

## PERCEPTIONS OF URBAN FARMING ACTORS ON HYDROPONIC-BASED AGRICULTURAL DEVELOPMENT WITHIN URBAN AGRIFOOD SYSTEMS

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### Article history:

Received: July 08, 2024

Accepted: October 10, 2024

Published: April 13, 2025

### Keywords:

actor perceptions, food sustainability, household food, hydroponic cultivation, institutional support, market integration, urban agriculture.

### ABSTRACT

Urban farming is increasingly promoted as an adaptive response to food system challenges in rapidly urbanizing areas. This study analyzes the perceptions of urban farming actors toward hydroponic-based agricultural development within urban agrifood systems. A census-based survey was conducted among hydroponic practitioners participating in an urban farming program in Parepare City, Indonesia. Data were collected using a structured Likert-scale questionnaire and analyzed descriptively to capture technical, economic, institutional, and market-related perception dimensions. The results show that hydroponic urban farming is perceived as technically feasible and well-suited to limited urban spaces, with positive contributions to household food provision. However, perceptions of income potential, market integration, and program continuity remain moderate, indicating structural constraints that limit wider agrifood system impacts. These findings suggest that hydroponic urban farming currently functions mainly as a complementary food production strategy rather than a fully commercial activity. The study highlights that long-term sustainability depends not only on technological adoption but also on sustained institutional support and stronger integration with urban food markets, emphasizing the need for system-oriented development approaches.

### Keywords:

budidaya hidroponik, dukungan kelembagaan, integrasi pasar, keberlanjutan pangan, pangan rumah tangga, persepsi aktor, pertanian perkotaan.

### ABSTRACT

Pertanian perkotaan semakin dipromosikan sebagai respons adaptif terhadap tantangan sistem pangan di daerah yang mengalami urbanisasi pesat. Studi ini menganalisis persepsi para pelaku pertanian perkotaan terhadap pengembangan pertanian berbasis hidroponik dalam sistem agrifood perkotaan. Survei berbasis sensus dilakukan di antara para praktisi hidroponik yang berpartisipasi dalam program pertanian perkotaan di Kota Parepare, Indonesia. Data dikumpulkan menggunakan kuesioner skala Likert terstruktur dan dianalisis secara deskriptif untuk menangkap dimensi persepsi teknis, ekonomi, kelembagaan, dan terkait pasar. Hasil menunjukkan bahwa pertanian perkotaan hidroponik dianggap layak secara teknis dan sangat cocok untuk ruang perkotaan yang terbatas, dengan kontribusi positif terhadap penyediaan pangan rumah tangga. Namun, persepsi tentang potensi pendapatan, integrasi pasar, dan keberlanjutan program tetap moderat, menunjukkan kendala struktural yang membatasi dampak sistem agrifood yang lebih luas. Temuan ini menunjukkan bahwa pertanian perkotaan hidroponik saat ini berfungsi terutama sebagai strategi produksi pangan pelengkap daripada aktivitas komersial sepenuhnya. Studi ini menyoroti bahwa keberlanjutan jangka panjang tidak hanya bergantung pada adopsi teknologi tetapi juga pada dukungan kelembagaan yang berkelanjutan dan integrasi yang lebih kuat dengan pasar pangan perkotaan, menekankan perlunya pendekatan pengembangan yang berorientasi sistem.

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## INTRODUCTION

Rapid urbanization has increasingly transformed food production and distribution systems (Reardon et al., 2014; 2019), intensifying pressures on food security (Godfray & Garnett, 2014), land availability (Lambin & Meyfroidt, 2011), and environmental sustainability in urban areas (Patel & Raval, 2024). As cities expand, conventional agricultural practices face spatial and ecological constraints (Gren & Andersson, 2018; Lin & Fuller, 2013), prompting the emergence of alternative production systems that can operate within limited urban spaces (Gulyas & Edmondson, 2021; Thornton, 2017). Urban agrifood systems have therefore gained attention as integrated frameworks that link food production, distribution, and consumption within urban contexts while addressing sustainability challenges (Aldilla et al., 2024; Berti & Mulligan, 2016; Preiss et al., 2017; Specht et al., 2014).

Urban farming has emerged as a strategic component of urban agrifood systems by contributing to local food availability, environmental management, and livelihood diversification (Aldilla et al., 2024; Fatmawati et al., 2021). Among various urban farming approaches, hydroponic agriculture is increasingly promoted for its efficient use of water, reduced land requirements, and its ability to produce fresh vegetables in densely populated areas (Abdelfatah et al., 2024; Al-Kodmany, 2024; Naresh et al., 2024; Orsini et al., 2013; Xi et al., 2022). Previous studies have highlighted the technical and environmental advantages of hydroponic systems, particularly in enhancing productivity and reducing resource use compared to soil-based cultivation (Gashgari et al., 2018; Hamdaoui et al., 2024; Zhang et al., 2024).

