



# Multidimensional Assessment and Policy Strategies for Enhancing Sustainable Urban Agriculture in Makassar, Indonesia

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## Keywords

Urban Agriculture, Sustainability Assessment, Prospective Analysis, Interdependency Analysis, Policy Strategy, Makassar City, Indonesia.

Urban agriculture (UA) has been recognised as an important strategy for promoting sustainable urban development by integrating food production, environmental management, and socio-economic resilience. The objective of this study is to evaluate the multidimensional sustainability of UA in Makassar City, Indonesia, and to formulate policy strategies to enhance its long-term sustainability. Data were obtained through expert discussions and semi-structured interviews with 23 purposively selected stakeholders, including academics, practitioners, urban planners, legislators, and government officials. A Multidimensional Scaling (MDS) approach was utilised to compare sustainability indices from two previous studies, complemented by prospective and interdependence analyses to identify key leverage factors influencing UA development. The results indicate that the overall sustainability status of UA in Makassar during the 2016–2020 period remains less sustainable, with a multidimensional sustainability index of 43.02%. The ecological dimension (51.84%) and the technological dimension (65.09%) exhibited enhancements, attaining a moderately sustainable status. In contrast, the economic (46.15%), social (49.81%), and institutional (39.20%) dimensions exhibited declining sustainability performance. These findings underscore the necessity for enhanced governance and integrated policy support to ensure balanced development across sustainability dimensions. The analysis yielded three strategic policy directions: (1) The enhancement of UA planning and management systems, (2) the improvement of institutional coordination among stakeholders, and (3) the augmentation of the socio-economic and environmental functions of UA. The study provides empirical insights for policymakers in designing integrated and context-specific strategies to promote sustainable UA in rapidly growing tropical cities.

## 1. Introduction

Urban areas are increasingly characterised by rapid development driven by population growth, urbanisation, industrial expansion, and infrastructure development. While these processes stimulate economic progress, they also generate complex social, economic, and environmental challenges. Escalating pressure on urban land resources, environmental degradation, and widening socio-economic disparities have become major concerns for many rapidly expanding cities. Consequently, sustainable urban management has become a key priority in addressing these challenges.

Within the global development agenda, the concept of sustainable cities has gained increasing attention, particularly through the framework of the Sustainable Development Goals (SDGs). Goal 11 emphasises the importance of developing cities that are inclusive, safe, resilient, and sustainable (UNDP, 2025). The concept of sustainability highlights the need to meet present needs without compromising the ability of future generations to meet their own needs, while maintaining a balance between economic growth, social welfare, and environmental protection (Bhattarai & Adhikari, 2023; Sampeliling, 2012).

Urban agriculture (UA) has emerged as a strategic approach to addressing sustainability challenges in urban environments. UA generally refers to the cultivation of crops, livestock, and aquaculture within or around urban areas, including related activities such as processing, distribution, marketing, and the recycling of organic waste (FAO, 2025; Papanek, Campbell, & Wooten, 2023). Beyond its role in food production, UA is increasingly recognised as a multifunctional system that contributes to economic resilience, environmental sustainability, and social well-being in urban communities (Gray, Elgert, & WinklerPrins, 2020; Pradhan et al., 2023).

A growing body of literature highlights the multiple benefits of UA. From an economic perspective, UA has the capacity to enhance household income and facilitate the development of alternative livelihood opportunities for urban residents (Grover & Wahee, 2013; Güneralp et al., 2020). Socially, it enhances food and nutrition security by providing locally produced food and supporting nutritional diversity, particularly for low-income households (Orsini et al., 2020; Serbessa, Makonnen, & Abi, 2023; Specht et al., 2014). From an environmental perspective, the expansion of green spaces, enhancement of urban biodiversity, and recycling of organic waste into

compost (Jasionkowski & Lewandowska-Czarnecka, 2016; Pradhan et al., 2023). In addition, UA has been demonstrated to enhance community interaction, encourage collective learning, and raise public awareness of environmental stewardship (Khosravi et al., 2022; Popartan et al., 2023; Russ & Gaus, 2021).

