

Sustainability Status Assessment of Urban Agriculture Types in Malang City

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ABSTRACT

Urban agriculture (UA) and urban-peri-urban agriculture (UPA), is one of the approaches to improve sustainability of urban food system. Urban agriculture can increase access to fresh food for the community, by shortening the food supply chain. There are many impacts from ecological, economic, social dimensions. However, it is undeniable that urban agriculture also brings other negative impacts in various dimensions. Which directly or indirectly affect the sustainability of urban agriculture. Many urban agriculture have low sustainability. Malang City itself has the potential for urban agriculture. At least there are 7 types of urban agriculture in Malang City, namely (1) wetland/irrigated agricultural land, (2) Rainfed dryland farming, (3)recreational activity, (4) community gardening, (5) commercial farming, (6) agro-educational tourism, (7) institution. The purpose of this study is to assess the sustainability status of each type of urban agriculture. A quantitative approach, using the multidimensional scaling method and RAPHYTON tools was used to analyze the data. Primary data were collected from expert informant interviews, supporting informants, field surveys and observations. The results of the analysis showed that the sustainability level of urban agriculture various types in Malang City is generally in the moderately sustainable category. The ecological dimension of irrigated agricultural land is categorized as unsustainable. Conversely, the highest sustainability status (categorized as sustainable) is achieved by agro-educational tourism type agriculture in the social dimension. This research also suggests attributes that leverage the sustainability status of each dimension. One of them is the application of integrated agriculture to achieve ecological sustainability.

Keywords: : Sustainability status, Urban Agriculture types, Multidimensional Scaling, Malang City

BACKGROUND

The agricultural sector has always been associated with rural areas (UU No. 26/2007). Agricultural production in rural areas is typically directed toward urban food needs. Practically, cities depend on rural areas. FAO predicts that by 2050 the world population will reach 9.7 billion and 70% of them will live in cities (FAO, Rikolto, & RUAF, 2022). Likewise in Indonesia. The Sustainability Status Assessment of Urban Agriculture Types in Malang City (Prasundari., et al, 2026) 259

World Bank in its report predicts that by 2045, around 70% of Indonesia's population will live in urban areas (Roberts, Sander, & Tiwari, 2019). As the urban population will increase, that means cities become increasingly dependent on rural areas to fulfill their food needs. Ironically, cities often do not plan how to ensuring food provision of their citizens. This is further reinforced by the fact that urban development planning frequently overlooks food issues (Cabannes & Marocchino, 2018)

Urban agriculture (UA), also referred as urban farming (UF) and urban-peri-urban agriculture (UPA), is one of the approaches to improving sustainability of urban food system. The implementation of urban agriculture can enhance access to fresh food for the communities, by shortening the food supply chain. From an environmental perspective, urban agriculture contributes to waste management, increasing green open space, energy efficiency and reduces pollutant emissions (Atmaja, Yanagihara, & Fukushi, 2020; Chairinisa, Perkasa, Rahmawati, & Kurniasari, 2022; FAO et al., 2022). Urban agriculture is a sustainable development strategy that aims to address food insecurity, environmental degradation and poverty alleviation through community empowerment, as leading to food self-sufficiency (Armansyah et al., 2024; Purba & Amir, 2021).

Urban agriculture also plays a significant role in socio-economic dimension by employment opportunities for urban residents and helping to reduce household expenses, especially for daily necessities, such as vegetables, fruits, and spices (Armansyah et al., 2024). Moreover, urban agriculture also contributes to food security education, human health, community engagement, social justice and gender equality (Alynda & Kusumo, 2021; Mardiana, Nurdiana, Supatminingsih, Inanna, & Hasan, 2024; Nicholls, Ely, Birkin, Basu, & Goulson, 2020). The estimated economic valuation of urban agriculture activities- under an intensive urban agriculture scenarios- is estimated at USD 80-160 billion per year (Clinton et al., 2018)

However, the sustainability of urban agriculture remains a common challenge. Behind the positive impacts of urban agriculture practices, there are also significant obstacles that must be addressed, which pose challenges to its long-term sustainability. From environmental and health perspective, there are 5 potential health risks have been identified in relation with urban agricultural practices, including heavy metal contamination risks, health risks from using wastewater for irrigation, zoonotic risks, and other health, social and economic risks (Ganguli, 2024). In fact, recent research indicates that urban agriculture may not necessarily be more "environmentally friendly" than conventional agriculture. The carbon footprint of urban agriculture is 6 times greater than conventional agriculture (Hawes et al., 2024). From social perspective, Nchanji, Cosmas, & Nchanji, (2023) in their study of urban agriculture in Tamale, Ghana (2013 -2015) found that urban farmers must rely on their socio-political, religious, and economic networks to access and control land and water resources. The abundance of institutions and actors involved in Tamales urban agriculture poses challenges for development of urban and peri-urban agricultural potential. Overlapping mandates and a lack of itegration of policy framework has negatively affected the function of urban agriculture system in the city. While a study conducted by (Alkhaja, Alawadi, Almemari, & Alshehhi, 2024) states the land tenure plays an important role as it determines how agricultural activities are carried out by stipulating the

duration and security of land access.

Several major cities in Indonesia, such as Jakarta, Bandung, and Surabaya, have initiated urban agriculture programs through government and community initiatives. Programs such as Pekarangan Pangan Lestari (P2L) organized by the Ministry of Agriculture and implemented nationally. Kampung Tematik (Sukowati, 2022), fish farming in bucket (budikdamber) and community gardens at the regional level show government attention and community enthusiasm in utilizing limited space for productive activities. The issue of sustainability of urban agriculture in Indonesia also faces problems related to sustainability.

Several studies indicate that the sustainability of urban agriculture is not sustainable. For example, urban agriculture in Central Jakarta shows a very low sustainability status across various dimensions, including economic, ecological, social, and technological dimension (Fitri, Perkasa, Widjaja, Seanders, & Fauzi, 2024). In Surakarta City, a study conducted by Rachmadillah, (2023) on urban farming in Ngemplak Sutan village showed high social sustainability in the social-cultural aspect and the lowest sustainability category in the economic dimension.

Malang City, as the second largest city in East Java, has 130 Urban Farming Households (Badan Pusat Statistik Indonesia, 2023). Compared to other cities in East Java, Malang ranks second. This relatively high number indicates that urban agriculture activities in Malang City are still feasible and in demand. Atmaja et al., (2020) found that the total value of urban farming in Malang City is US\$ 395.095,68 per year and has the potential to reach US\$ 60.646.800,35 per year. However, urban farming as an approach to enhance food security in Malang City where 40-70% of households spend more than 65% of their total consumption on food (FSVA, 2023). If urban agriculture is developed optionally, it can certainly improve access to fresh food for the community. There are at least 7 types of urban agriculture in Malang City, including (1) irrigated agriculture land, (2) rain-fed dryland farming, (3) recreational activity, (4) community gardening, (5) commercial farming, (6) Agro-educational tourism, and (7) Institution. The objective of this study is to diagnose the sustainability of each type of urban agriculture in Malang City.