Despite growing interest in hydroponic urban farming, its development and sustainability depend not only on technical performance but also on the perceptions and responses of the actors involved (Ivascu et al., 2021). Urban farming actors play a central role in shaping how technologies are adopted, managed, and integrated into local agrifood systems (Farhangi et al., 2021; Hosseinifarhangi et al., 2019). Perceptions related to economic feasibility, technical complexity, institutional support, and market access influence decision-making processes and ultimately determine whether hydroponic initiatives can be sustained beyond pilot or program-based implementation.

Existing research on urban farming has predominantly focused on production efficiency, environmental benefits, or policy frameworks, often treating urban agriculture as a technical intervention rather than a socio-economic process embedded in broader agrifood systems. Consequently, less attention has been given to how urban farming actors perceive hydroponic-based agricultural development and how these perceptions reflect interactions between production practices, institutional programs, and urban market environments. Understanding these perceptions is essential for interpreting the effectiveness of urban farming initiatives within complex urban agrifood systems.

From an agrifood system perspective, hydroponic urban farming represents an interface between technology, urban livelihoods, and food system sustainability. Actor perceptions provide valuable insights into how integrated agricultural practices are experienced at the ground level and how program-driven interventions align with local capacities and expectations. Incorporating these

perspectives enables a more comprehensive understanding of urban farming development beyond purely technical assessments.

Against this background, this study examines the perceptions of urban farming actors regarding hydroponic-based agricultural development within an urban agrifood system. By analyzing actors' perceptions across key dimensions of hydroponic farming implementation, this research aims to generate insights into the role of hydroponic urban farming in supporting sustainable urban agrifood systems and to inform strategies for strengthening future urban agriculture initiatives.

## RESEARCH METHODS

### Research Design and Analytical Approach

This study employed a descriptive–analytical research design with an actor-based perception approach to examine hydroponic-based agricultural development within an urban agrifood system. The research focuses on understanding how urban farming actors perceive various dimensions of hydroponic farming implementation, recognizing that actors' perceptions influence technology adoption, program sustainability, and system integration in urban agriculture. The study adopts an analytical generalization approach, in which findings are interpreted within the specific context of an urban agrifood system rather than intended for broad statistical generalization. This approach is appropriate for perception-based and system-oriented studies with a limited but well-defined population.

### Study Area

The research was conducted in Parepare City, South Sulawesi, Indonesia, an urban area characterized by limited agricultural land availability and growing interest in alternative food production systems. Urban farming initiatives in Parepare City have been promoted as part of local efforts to improve household food access, utilize unused urban spaces, and support sustainable urban agriculture.

Hydroponic farming has been introduced in Parepare City through an urban farming program targeting community groups and small-scale producers. This context provides a relevant setting for examining hydroponic-based agricultural development within an urban agrifood system, as it reflects interactions between technology adoption, institutional support, and urban food demand.

### Unit of Analysis

The unit of analysis consisted of individual urban farming actors who actively participate in hydroponic-based farming activities under the urban farming program in Parepare City. These actors represent direct implementers and beneficiaries of hydroponic technology within the urban agrifood system and possess experiential knowledge of program implementation, production practices, and market engagement.

### Population and Sampling

The study population included all urban farming actors participating in the hydroponic farming program in Parepare City at the time of the study. Given the limited number of active

participants, a census sampling approach was applied, whereby all eligible actors were included as respondents. This approach ensures full population coverage, minimizes sampling bias, and strengthens the internal validity of perception-based findings.

### **Data Collection and Research Instrument**

Primary data were collected using a structured questionnaire administered through direct interviews. The questionnaire employed a five-point Likert scale to capture actors' perceptions across key dimensions of hydroponic farming development, including technical feasibility, economic benefits, institutional support, environmental considerations, and market access. The perception indicators were derived from the objectives of the urban farming program and relevant literature on urban agriculture and hydroponic systems. Conducting interviews directly with respondents helped ensure clarity of responses and reduced potential misinterpretation of questionnaire items.

### **Data Analysis**

Quantitative data from the Likert-scale responses were analyzed using descriptive statistical methods, including mean scores and percentage distributions. Mean values were used to classify perception levels into positive, neutral, or negative categories based on predetermined scale intervals. This approach allows for systematic comparison across perception dimensions while remaining consistent with the descriptive nature of the data.