Despite these potential benefits, the development of UA often faces a range of structural challenges, including limited technical capacity, unstable production systems, restricted access to urban land, and insufficient institutional support (Caputo, Schoen, & Blythe, 2023; Yuan et al., 2022). These challenges indicate that the sustainability of UA systems depends on complex interactions among ecological, economic, social, technological, and institutional factors.

Makassar City, the capital of South Sulawesi Province, Indonesia, is a rapidly growing metropolitan area experiencing significant urban transformation. Continuous infrastructure expansion, coupled with a population growth rate of approximately 0.71% per year, has resulted in heightened pressure on urban resources and ecological systems (BPS-Statistics of Makassar Municipality, 2024). These dynamics have also given rise to concerns regarding urban food security, environmental quality, and socio-economic inequality. In this context, urban agriculture has been recognised as a potential adaptive strategy to strengthen urban food systems while optimising the utilisation of limited urban resources (Serbessa et al., 2023; Walters & Stoelzle Midden, 2018; Yalaw, 2020; Yan et al., 2022).

However, despite the growing global interest in UA, empirical studies evaluating its multidimensional sustainability performance and policy leverage factors remain limited, particularly in rapidly growing tropical metropolitan areas in developing countries such as Indonesia. An understanding of how ecological, economic, social, technological, and institutional dimensions interact to influence the sustainability of UA is therefore essential for informing effective urban development policies.

The objective of this study is to assess the multidimensional sustainability of UA in Makassar City by analysing ecological, economic, social, technological, and institutional dimensions. In addition, the study identifies key leverage factors influencing sustainability performance and formulates policy strategies to support the development of sustainable UA in Makassar City, South Sulawesi, Indonesia.

## 2. Research Methods

### 2.1. Description of Research Location

This study was conducted in Makassar City, the capital of South Sulawesi Province, Indonesia. Makassar is one of the fastest-growing metropolitan areas in eastern

Indonesia and plays a strategic role as an economic and administrative hub in the region. In 2024, the city had an estimated population of approximately 1,477,860 inhabitants, with a population density of 8,408 persons per square kilometre within a total area of 175.77 km<sup>2</sup> (BPS-Statistics of Makassar Municipality, 2024).

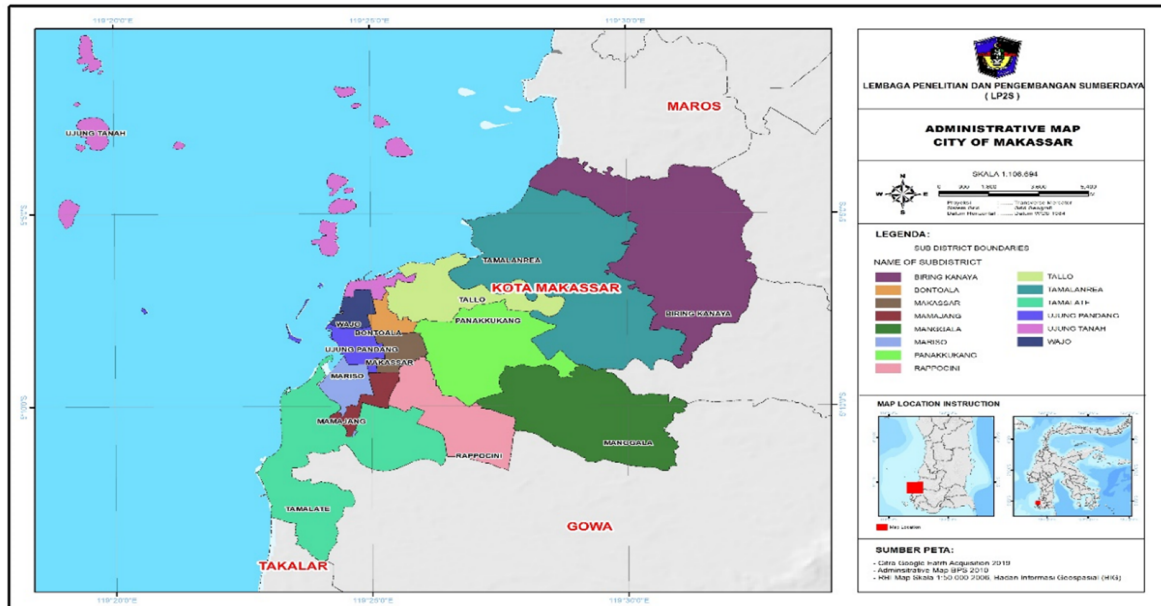


Figure 1: Map of Makassar City and Research Location.