RESEARCH METHODS

This study uses a quantitative approach and was conducted in Malang City from February to March 2025. Interviews, surveys and observations were conducted to obtain primary data. Data sources came from expert informants—specifically the coordinators of agricultural extension officers in Malang City— and supporting informants selected from urban agriculture practitioners representing each typology identified in the city. The collected data were analyzed using the Multidimensional Scaling (MDS) RAPFISH method, with data processing performed through the RPYTHON application.

Rapfish (Rapid Appraisal for Fisheries) is a rapid assessment tool developed by the fisheries Centre of the University of British Columbia to evaluate fisheries sustainability (Fauzi, 2019). In its development MDS/Rapfish method has been adapted for diagnostic and cross-sectoral sustainability assessments. During sustainability status analysis phase, leverage feature will also provide an analysis of leverage factors, which can later inform urban agriculture development strategies. The Sustainability Status Assessment of Urban Agriculture Types in Malang City (Prasundari., et al, 2026) 261

leverage feature in MDS/Rapfish helps detect dominant attributes. The principle of leverage is based on the change in ordination when attributes are removed one by one. In other words, leverage reflects a sensitivity analysis. The length of each bar represents the degree of influence that a specific attribute has on the ordination results.

The sustainability assessment in this study includes five dimensions: ecological, social, economic, institutional, and technological. The sustainability analysis of urban agriculture from the ecological dimension is based on 8 attributes, including agricultural practices and systems implemented by each unit (Bathaei & Štreimikienė, 2023; Mishra et al., 2018); the use of local plant; integrated pest and disease management; the level of non-organic pesticide and herbicide application; the level of non-organic fertilizer use (Mishra et al., 2018); the level of organic fertilizer application beneficial for soil improvement (Bathaei & Štreimikienė, 2023; Lebacqz, Baret, & Stilmant, 2013) and the utilization of renewable natural resources (Tey et al., 2012). Analysis of the sustainability in the social dimensions assessed on 8 attributes. These attributes include the demographic structure of actors particularly their age and educational background (Miftari & Musaraj, 2019); social interaction among fellow urban farmers (Ip, 2023; Wang & Xu, 2024); the role of local leaders or community mobilizers (Andari, Hudaiby Galih Kusumah, & Ningsih, 2024), urban agriculture practices that may involve conflicts with surrounding community and their impacts; the role of women (Bathaei & Štreimikienė, 2023); and attributes that assess the multifunctionality of urban farming (Lebacqz et al., 2013). The assessment of sustainability status economic dimension is based on nine key attributes, including post-harvest activities, additional farming-related income-generating ventures, access to markets, availability of capital or financial support, overall profitability, productivity levels, and the extent of government subsidies provided for urban agriculture activities (Bathaei & Štreimikienė, 2023; Lebacqz et al., 2013). These attributes collectively offer a comprehensive picture of the financial viability and resilience of urban agriculture initiatives in the city.

The institutional sustainability of urban agriculture in Malang City is assessed through eight key indicators that reflect both organizational structure and support systems. These include the role of agricultural institutions in facilitating urban farming activities; the role and performance of agricultural extension services, particularly in terms of their effectiveness, intensity, and accessibility; and the extent of collaboration with external stakeholders such as private sector actors and academic institutions. Furthermore, government involvement in providing guidance, supervision, and regulatory support plays a crucial role in maintaining institutional sustainability. Another important indicator is the administrative capacity of urban farming institutions, especially as demonstrated through record-keeping practices maintained by the practitioners. Lastly, land tenure status is a critical consideration, as it relates to the vulnerability of urban agricultural land to conversion for non-agricultural uses (Nugroho, Kusnandar, & Sutrisno, 2023). These institutional factors collectively shape the enabling environment for urban agriculture to thrive or decline. The technological sustainability of urban agriculture in Malang City is assessed based on several indicators, including the adoption of urban farming technologies, the use of the internet for automation and information access, facilitation of access to training, access to subsidies, the implementation of urban agricultural waste management technologies, and the application of fertilizer production technologies (Nugroho et al., 2023). The MDS analysis results in a sustainability index for each dimension. The sustainability

index is categorized into four groups: 0-25% (unsustainable), 25-50% (less sustainable), 50-75% (fairly sustainable), and 75-100% (highly sustainable).

RESULT AND DISCUSSION

Types of Urban Agriculture in Malang City

The typology of urban agriculture in Malang City presented in this study is based on empirical fieldwork, including interviews with key informants and direct observation. While the classification was developed inductively from the local context, it aligns with existing frameworks proposed by global organizations and scholars. The *Urban and Peri-urban Agriculture Sourcebook* by FAO, Rikolto, and RUAF (2022) categorize urban agriculture based on primary purpose and functions, production practice, land use and management, water resources use and management, and labour, financial resources. Similarly, Jansma, Veen, & Müller, (2024) propose a functional typology of urban and peri-urban agriculture in Europe, using 5 dimension for distinguishable in creating typology. There are spatial, production, operational and community dimension. These existing typologies provide a comparative basis for the classification found in Malang City, which comprises seven context-specific types of urban agriculture.

Urban agriculture in Malang City in this study divided into seven types, namely (1) irrigated agricultural land, (2) rain-fed dryland farmin, (3) recreational activity, (4) community gardening, (5) commercial farming (6) agro-educational tourism, (7) institutional farming. **Irrigated agricultural land** is characterized by participants predimunantly aged over 50 years. These farmers are generally members of farmer groups. The cultivation system applied is monoculture, with rice as the main commodity. Technological adaptation remains limited, primarily involving the use of agricultural machinery to improve labor efficiency. In general, the main motivation for engaging in this type of farming is as livelihood, though some do it as a hobby or for secondary income. This type of UA is still commonly found in peri-urban areas such as Kedungkandang subdistrict and parts of Sukun, Lowokwaru, and Blimbing Subdistricts.

Rainfed dryland farming is still commonly found in peri-urban areas such as Kedungkandang and parts of Sukun and Lowokwaru Subdistricts. This type of agriculture characterized by reliance on rainwater ad the primary source of irrigation and the application of polyculture systems. The main commodities cultivated include horticulture crops (such as chilli tomato, and orange), *empon-empon* or medical plants (such as traditional herrbal plants), and staple food crops (such as corn, sweet potato, and taro). Generally, the practitioners of this type of urban agriculture are predominantly men in their 50s. They are typically organized in farmer groups or *Kelompok Tani*. This type of agriculture also often engages in other activities related to livestock and/or fisheries production. The primary motivation for engaging in these activities is to earn a livelihood. Technology adoption is limited to machinery that improves labor efficiency.

