%; P2O5 0.05%; K2O 1.478%; C/N 4.62% and pH 4.8 while liquid fertilizer of kepok banana peel namely, C-organic 0.55%; N-total 0.18%; P2O5 0.043%; K2O 1.137%; C/N 3.06% and pH 4.5. From the analysis above, banana peel contains nutrients that are much needed by plants, namely nitrogen. Nitrogen is an important constituent element in protein synthesis, in stimulating the growth of stems, branches and leaves in plants as well as in the formation of leaf green substances (chlorophyll) and plays a role as a form of protein, fat, and various other organic compounds. Banana peel is a fresh organic material that contains potassium, when used as fertilizer directly in its fresh state, the complex organic matter in banana peel cannot be used directly by plants for their growth. Therefore, through decomposition activity by microorganisms, the complex organics can be converted into simple organics, which in turn produce potassium elements that can be absorbed by plants. The use of organic fertilizer can be an environmentally friendly and sustainable solution to increase agricultural productivity (Marsh, 2022; Castillo, 2023).

The management of waste into organic fertilizer in addition to increasing production cost efficiency can also create added value and profit. This is the main goal of the circular economy (Otero et al., 2023; Erdiaw et al., 2024). Community households and livestock farmers can manage waste to produce solid organic fertilizer (POP) and liquid organic fertilizer (POC) for agricultural activities, creating value-added products and producing superior food (Doyeni et al., 2023). Organic agricultural post-harvest waste can be reused as organic agricultural by-products that can be processed into biogas energy products so that farmers' profits also increase (Rank 2; GW: 0.108).

The social dimension (GW 0.215) is the second priority dimension after the economic dimension. Community empowerment (Rank 5; GW 0.066) is the most prioritized alternative in the social dimension and has a large intersection with waste management and environmental health (Rank 17; GW 0.016). Figure 5. also explains that community empowerment is the most important factor for organic farming in the circular economy. Empowering the farming community is a very important part and can even be said to be the spearhead of the implementation of organic farming based on a circular economy (Figge et al., 2023). One way to empower the farming community is by conducting organic farming counseling. This extension is intended to educate farmers so that they can carry out environmentally friendly and sustainable agriculture (Mujtaba et al., 2023). The trick is to introduce organic farming practices such as making fertilizer and compost from organic materials or waste, using natural pesticides and reducing chemical pesticides, crop rotation, and optimizing available resources. If farmers have implemented organic farming, it will create environmental health because food quality will be guaranteed organic, families are healthier, preserve the environment, and food sovereignty is guaranteed. This will create environmental health (Giri et al., 2022; Morseletto, 2022).

Based on Figure 5, Adoption of Environmentally Friendly Technology (Rank 8, GW 0.054) and Innovation and Research (Rank 11; GW 0.048) are factors that are prioritized in the circular economy of organic agriculture in the technology dimension (GW 0.145). Table 7 shows that the adoption of environmentally friendly technology has a large intersection with waste management. This means that managing waste requires the use of environmentally friendly technology (Susanti et al., 2019; Hastuti et al., 2024). Technology in managing environmentally friendly waste is intended to minimize the impact of climate change and reduce pollution. Innovation and research have the greatest interconnection with waste management (Martínez et al., 2024). Environmentally friendly technology needs to be supported by innovation and research on organic farming in managing its waste. So that it will create organic farming that is zero waste and guaranteed food quality. If the implementation model of organic farming with circular economy principles has been formed, the next important step is government regulation (GW 0.119). In managing waste and environmental health, environmental regulations (Rank 15; GW 0.033) are important. Based on Table 8, environmental regulations have the greatest intersection with waste management and environmental health. Environmental regulations in Semarang Regency need to be made strict on the environment as an effort to reduce carbon emissions.

This research has a novelty in integrated organic farming based on circular economy. This novelty concept combines the processes of production, consumption, and residue management to create a cycle that minimizes waste. This concept has not been applied by many previous studies that discuss circular economy on organic farming comprehensively. The strategy for implementing this concept does not only focus on environmental sustainability by managing waste and reducing carbon emissions. However, it also pays attention to social, technological, and regulatory dimensions.

CONCLUSION

In implementing organic farming in the circular economy, proper waste management will create high production cost efficiency. Waste that can be processed can come from livestock waste and community household waste. The organic waste has benefits because it contains Nitrogen, Phosphorus, and Potassium (NFK) compounds that can fertilize the soil. The management of waste into organic fertilizer in addition to increasing the efficiency of production costs can also create added value and profit. This is the main goal of the circular economy. Another factor is community empowerment, which is the most important factor for organic farming in the circular economy. This empowerment is intended to educate farmers so that they can carry out environmentally friendly and sustainable agriculture. Environmentally friendly technology needs to be supported by innovation and research on organic farming in managing its waste. So that it will create zero waste organic farming and guaranteed food quality. Suggestions in this study, it is hoped that Semarang Regency can empower the farming community in educating the circular economy of organic farming in order to realize sustainable agriculture so that food quality is guaranteed. It is necessary to subsidize environmentally friendly technology and develop innovation research so that farmers can produce low-carbon organic agriculture. The government also needs to make strict environmental regulations on the circular economy of organic farming. The limitation of this study is that there is still little literature discussing the circular economy in organic farming, including studies that discuss it in a large regional scope. The circular concept of organic farming in the economy does have complex principles, so that at first it still requires high costs. In addition, farmers' knowledge is also still limited in adopting this circular concept. To overcome this, future studies should focus on longitudinal studies and the development of cost-effective solutions. The recommendations emphasized in this study are the development of investment in farmer education and expertise and the preparation of comprehensive policies in the implementation of this circular organic farming.

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AUTHOR CONTRIBUTIONS

Author1-3 creates articles and creates instruments and is responsible for research.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

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