Rapid urbanisation and infrastructure expansion have intensified pressure on urban land resources and ecological spaces in Makassar. Currently, green open space constitutes a mere 9.7% of the total urban area, a proportion significantly below that recommended for sustainable urban environments (30%). These conditions highlight the importance of alternative strategies for improving urban environmental quality and strengthening local food systems.

Makassar City experiences a tropical climate characterised by relatively high temperatures ranging from 20.1°C to 34.6°C, which allows agricultural activities to be carried out throughout the year. The city is geographically bordered by Maros Regency to the north and east, Gowa Regency to the south, and the Makassar Strait to the west.

In addition to environmental challenges, Makassar has experienced relatively strong economic growth, reaching 5.56% in 2024, exceeding the provincial average of South Sulawesi. However, the open unemployment rate remained relatively high at 9.71% (BPS-Statistics of Makassar Municipality, 2024). The socio-economic conditions prevailing in these areas provide a significant context for the examination of the potential role of UA as a strategy

for improving food security, strengthening community livelihoods, and enhancing urban sustainability.

### 2.2. Analysis of Sustainability Potential

The sustainability potential of UA development in Makassar City was analysed using secondary data derived from two previous studies conducted by Abdullah (2016) and Wisneni, Abdullah, & Boceng (2020). Both studies spanned a four-year assessment period and employed the same set of sustainability attributes and analytical procedures based on a Multi-Dimensional Scaling (MDS) approach.

The analytical framework utilised in this study constitutes a modification of the RAPFISH (Rapid Appraisal for Fisheries) technique, which was developed by the Fisheries Centre, University of British Columbia, Canada (Kavanagh & Pitcher, 2004). This approach has been widely applied to evaluate sustainability across multiple dimensions and to identify key leverage attributes influencing system performance. The analysis was performed using RALED SBH (Rapid Assessment Techniques for Local Economic Development) software to estimate the sustainability index and determine the

sustainability status across different dimensions. Sensitive attributes influencing sustainability performance were identified through leverage analysis based on changes in the Root Mean Square (RMS) value along the MDS ordination axis (Abdullah, 2016; Budiharsono, 2007; Sampeliling et al., 2012; Wisneni et al., 2020).

The analytical procedure comprised five principal stages: (1) Attribute scoring is conducted using questionnaire-based assessments with an ordinal scale ranging from 0 to 3, where 0 represents the worst condition and 3 represents the best condition. (2) MDS ordination is utilised in the calculation of the sustainability index for each dimension. The sustainability status was classified into four categories: unsustainable (0–25), less sustainable (25.01–50), moderately sustainable (50.01–75), and highly sustainable (75.01–100). (3) Leverage analysis is a method of identifying the most influential attributes based on changes in the Root Mean Square (RMS) value. (4) Monte Carlo simulation was conducted to evaluate the stability of the MDS results and to assess potential estimation errors at a 95% confidence level (Budiharsono, 2007; Pitcher & Preikshot, 2001). (5) Model validation was evaluated using the S-Stress value (<0.25) and the coefficient of determination ( $R^2 > 0.95$ ). These indicators are widely accepted as reliable measures of the reliability of the ordination model in explaining data variability (Budiharsono, 2007; Kavanagh & Pitcher, 2004; Sampeliling et al., 2012).

A comparative analysis was conducted between the two studies to identify changes in sustainability index values and sustainability status across five main dimensions: ecological, economic, social, technological, and institutional.

### 2.3. Prospective and Need Analysis

Primary data were collected through semi-structured interviews and questionnaires administered to selected experts and stakeholders. In addition, focus group discussions (FGDs) were conducted to obtain a deeper understanding of stakeholders' perceptions, priorities, and requirements related to the sustainability of UA in Makassar City. A total of 23 respondents were purposively selected based on their expertise and institutional roles in areas relevant to urban agriculture development, including agricultural sociology, urban agriculture, parks and green space management, urban planning and regulation, environmental management, legislative institutions, city government, and agricultural extension services.