Type 3 or recreational activity is dominated by individual farmers whi engage in farming as a leisure activity, or a voluntary activity, with production aimed for self consumption. Most practitioners are over the age of 45. The land used typically privatetly owned, with an average areas

of less than 200 m². Cultivation system include direct planting in soil and/or planting in container (polybags/pots). Technology is still limited to container-based crop cultivation. The advantage of this type is that products have minimal chemical residue. This type easily found in urban and peri-urban areas such as Klojen, Lowokwaru, Blimbing, and Sukun Subdistrict.

Community gardening (Type 4) can be found in almost all subdistricts, but is commonly located within residential areas. This type is typically managed collectively by local residents who are organized into a group. The space used for activities is idle plots, public facilities, or land properties owned by group members. The farmers are generally housewives and/or elderly people. The cultivation techniques applied are generally diverse, ranging from direct planting on land, planting in container, and hydroponics. Potential conflicts that could halt this type of agricultural activity include land use conversion and the influence or absence of local leaders or community mobilizers.

The next type is **Commercial urban farming**. This type is generally oriented toward the sale of agricultural products. It often evolves from recreational activity based or community gardening. The crops cultivated are typically more diverse and have higher economic value. The cultivation systems commonly used include direct planting in soil, container planting, hydroponics, and aquaponics. Farmers engaged in this type are usually part of farmer groups. The technologies adopted in this type of farming are more advanced and varied, This type of agriculture also adopts information technology to access agricultural and market information

The sixth type is **agro-educational tourism**, which is generally a development of recreational activity or community gardening. The main characteristic of this activity is that agro-edutourism activities generate higher income than crop sales. Visitors typically include preschool and elementary school children as well as adult urban farming enthusiasts. Harvested crops are often processed and served as part of the tourism package Product diversification extends beyond fresh food to include the sale of plant seedlings and consulting services. This type frequently collaborates with various parties, including private enterprises and academic institutions. Such partnerships enable access to technological facilities that are not commonly available in other types. The technologies adopted include direct planting, container planting, hydroponics, aquaponics, indoor planting, drip irrigation, and automation. Additionally, the use of information technology is quite optimized in this type of farming.

The seventh type of urban agriculture is identified as **institutional urban agriculture**. This type is managed by institutions, both governmental and non-governmental, that provide part of their space for urban agriculture activities. The main motivation behind this initiative is to meet the needs of the institution itself while also serving as a demonstration of the institution's commitment to addressing food security issues. Additionally, this type of farming is often used as an educational space for promoting urban agriculture. The level of technological adaptation is relatively high and diverse. Workers are employees assigned to these activities, though volunteers from the institution's members or community may also participate. The commodities cultivated are generally staple food crops for daily consumption.

Validation

The validity of the MDS model is assessed based on 2 main parameters: Stress Value and R-squared value. According to Kavanagh & Pitcher, (2004), a Stress value below 0,25 and an R-squared value above 0,95 indicate that MDS analysis results are sufficiently representative and reliable. Based on the sustainability analysis of urban agriculture typologies in Malang City using the MDS-RAPYTHON method, it was found that Stress and R-squared values for each dimension (table 1) met the criteria. Therefore, it can be concluded that the analysis results are considered valid.

Table 1 Stress Values and R-Squared for each Dimension

Dimension	Stress:	R-squared:	Model Status
Ecology	0,1248	0,9844	Good fit
Social	0,1207	0,9854	Good fit
Economy	0,1283	0,9835	Good fit
Institutional	0,1158	0,9866	Good fit
Technology	0,126	0,9841	Good fit

Source: Primary Data, 2025

Ecological Dimension Sustainability Status

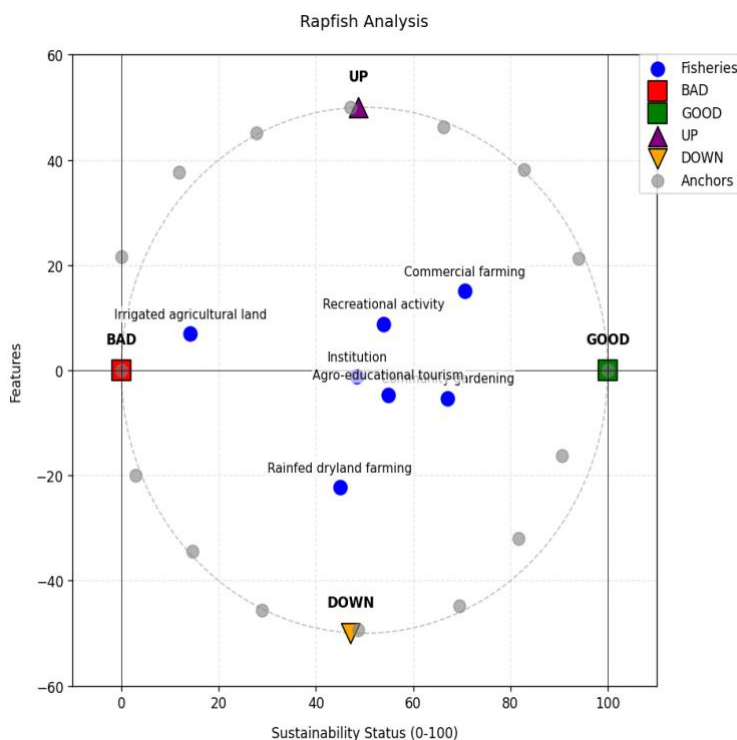


Figure 1 Sustainability Index of Ecology Dimension

Source: Primary Data (2025)

The figure 1 presents the sustainability status of urban agriculture types in Malang City based on the ecological dimension. The x-axis represents the sustainability index (ranging from 0-100), while the y-axis reflects the influence of each attribute (features). Among the 7 types of urban agriculture, commercial farming shows the highest ecological sustainability score, positioning it close

to the “GOOD” quadrant. Notably, irrigated agricultural land is located in the “BAD” quadrant, indicating poor ecological sustainability. The directional flags (UP, DOWN) indicates the strenght and direction of leverage factors within this dimension. The plot presents in figure 1 can could be visual clustering to see which types of urban agriculture behave similarly.

Table 2 Sustainability Index of Ecological Dimensions for Each Type of Urban Agriculture

	Types	Sustainability Index
1	Irrigated agricultural land	14,19
2	Rainfed dryland farming	44,91
3	Recreational activity	53,96
4	Community gardening	67,08
5	Commercial farming	70,58
6	Agro-educational tourism	54,91
7	Institution	48,43

Source: Primary Data (2025)

The analysis revealed (Table 2) that out of the 7 types of urban agriculture, 4 types had index values in the range of 50.01-75.00%, indicating that these types fall into the category of moderate sustainability. The 4 types, ranked from highest to lowest index values, are commercial farming (70.58%), community gardening, agro-educational tourism, and recreational activities (53.96%). In contrast, the irrigated agricultural land (14.19%) placing it in the unsustainable category.