A needs analysis was conducted to identify the main strategic requirements for strengthening the sustainability of UA in Makassar. Information obtained from interviews and focus group discussions (FGDs) served as the basis for identifying stakeholders' key priorities and development needs (Hidayanto et al., 2009; Sampeliling, 2012). In order to further analyse the strategic factors influencing UA sustainability, a prospective analysis was applied. The objective of this method is to identify the key driving factors that influence the future development of the system (Sampeliling et al., 2012). The analysis integrates two sources of information: (1) sensitive attributes identified in the sustainability analysis and (2) stakeholders' priority needs obtained from the needs assessment.

The level of influence between factors was assessed by experts using a scoring scale based on prospective analysis guidelines, where 0 = indicates no influence, 1 = indicates weak influence, 2 = indicates moderate influence, and 3 = indicates strong influence. The resulting influence matrix was utilised to identify key variables through influence-dependence analysis, thereby unveiling the relationships between factors affecting the sustainability potential of UA (Bourgeois & Jésus, 2004; Sampeliling, 2012; Sampeliling et al., 2012).

### 2.4. Interdependency Analysis

The interdependency relationships among the key factors influencing the sustainability of UA were analysed using influence-dependence analysis based on prospective structural analysis. This method is employed to identify the relative position of each factor within the system and to determine its strategic importance for policy formulation.

The analysis was conducted by mapping the factors into a two-dimensional influence-dependence matrix. The horizontal axis (X-axis) is representative of the degree to which a factor influences the system, whilst the vertical axis (Y-axis) is indicative of the degree to which a factor is dependent on other factors.

In accordance with their position within the matrix, the factors are classified into four quadrants (Bourgeois & Jésus, 2004; Santoso, 2015), namely: Quadrant I (Driving factors) is characterised by factors that exert a significant influence yet demonstrate a low degree of dependence. These variables play a crucial role in determining system dynamics and often serve as key drivers of change. Quadrant II (linkage factors) is characterised by factors that exhibit both high influence and high dependence. These factors interact with one another within the



system and are frequently unstable, meaning that any change in these variables may strongly affect other system components. Quadrant III (dependent factors) is characterised by factors that, despite their low level of influence, exhibit a high degree of dependence. These variables are found to be strongly influenced by other factors; however, their capacity to effect alterations to the system is comparatively limited. Quadrant IV (Autonomous factors) is characterised by factors that exhibit both a low degree of influence and low degree of dependence. These variables are relatively disconnected from the system and have limited strategic importance.

Factors located in Quadrants I and II are considered the most strategic variables and serve as the basis for formulating alternative policy models and development strategies aimed at enhancing the sustainability of UA in Makassar City, South Sulawesi.

### 3. Results and Discussion

#### 3.1. Potential for Urban Agriculture Development in Makassar City

The simulation results of the potential sustainability of UA in Makassar City, South Sulawesi, during the 2016–2020 period indicate that the analytical model has a high level of validity. The coefficient of determination ( $R^2$ ) ranged from 0.93 to 0.96, while the stress (S) values ranged from 0.13 to 0.17, which is far below the acceptable threshold of 0.25 (see Table 1). In accordance with the criteria proposed by Bourgeois & Jésus (2004), an  $R^2$  value exceeding 0.90 indicates that the model provides a strong representation of the analysed system. The findings of this study indicate that the model has satisfactory capacity and can represent the sustainability conditions of the UA system.

**Table 1:** Potential of UA Sustainability in Makassar City in 2016 and 2020.

Dimensions of Sustainability	Sustainability Index (%)							
	2016				2020			
	MDS	Stress	$R^2$	Description	MDS	Stress	$R^2$	Description
Ecology	42,66	0,14	0,95	Less Sustainable	51,84	0,16	0,93	Sustainable Enough
Economics	50,69	0,15	0,95	Sustainable Enough	46,15	0,15	0,93	Less Sustainable
Social	51,29	0,14	0,95	Sustainable Enough	49,81	0,17	0,94	Less Sustainable
Technology	44,69	0,15	0,94	Less Sustainable	65,09	0,14	0,95	Sustainable Enough
Institutions	51,04	0,15	0,95	Sustainable Enough	39,20	0,15	0,95	Less Sustainable
Multidimensional	<b>48,52</b>	<b>0,13</b>	<b>0,96</b>	<b>Less Sustainable</b>	<b>43,02</b>	<b>0,13</b>	<b>0,96</b>	<b>Less Sustainable</b>

Source: Research Results in 2016 (Abdullah, 2016) and 2020 (Wisneni et al. 2020)

The comparison between the two assessment periods indicates that the overall sustainability performance of UA in Makassar City shows a declining trend. The multidimensional sustainability index demonstrated a decline from 48.52% in 2016 to 43.02% in 2020, indicating that the system was within the less sustainable category. This finding lends support to the argument that the sustainability performance of UA may fluctuate over time depending on changing environmental, social, and economic conditions (Eiter, Fjellstad, & Van Schaik, 2025).

Despite this decline, UA continues to play an important role in urban systems. Previous studies have demonstrated that UA contributes not only to food production but also to public health, livelihood opportunities, social interaction, urban green infrastructure, biodiversity conservation, and environmental improvement (Pradhan et al., 2023; Yuan et al., 2022). In numerous developing countries, UA has also demonstrated significant socio-economic benefits for urban communities (Fei et al., 2025; Tapia et al., 2021).

However, the results of this study indicate that the sustainability of UA in Makassar still requires

strategic policy interventions. Government support, infrastructure provision, community capacity building, and environmentally responsible behaviour are all essential factors for strengthening the sustainability of UA practices (Dewi et al., 2023; Hanifa et al., 2023; Yuan et al., 2022). The multidimensional analytical framework applied in this study highlights the complex interactions among ecological, economic, social, technological, and institutional dimensions in shaping UA development (Fei et al., 2025).

A more detailed analysis of the individual dimensions indicates the presence of different sustainability. The ecological and technological dimensions have shown notable improvements, moving from the less sustainable category in 2016 to a moderately sustainable status in 2020. These improvements suggest that greater attention has been given to environmentally oriented practices and technological innovation in UA development. The ecological contribution of UA is reflected in the expansion of urban green spaces, increased environmental awareness among communities, the development of urban gardening activities, and the utilisation of organic waste for compost production. These contributions suggest that UA has the

potential to enhance the ecological functions of urban environments and support environmental sustainability in the long term.

Technological innovation also plays a significant role in improving the efficiency and resilience of UA systems. The integration of technologies such as hydroponics, vertical gardening, aquaponics, rooftop farming, and organic cultivation systems facilitates the optimisation of limited urban space while ensuring environmental sustainability. These innovations are increasingly recognised as key drivers of modern UA systems (Fei et al., 2025).

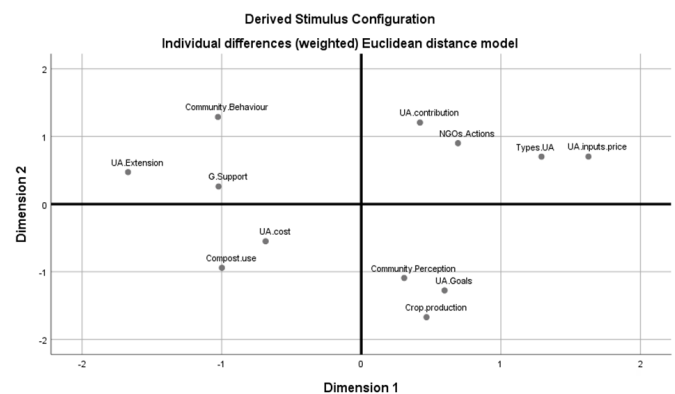
In contrast, the economic, social and institutional dimensions demonstrate a decline in sustainability performance. Between 2016 and 2020, the sustainability index demonstrated a decline of 4.54% in the economic dimension, 1.48% in the social dimension, and 11.84% in the institutional dimension. This decline indicates that the development of UA in Makassar City has not yet resulted in substantial economic and social benefits for urban communities.

The limited integration of UA activities with local economic systems and community development programmes may provide a possible explanation for this trend. In many cases, UA initiatives remain small-scale and are not yet integrated into broader urban economic structures. Furthermore, institutional support and stakeholder coordination appear to have weakened during the observed period. It is evident from previous studies that strong institutional frameworks, supportive policies, and cross-sector collaboration are critical factors in ensuring the sustainability of UA initiatives (Indraprahasta, 2013; Qasemi et al., 2023; Yuan et al., 2022).