In line with its characteristics, the high sustainability status of commercial farming is attributed to the application of organic cultivation practices. A similar trend is observed in community gardening and recreational activity, where practitioners tend to minimize the use of chemical inputs and prefer using botanical pesticides self made from common household ingredients. In agro-educational tourism and institutional farming, organic materials such as manure remain the primary input, although chemical fertilizers and pesticides are still applied within recommended usage limits. Meanwhile, rain-fed dryland farming generally maintains conventional practices with continued reliance on chemical inputs. However, this type has strengths in implementing multicropping systems and cultivating local crops such as *Zingiber* sp. and *Colocasia* sp. On the other hand, irrigated agricultural land is categorized as unsustainable due to its monoculture system and heavy dependence on chemical fertilizers and pesticides. Abdullah, Dirawan, & Pertiwi, (2017) in their study, stated that the ecological sustainability status of urban farming in Makassar City categorized as unsustainable. The use of fertilizers and pesticides, the dominant types of crops cultivated, and the management of post-harvest waste are the three highest factors affecting the sustainability of urban farming in Makassar City.

Three factors with high sensitivity (Figure 2) toward urban agriculture in Malang City are the implementation of integrated farming system (19,84); utilization local plants (19,61); and the application of integrated pest and disease management(17,15). able 3 shows that the most influential ecological attributes are the implementation of integrated farming practices, utilization of local plant species, and integrated pest and disease management. These factors play a key role in determining the ecological sustainability of each urban agriculture type.

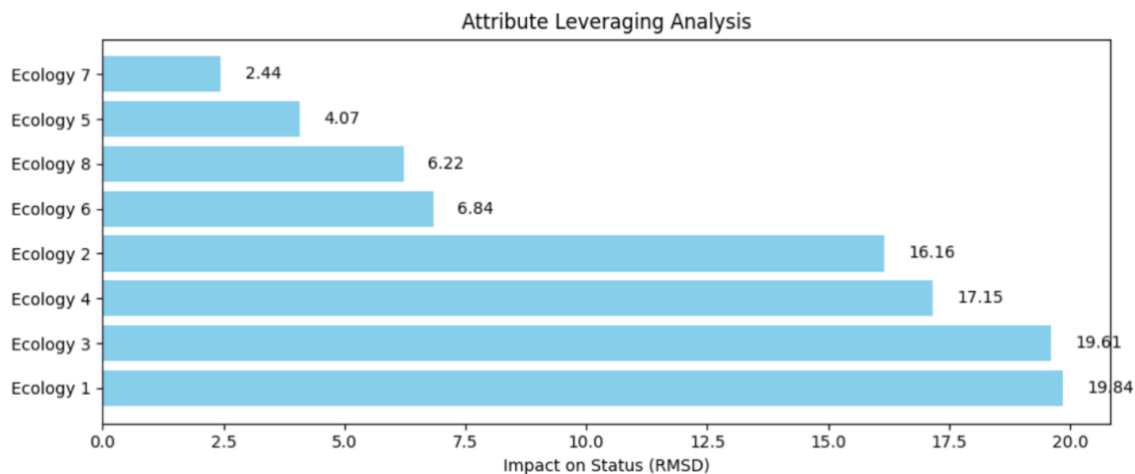


Figure 2 Leverage Analysis of the Ecological Dimension
Source: Primary Data, 2025

Table 3 Leverage Values of Each Attribute in the Ecological Dimension

Attribute		Index
Ecology 1	Implementation of integrated farming practices	19,84
Ecology 2	Adoption of monoculture/polyculture agricultural systems	16,16
Ecology 3	Utilization of local plant species	19,61
Ecology 4	Integrated pest and disease management (IPDM)	17,15
Ecology 5	Level of non-organic pesticide and herbicide usage	4,07
Ecology 6	Level of organic fertilizer application	6,84
Ecology 7	Use of non-organic fertilizers	2,44
Ecology 8	Utilization of renewable natural resources	6,22

Source: Primary Data, 2025

High scores in key ecological attributes are associated with more sustainable types, such as commercial farming and agro-educational tourism. In contrast, types with lower sustainability tend to underperform in these areas. These findings suggest that improving ecological practices—particularly in terms of system integration, biodiversity, and pest management—can significantly enhance the sustainability of urban agriculture systems.

The implementation of integrated urban agriculture is particularly important, as it has the capacity to manage and connect multiple resource flows, including water, waste, and energy (Diehl et al., 2020; Skar et al., 2020). Urban agriculture can also serve as a reconciliatory space between plant conservation and food production (Seitz, Buchholz, Kowarik, Herrmann, & ..., 2022). The cultivation of local plant species not only contributes to food security, but also plays a role in conserving biodiversity within urban environments.

Social Dimension Sustainability Status

Figure 3 illustrates the sustainability index of the social dimension across seven types of urban agriculture in Malang City. The majority of types fall within the moderately to highly sustainable category. Community gardening and agro-educational tourism show the highest social sustainability

scores and are positioned near the "GOOD" quadrant, indicating strong social cohesion, participation, and community engagement within these types. The spatial distribution on the plot suggests that urban agriculture types with a community-based or educational component tend to score higher in the social dimension, while conventional or individually-managed systems face greater challenges in fostering social sustainability.

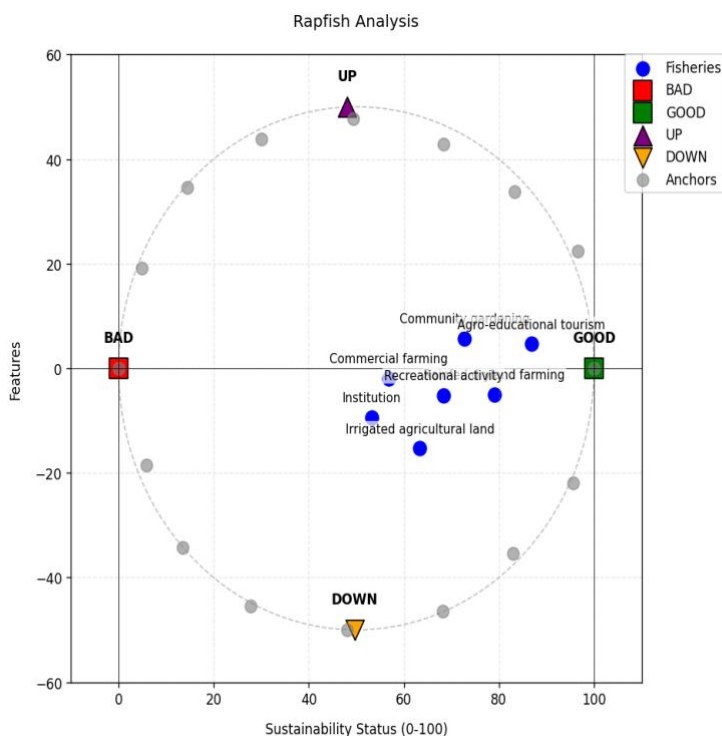


Figure 3 Sustainability Index of Social Dimension
Source: Primary Data, 2025

Table 4 Sustainability Index of Social Dimensions for Each Type of Urban Agriculture