The survey results and expert assessments further indicate that several institutional actors play important roles in supporting the sustainability of UA in Makassar City, including the city government, relevant government agencies, UA communities, agricultural extension services, and non-governmental organisations. Strengthening collaboration and coordination among these institutions is therefore essential for creating a more adaptive, inclusive, and sustainable UA system. Overall, the findings indicate that improvements in ecological and technological dimensions alone are insufficient to ensure the long-term sustainability of UA. In order to support a resilient and sustainable UA system in Makassar City, it is necessary to achieve balanced development across the economic, social, and institutional dimensions.

### 3.2. Determinants of Urban Agriculture Sustainability in Makassar City

A prospective analysis was conducted to identify the key determinants influencing the sustainability of UA in Makassar City, as well as the fundamental needs of relevant stakeholders. The analysis identified twelve key factors that significantly influence the sustainability of UA development. These factors are as follows: (1) utilisation of organic waste and compost in UA systems, (2) availability and access to capital, (3) public perception of UA, (4) clarity of UA development objectives, (5) crop productivity levels, (6) community behaviour in supporting UA practices, (7) strengthening the role of agricultural extension institutions, (8) government institutional support, (9) the contribution of UA to household needs, (10) involvement and assistance from non-governmental organisations (NGOs), (11) effectiveness of urban open-space planning and utilisation, and (12) prices of agricultural production inputs.



**Figure 2:** Illustrates the Relationships and Levels of Interdependence among the twelve Key Sustainability Factors in Makassar City, South Sulawesi.

The findings of this study indicate that the sustainability of UA in Makassar City is determined not only by technical aspects of production but also by interacting social, institutional, and economic factors. Consequently, endeavours to enhance the sustainability of UA necessitate an integrative approach, encompassing collaboration between communities, government institutions, and the private sector in the domains of resource management, technological innovation, and the formulation of sustainable supporting policies.

Based on the interdependency analysis, the factors are distributed across four analytical quadrants representing different levels of influence and dependence within the UA sustainability system. The analysis identified seven key factors in Quadrants I and II, indicating their

strategic importance in determining the direction of UA development. The remaining five factors are distributed across Quadrants III and IV (see Figure 2).

In Quadrant I, three key factors demonstrate a high level of influence but relatively low dependence, indicating their role as primary driving forces in the sustainability system. The factors contributing to this phenomenon include community behaviour in supporting UA practices, government institutional support, and the strengthening of agricultural extension services. The significant impact of these factors highlights the importance of behavioural change, institutional commitment, and knowledge dissemination in promoting sustainable UA.

Meanwhile, Quadrant II contains four factors characterised by both high influence and high interdependence, meaning that these factors are closely interconnected and jointly determine the sustainability performance of UA systems. The factors under consideration include the price of agricultural production inputs, the effectiveness of urban open-space planning and utilisation, the role of environmental non-governmental organisations (NGOs), and the contribution of UA to household needs. Their strategic position indicates that improvements in one factor may generate cascading effects on other elements of the system.

The key factors located in Quadrants I and II therefore represent critical leverage points for policy intervention and strategic planning. The enhancement of these factors has the potential to significantly contribute to the sustainability of UA development in Makassar City. Moreover, the functional relationships among these determinants provide the basis for developing an integrated policy framework that combines social, institutional, economic, and environmental dimensions in order to strengthen the resilience and long-term sustainability of UA systems.

### 3.3. Policy Instrument of Urban Agriculture

Urban areas are defined as agro-ecosystems and socio-economic entities that exhibit fundamentally different characteristics compared to rural areas, particularly in terms of spatial planning, resource availability, and institutional framework. Consequently, the form and performance of agricultural development policies in urban areas tend to differ from those in rural areas (Abdullah, 2016). The sustainable management of UA has been demonstrated to provide multifunctional benefits and contribute significantly to achieving sustainable urban development (Orsini et al., 2020; Yuan et al., 2022).

In recent years, UA has also been increasingly associated with the concept of Food-Oriented Development (FOD), which positions cities not only as centres of food consumption but also as potential food production systems capable of contributing to urban food and nutrition security (Hanifa et al., 2023). Within this framework, UA plays a strategic role in strengthening local food systems while enhancing socio-ecological resilience in urban environments.