Types	Sustainability Index
1 Irrigated agricultural land	63,37
2 Rainfed dryland farming	79,04
3 Recreational activity	68,4
4 Community gardening	72,75
5 Commercial farming	56,83
6 Agro-educational tourism	86,86
7 Institution	53,23

Source: Primary Data (2025)

Shows in table 4, The most sustainable type in the social dimension is agro-edutourism agriculture (86.86%), while the type of agriculture organized by institutions has the lowest value in the moderately sustainable category (53.23%). The high level of social sustainability in the agro-educational tourism type is the influence of local leaders, and the strong multifunctionality of urban agriculture. In addition to food production, this type contributes to various social benefits, such as

strengthening community cooperation, supporting mental well-being, improving access to fresh food, and creating employment opportunities. Meanwhile, institutional farming falls into the fairly sustainable category in the social dimension. This is primarily due to limited interaction with surrounding communities and the relatively low involvement of women in institutional urban agriculture activities.

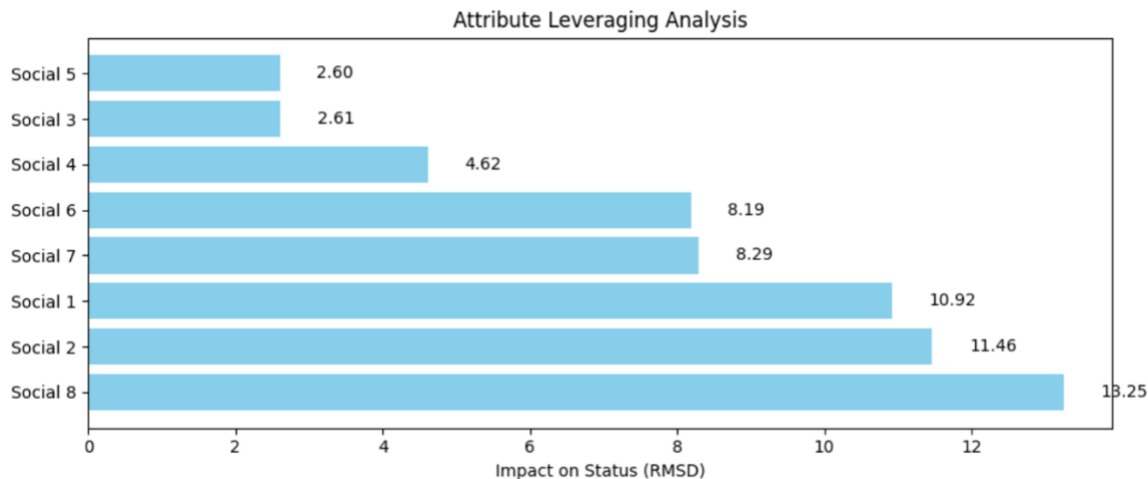


Figure 4 Leverage Analysis of the Social Dimension
Source: Primary Data, 2025

Table 5 Leverage Values of Each Attribute in the Social Dimension

Attribute	Index
Social 1 Educational background of farmers	10,92
Social 2 Average age of urban farming practitioners	11,46
Social 3 Interaction with fellow urban farmers	2,611
Social 4 Influence of local leaders or community figures	4,61
Social 5 Conflicts with the surrounding community regarding urban farming practices	2,60
Social 6 Magnitude of complaints' impact on urban farming activities	8,18
Social 7 Role of women in urban farming	8,29
Social 8 Other observed social impacts	13,24

Source: Primary Data, 2025

Three attributes (Figure 4) that significantly influence the sustainability of the social dimension are (Table 5) multifunctional urban agriculture (13.24) and demographic conditions, namely the average age of practitioners (11.46) and educational background (10.92). In addition to improving food access, urban agriculture also has social and economic impacts, commonly referred to as multifunctionality. It not only contributes to food security but also plays a significant role in strengthening community relationships and promoting inclusive urban development. Studies in cities such as Vancouver (Valley & Wittman, 2019) and Baltimore (Poulsen, Neff, & Winch, 2017) have shown that urban agriculture contributes to enhancing social cohesion, improving the quality of living environments, advancing education, and expanding employment opportunities, especially in underserved areas. Furthermore, these benefits often extend beyond individual households, fostering Sustainability Status Assessment of Urban Agriculture Types in Malang City (Prasundari., et al, 2026)

collective action and community empowerment. Regarding age and educational background, research conducted by Bang & Han, (2025) in South Korea found that farmers under the age of 30 with higher education levels have a strong desire to adopt new agricultural technologies as innovative solutions for improving their farming practices. This indicates the importance of demographic factors in shaping the adaptability and sustainability of urban agriculture systems.

Economic Dimension Sustainability Status

The economic sustainability of urban agriculture in Malang City varies considerably (Figure 5), with practices falling into two main categories: less sustainable (such as recreational activities and community gardening) and fairly sustainable types (Table 6). This variation reflects the different levels of economic performance and capacity across the urban farming typologies.

Urban agriculture types categorized as moderately sustainable—such as commercial farming, agro-educational tourism, and institutional farming—demonstrate relative economic potential through income generation, employment opportunities, or access to markets. In contrast, recreational activities and community gardening are positioned closer to the "BAD" quadrant, indicating limited economic contribution, likely due to their non-commercial orientation. Conversely, irrigated agricultural land and rain-fed dryland farming appear slightly more economically sustainable, possibly due to their role as household income. The placement of the "UP" marker near irrigated and rain-fed types suggests that strengthening key economic attributes could play a significant role in improving their overall sustainability.