However, the development of UA in Makassar City represents a complex and dynamic system involving multiple actors, institutions, and resource interactions. The sustainability of UA is therefore strongly influenced by the degree of integration among ecological, social, economic, technological, and institutional dimensions. Previous studies have indicated that different forms of UA may exhibit varying strengths and vulnerabilities across sustainability dimensions. This necessitates the implementation of policy and management strategies that are tailored to local conditions (Pradhan et al., 2023).

For this reason, the continuous monitoring and evaluation of sustainability indicators is essential for supporting evidence-based policymaking, improving resource allocation, and strengthening adaptive governance mechanisms in UA development (Gómez-Villarino & Ruiz-Garcia, 2021; Tapia et al., 2021). Such policy instruments can facilitate the development of UA as a resilient, inclusive, and sustainable component of urban development systems.

The sustainability of UA in Makassar City is also closely linked to policy support from local government institutions and active participation from relevant stakeholders (Sampeliling et al., 2012; Yuan et al., 2022). Therefore, the formulation of effective policy instruments is essential to support the long-term development and sustainability of UA initiatives.

Based on the findings of interviews conducted with experts and key stakeholders, four major policy dimensions were identified as strategic leverage points for strengthening the sustainability of UA in Makassar City. The following are included: (1) sustainable UA management, (2) institutional coordination, (3) strengthening socio-economic functions, and (4) environmental enhancement. These dimensions form the basis for developing policy strategies aimed at improving the sustainability performance of UA systems (see Table 2).

The policy instruments emphasise the optimisation

of urban open spaces for productive agriculture, the strengthening of institutional collaboration, the enhancement of the socio-economic contribution of

UA to urban communities, and the improvement of urban environmental quality through sustainable agricultural practices.

**Tables 2:** Summarises the Policy Framework for Strengthening UA Sustainability in Makassar City.

Dimensions of Policy	Policy Focus	Strategic Policy	Objectives of the Policy
1. Management of sustainable UA	<ul style="list-style-type: none"> <li>Development of functional and productive systems</li> </ul>	<ul style="list-style-type: none"> <li>Beneficial for society and the environment</li> <li>Optimisation of green open spaces and the enhancement of food and nutrition security</li> <li>Promoting organic and environmentally friendly practices</li> </ul>	<ul style="list-style-type: none"> <li>Optimizing the use of urban open spaces</li> <li>Improving urban food and nutrition security</li> <li>Improved utilisation of household organic waste</li> </ul>
2. Institutional coordination	<ul style="list-style-type: none"> <li>Strengthening governance and stakeholder collaboration</li> </ul>	<ul style="list-style-type: none"> <li>The role of facilitators and supporters from government agencies and stakeholders.</li> <li>Improving community capacity and capabilities</li> </ul>	<ul style="list-style-type: none"> <li>Effectiveness of government intervention and stakeholder engagement</li> <li>Optimisation of the function of agricultural extension institutions</li> </ul>
3. Socio-economic functions	<ul style="list-style-type: none"> <li>Community-based and food and nutrition-oriented development</li> </ul>	<ul style="list-style-type: none"> <li>Sustainable urban agriculture</li> <li>Improvement of public welfare and health</li> </ul>	<ul style="list-style-type: none"> <li>The relationship between community participation and independence</li> <li>Community's food and nutrition needs)</li> <li>Potential of subsidies and incentives</li> </ul>
4. Environmental Functions	Improving environmental quality	<ul style="list-style-type: none"> <li>Beautiful, comfortable and clean environment, as well as productive</li> <li>Community education and environmental tourism</li> <li>Proportion of green open space and the achievement of the Eco City concept</li> </ul>	<ul style="list-style-type: none"> <li>Environmentally conscious attitudes and behavior</li> <li>Education-ecology-urban tourism</li> <li>Utilization of urban land for urban agriculture practices</li> </ul>

Within the sustainable management dimension, policy priorities focus on developing functional and productive UA systems, promoting environmentally friendly agricultural practices, and improving the utilisation of organic waste for compost production. These measures aim to optimise urban land use while simultaneously strengthening food and nutrition security within urban communities.

The institutional coordination dimension emphasises the importance of strengthening governance structures and enhancing collaboration among stakeholders, including government agencies, community organisations, and agricultural extension services. Strengthening institutional coordination is expected to improve the effectiveness of policy implementation and increase community capacity in managing UA systems.

Meanwhile, the socio-economic dimension focuses on the development of community-based urban agriculture systems that contribute to public welfare, food security, and community independence. Within this dimension, policy measures may encompass support mechanisms such as subsidies, incentives, and programmes that encourage increased community participation in UA activities.

The environmental dimension highlights the role of UA in improving urban environmental quality through the expansion of green open spaces, environmental education, and the development of ecological tourism initiatives. In addition to enhancing environmental sustainability,

these initiatives also support the broader objectives of eco-city development.

The implementation of these policy instruments necessitates an integrated governance approach that considers both agro-ecological resources and socio-demographic characteristics within the urban system. The effective implementation of policy is also contingent on robust collaboration between the municipal government and local communities. As primary stakeholders, the residents of urban areas play a crucial role in shaping attitudes, perceptions, and participatory behaviour in UA activities. In addition, local governments must establish conducive policy frameworks that promote community participation and ensure the long-term sustainability of UA systems (Hallett, Hoagland, & Toner, 2016; Parvin & Islam, 2023; Qasemi et al., 2023).

#### 4. Conclusion

Urban agriculture (UA) in Makassar City, South Sulawesi, Indonesia, faces multidimensional challenges in fulfilling its social, economic, and environmental roles within the urban system. A sustainability assessment indicates that UA remains in the less sustainable category, necessitating strategic interventions to strengthen its long-term sustainability. The sustainability of UA is influenced by a combination of technical and socio-institutional factors, including community behaviour, government institutional support, the effectiveness of agricultural extension services, urban open space planning, agricultural input

prices, the role of non-governmental organisations, and the UA's contribution to household needs.

Prospective analysis and stakeholder needs identified four key policy dimensions as strategic levers for improving the sustainability of UA in Makassar City: (1) strengthening sustainable UA management, (2) improving institutional coordination among stakeholders, (3) enhancing the socio-economic functions of UA, and (4) reinforcing the environmental functions of UA within the urban landscape. These dimensions provide a policy framework for guiding integrated and adaptive UA development strategies.

The successful implementation of UA policies is contingent upon strengthened government commitment, effective institutional coordination, and active stakeholder participation. The integration of governance and participatory approaches has the potential to contribute to urban food security, community well-being, and environmental sustainability, thereby supporting broader sustainable urban development goals. Future research may explore the application of integrated governance models and quantitative monitoring frameworks to evaluate the long-term effectiveness of UA policies in developing cities.

## 5. Recommendations

1. Based on the results of the sustainability assessment, UA development policy strategies need to focus on strengthening an integrated regulatory framework, providing adequate production and marketing infrastructure, and community capacity building programs, because these factors play an important role in increasing the sustainability of UA systems.
2. Policy implementation requires a participatory coordination mechanism between local governments and UA communities to build positive perceptions, strengthen community involvement, and ensure the long-term sustainability of UA activities.

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### 5.2. Ethical Considerations

In line with ethical guidelines, consent both verbal and writing was acquired from all participants before the collection of data.

### 5.3. Declaration of competing interest

The authors have not disclosed any potential conflicts of interest. As the authors of the paper, we confirm that the manuscript has not been previously published or is under consideration by another journal. Furthermore, we have no competing financial interests, affiliations, or commitments that could compromise the impartiality and integrity of the research conducted.

### 5.4. CRediT authorship contribution statement

Abdullah Abdullah: Conceptualization, Supervision, Methodology, Investigation, Formal analysis, Validation, Writing-original draft, Writing-review & editing. Abdul Haris: Methodology, Formal analysis, Data curation, Writing-review & editing. Andi Wisneni: Conceptualization, Methodology, Investigation, Formal analysis, Writing – review & editing, Writing – original draft. Annas Boceng: Methodology, Investigation, Formal analysis, Writing-review & editing. Maemuna Nontji: Methodology, Investigation, Writing-review & editing. Anwar Robbo: Investigation, Formal analysis, Writing-review & editing. Muhammad Munawir Syarif: Investigation, Formal analysis, Writing-review & editing.

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