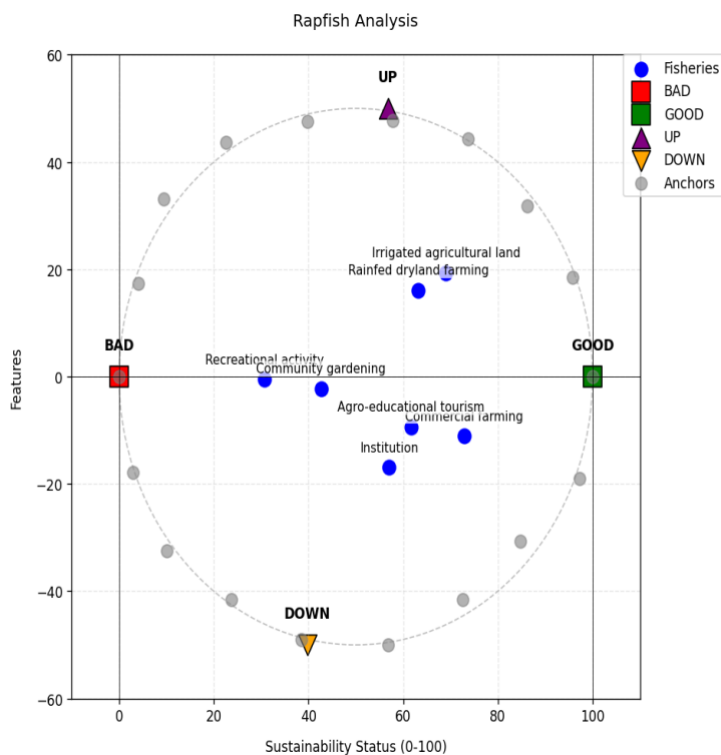


Figure 5 Sustainability Index of Economy Dimension
 Source: Primary Data (2025)

Table 6 Sustainability Index of Economy Dimensions for Each Type of Urban Agriculture

Types		Sustainability Index
1	Irrigated agricultural land	69,08
2	Rainfed dryland farming	63,19
3	Recreational activity	30,72
4	Community gardening	42,65
5	Commercial farming	72,82
6	Agro-educational tourism	61,68
7	Institution	57,07

Source: Primary Data (2025)

The sustainability of the economic dimension of urban agriculture in Malang City is greatly influenced by productivity related factors (Table 7), particularly the time spent by practitioners on urban agriculture activities (12.93), the use of high-quality seeds (8.96), and profitability (8.42). This is similar to the findings of a study conducted on Pekarangan Pangan lestari in Semarang City. Research conducted by Adi Nugraha & Ekowati, (2024) emphasized that the Pekarangan Pangan Lestari in Semarang City is also greatly influenced by the time spent by farmers on activities. These findings align with those of FAO et al., (2022), which emphasize that increasing productivity and profitability are key to the sustainability of urban agriculture. However, productivity-particularly in terms of time allocation- present a unique challenge. It is undeniable that for many urban agriculture practitioners, the primary motivation is recreational or voluntary engagement rather than economic gain. This tendency is particularly evident among recreational and community gardening types.

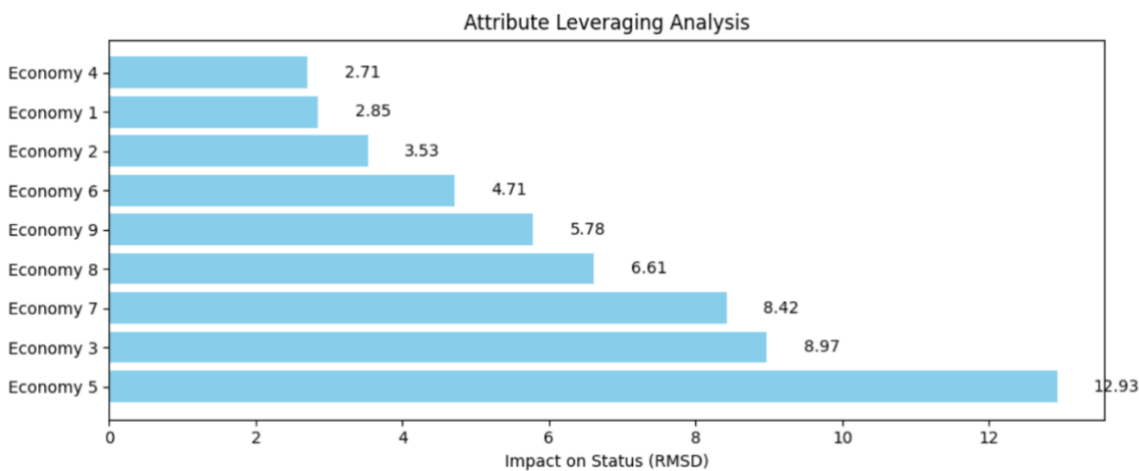


Figure 6 Leverage Analysis of the Economy Dimension
Source: Primary Data (2025)

Table 7 Leverage Values of Each Attribute in the Economy Dimension

Attribute		Index
Economy 1	Post-harvest activities	2,85
Economy 2	Other supplementary activities related to farming	3,53
Economy 3	Use of high-quality seeds	8,96
Economy 4	Number of planting seasons per year	2,71

Economy 5	Time allocation for urban farming activities	12,93
Economy 6	Access to markets	4,71
Economy 7	Profitability	8,42
Economy 8	Access to capital or financial support	6,61
Economy 9	Government subsidies for urban farming activities	5,78

Source: Primary Data (2025)

Institutional Dimension Sustainability Status

Table 8 Sustainability Index of institutional dimension

Types		Sustainability Index
1	Irrigated agricultural land	52,22
2	Rainfed dryland farming	54,27
3	Recreational activity	27,9
4	Community gardening	49,39
5	Commercial farming	44,92
6	Agro-educational tourism	63,58
7	Institution	36,39

Source: Primary Data (2025)

The analysis (table 8) revealed that three types of urban agriculture—agro-educational tourism (63.58%), rainfed dryland farming (54.27%), and irrigated agricultural land (52.22%)—are classified as moderately sustainable within the institutional dimension. This indicates that while institutional support structures are in place, there is still room for improvement to enhance the resilience and governance of these farming systems. On the other hand, community gardening (49.39%), commercial farming (44.92%), institutional farming (36.39%), and recreational activity (27.90%) fall into the less sustainable category, suggesting weaker institutional frameworks, limited support, or insufficient coordination among stakeholders.

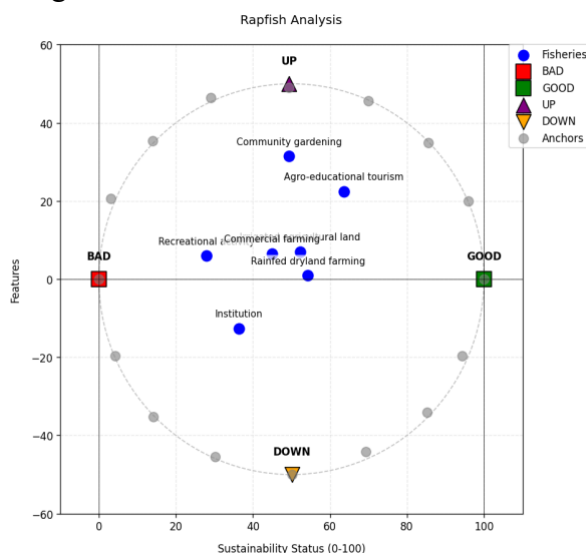


Figure 7 Sustainability Index of Institutional Dimension

Source: Primary Data (2025)

Figure 7 shows that most types of urban agriculture in Malang City fall within the moderately sustainable range in the institutional dimension. Community gardening and agro-educational tourism demonstrate that key factors play a highly significant role in supporting institutional sustainability. In contrast, for the institutional type, these key factors appear to have minimal influence on enhancing sustainability within the institutional dimension.

The most influential attributes affecting the sustainability status in this dimension include the role of groups or organizations that support and facilitate urban agriculture activities (15.15), the extent of collaboration with private sector entities and/or academic institutions (12.99), and the intensity of extension services provided by agricultural extension institutions (12.65). These factors play a critical role in ensuring continuity, capacity-building, and integration of urban agriculture into broader institutional systems. These findings are supported by the study of Zuwita, Yuliati, & Mubarakah, (2023), which underscores that enhanced communication and coordination among organizations can lead to significant positive outcomes in the implementation and sustainability of urban farming initiatives, as evidenced in the case of Surabaya.

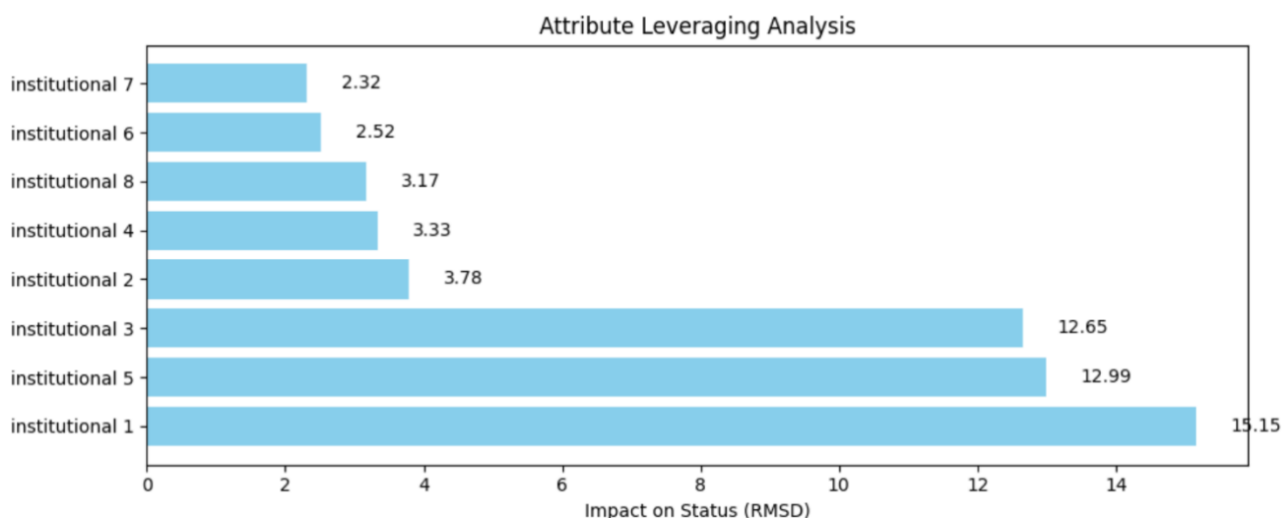


Figure 8 Leverage Analysis of the Institutional Dimension
Source: Primary Data (2025)

Table 9 Leverage Values of Each Attribute in the Institutional Dimension

Attribute	Index
institutional 1	15,15
institutional 2	3,78
institutional 3	12,65
institutional 4	3,33
institutional 5	12,99
institutional 6	2,52
institutional 7	2,31
institutional 8	3,17

Source: Primary Data (2025)

Technology Dimension Sustainability Status

The analysis shows that the technological sustainability of urban agriculture in Malang ranges from unsustainable to moderately sustainable. Recreational-type urban farming was identified as the least sustainable, with a score of 21.77% in the technological dimension. Meanwhile, institutional farming (33.14%), rainfed dryland farming (38.29%), and irrigated agricultural land (43.91%) fall under the less sustainable category. In contrast, community gardening (51.57%), commercial farming (64.31%), and agro-educational tourism (67.53%) are considered moderately sustainable in terms of technological adoption and support (Table 10)

Table 10 Sustainability Index of Technology Dimension

	Types	Sustainability Index
1	Irrigated agricultural land	43,91
2	Rainfed dryland farming	38,29
3	Recreational activity	21,77
4	Community gardening	51,57
5	Commercial farming	64,31
6	Agro-educational tourism	67,53
7	Institution	33,14

Source: Primary Data (2025)

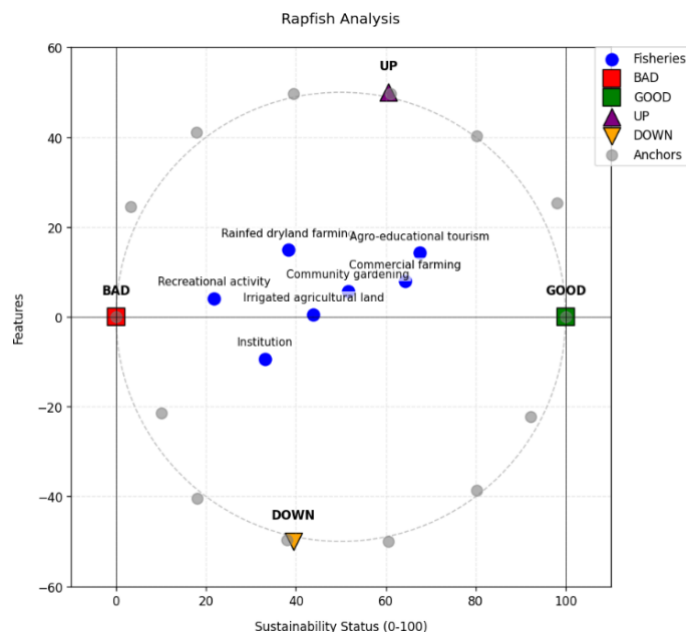


Figure 9 Sustainability Index of Technology Dimension

Source: Primary Data (2025)

Figure 9 illustrates the sustainability index of urban agriculture types within the technological dimension. Most types fall into the moderately sustainable category, with scores clustered around the mid-range of the scale. Commercial farming, community gardening, rainfed dryland farming, and agro-educational tourism show relatively higher sustainability scores in the technological dimension, indicating the adoption of certain technological tools or access to agricultural information platforms. In contrast, institutional farming has the lowest score in this dimension, positioned near the “DOWN” quadrant, suggesting limited access to or implementation of technological innovations—particularly in the use of information technology. Irrigated agricultural land and recreational activities are also situated closer to the lower-middle range, implying conventional practices with minimal use of technology. The spatial distribution indicates that agriculture types driven by educational or commercial purposes are more likely to adopt technology, while traditional or institution-based systems face challenges in accessing or implementing relevant technologies.

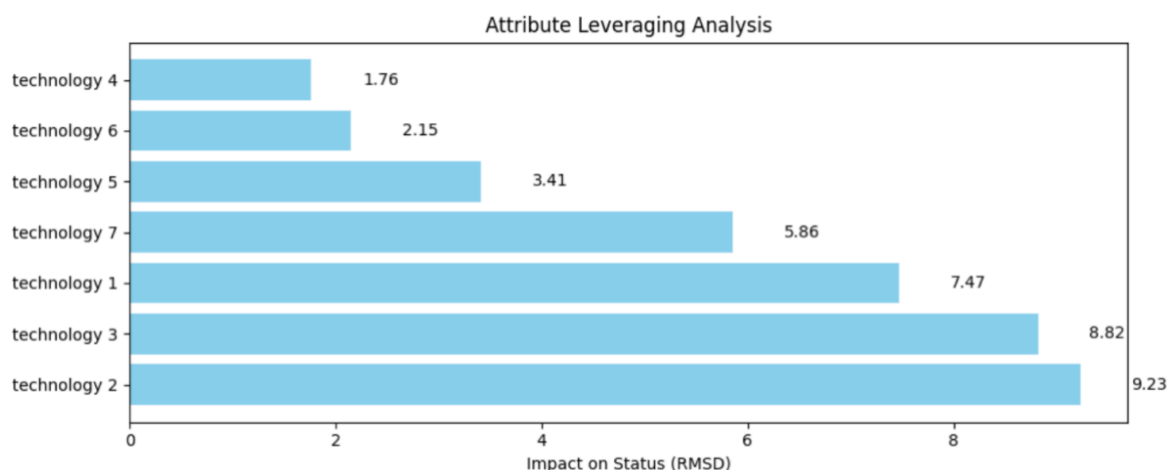


Figure 10 Leverage Analysis of the Technology Dimension
Source: Primary Data (2025)

Figure 10 and table 11 shows the key technological attributes that have the greatest influence on the sustainability of urban agriculture are the application of the Internet of Things (IoT) to support automation (9.23), accessing agricultural information via the internet or smartphones (8.82), and implementing technologies adapted to urban conditions (7.47). Using internet-based technologies for automation and information access in urban farming serves as a valuable tool for enhancing agricultural development. This utilisation is particularly effective in improving the efficiency with which resources are used for activities such as crop monitoring, pest and disease control, and other precision farming practices. Consequently, it improves accuracy and reduces resource wastage (Yuan et al., 2022).

Table 11 Leverage Values of Each Attribute in the Technology Dimension

	Attribute	Index
technology 1	Application of technology appropriate for urban conditions	7,47
technology 2	Implementation of Internet of Things (IoT) in farming	9,23

	Attribute	Index
technology 3	Use of internet, smartphones, or information technology to access agricultural information	8,82
technology 4	Government facilitation of access to urban farming technology training and education	1,76
technology 5	Government facilitation of access to urban farming technology subsidies	3,41
technology 6	Application of waste management technologies in urban agriculture	2,15
technology 7	Implementation of fertilizer production technologies	5,86

Source: Primary Data (2025)

An integrated analysis of all sustainability dimensions—ecological, social, economic, technological, and institutional—reveals interrelated patterns that shape the overall performance of urban agriculture types in Malang City. Types such as agro-educational tourism and commercial farming consistently demonstrate relatively high sustainability scores across most dimensions. This indicates that multifunctional purposes—such as combining food production with education or commercial value—are more resilient and adaptive, supported by ecological practices like environmentally friendly farming, adoption of information and urban-adaptive technologies, and institutional collaboration. In contrast, types such as institutional and recreational farming show uneven sustainability, often underperforming in the technological and institutional dimensions. Institutional farming remains limited in stakeholder involvement, primarily relying on extension agencies and policymakers. Meanwhile, hobby-based farming, being focused solely on personal fulfillment, shows low levels of technology use. Notably, ecological and technological improvements tend to have a reinforcing effect on economic outcomes, while strong social and institutional engagement can enhance the success of sustainable practices. Therefore, achieving balanced progress across all dimensions is essential for strengthening the long-term viability of urban agricultural systems.

CONCLUSION AND SUGGESTION

The sustainability status of urban agriculture types in Malang City in the ecological dimension is categorized as unsustainable (irrigated agricultural land), less sustainable (rainfed dryland farming and institutional), and moderately sustainable (recreational activity, agro-educational tourism, community gardening, and commercial farming). Attributes that significantly influence the sustainability status of the ecological dimension include the implementation of integrated farming, the use of local crops, and the application of integrated pest and disease management.

In the social dimension, the three types of urban agriculture in Malang City—agro-educational tourism, rain-fed dryland farming, and community gardening—are categorized as sustainable. Meanwhile, the other four types (recreational activity, irrigated agricultural land, commercial farming, and institutions) are categorized as moderately sustainable. Attributes sensitive to changes in the sustainability status of the social dimension of agriculture include the diversity of urban agricultural functions, average age, and educational background.

In the economic dimension, urban agriculture in Malang City is divided into two categories: less sustainable (recreational activity and community gardening) and moderately sustainable (commercial farming, irrigated agricultural land, rainfed dryland farming, and institutions). The time spent on urban agricultural activities, the use of high-quality seeds, and profitability are the three main attributes sensitive to economic dimension sustainability status.

Meanwhile, the institutional dimension of sustainability describes how stakeholder involvement and governance structures influence sustainability outcomes. It shows sustainability in the institutional dimension is divided into two groups, namely the type of agriculture in the moderately sustainable category (agro-educational tourism, rain-fed dryland farming, and irrigated agricultural land) and the less sustainable category (community gardening, commercial farming, institutions, and recreational activities). Meanwhile, the sustainability status of urban agriculture in the technological dimension, the types of agriculture in Malang City are grouped into the moderately sustainable category (community gardens, commercial farming, and agro-educational tourism), less sustainable (institutions, rain-fed dryland farming, and irrigated agricultural land), and unsustainable (recreational activities). Attributes that significantly influence the sustainability status of the technological dimension include the application of the Internet of Things to support automation, the use of the internet/smartphones to access agricultural information, and the adoption of technologies suited to urban agricultural conditions.

Based on the number of sustainability dimension In which each type of urban agriculture performs well, agro-educational tourism emerges as the most sustainable type compared to the others. This followed consecutively by commercial farming, rain-fed dryland, community gardening, irrigated agricultural land, institutional farming, and lastly, recreational farming. The ranking reflects the extent to which each type demonstrates balanced performance across ecological, social, economic, technological, and institutional dimension.

The results are expected to serve as a consideration for stakeholders in developing urban agriculture policies that are oriented toward sustainability from ecological, social, economic, institutional, and technological perspectives. Particular attention should be given to the sensitive factors within each dimension. Investing in critical attributes a dengan inicross all dimensions hold the key to unlocking the full potential of urban agriculture in shaping a more sustainable and livable Malang City.

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