### **Analytical Perspective**

Data interpretation was conducted within an urban agrifood system perspective, in which hydroponic urban farming is viewed as an integrated component connecting production practices, institutional programs, and urban food markets. Actors' perceptions were analyzed as reflections of how hydroponic-based agriculture functions within the broader urban agrifood system, providing insights into sustainability and development pathways.

## **RESULTS AND DISCUSSION**

### **Actors' Characteristics and Research Context within Urban Agrifood Systems**

The general characteristics of the urban farming actors involved in hydroponic activities are presented in Table 1. All respondents are active participants in a government-supported urban farming program in Parepare City, operating hydroponic systems within limited urban spaces. This context positions the actors as key implementers of alternative food production practices within the urban agrifood system, where agricultural activities intersect with household food provisioning, institutional support, and urban markets.

The use of a census approach ensures that the perceptions captured represent the full population of program participants, strengthening the internal validity of the findings despite the limited sample size. From an urban agrifood systems perspective, these actors function as micro-level nodes linking production technologies, policy interventions, and local food access.

Table 1. Characteristics of urban farming actors participating in hydroponic programs

Characteristics	Description
Location	Parepare City, South Sulawesi, Indonesia
Farming system	Hydroponic urban farming
Program status	Participants of government-supported urban farming program
Unit of analysis	Individual urban farming actors
Sampling method	Census (all active participants)
Data collection	Structured interviews using Likert-scale questionnaire

### Technical Feasibility of Hydroponic Urban Farming

Actors’ perceptions of the technical aspects of hydroponic farming are summarized in Table 2. Overall, respondents expressed positive perceptions regarding the suitability of hydroponic cultivation for limited urban spaces and the relative ease of implementation. These findings indicate that hydroponic systems are perceived as technically feasible within urban environments, supporting their role as an adaptive agricultural practice under land-scarce conditions.

However, moderate perceptions related to technical complexity, maintenance requirements, and input availability suggest that hydroponic farming still presents operational challenges. Similar observations have been reported in international studies, where hydroponic urban farming is recognized for its efficiency but requires continuous technical knowledge and input management to remain viable (Kiran et al., 2013). Within the urban agrifood system, these technical perceptions highlight the importance of sustained technical assistance to ensure long-term functionality rather than short-term adoption.

Table 2. Actors’ perceptions of technical aspects of hydroponic urban farming

Indicator	Mean Score	Perception Category
Ease of hydroponic cultivation	High	Positive
Suitability for limited urban space	High	Positive
Availability of production inputs	Moderate	Fair
Technical complexity	Moderate	Fair
Maintenance requirements	Moderate	Fair

### Economic and Market Perceptions in Urban Food Systems

Perceptions related to economic and market aspects are presented in Table 3. While respondents acknowledged the contribution of hydroponic farming to household food supply, perceptions of income generation potential and market competitiveness remained moderate. This indicates that hydroponic urban farming is primarily perceived as a food supplementation and livelihood support activity rather than a fully commercial enterprise.

This pattern aligns with findings from international urban agriculture research, which suggest that urban farming often enhances food access and dietary diversity but contributes modestly to household income unless supported by strong market integration (Orsini et al., 2013; Poulsen et al., 2015; Siegner et al., 2018). The moderate perception of market access and price competitiveness further suggests that hydroponic products in Parepare City are not yet fully embedded within urban food markets, limiting their economic impact at the system level.

Table 3. Actors' perceptions of economic and market aspects

Indicator	Mean Score	Perception Category
Contribution to household food supply	High	Positive
Income generation potential	Moderate	Fair
Production cost affordability	Moderate	Fair
Market access for hydroponic products	Moderate	Fair
Price competitiveness	Moderate	Fair

### Institutional Support and Program Sustainability

Actors' perceptions of institutional and program support are shown in Table 4. High scores for training and input assistance reflect strong initial program support, indicating that institutional intervention plays a critical role in facilitating hydroponic adoption. However, perceptions regarding program continuity and market facilitation were only moderate, raising concerns about long-term sustainability once external support diminishes.

Generally, urban agriculture initiatives driven by short-term programs often struggle to sustain results without institutional sustainability and market linkage strategies (Cabannes, 2012; Gernert et al., 2018). From an urban agrifood system perspective, these findings suggest that institutional support must evolve from input provision toward enabling autonomous production–market integration.

Table 4. Actors' perceptions of institutional and program support

Indicator	Mean Score	Perception Category
Training and technical assistance	High	Positive
Access to program inputs	High	Positive
Continuity of program support	Moderate	Fair
Access to market facilitation	Moderate	Fair
Policy support for urban farming	Moderate	Fair

### Synthesis of Perception Dimensions within the Urban Agrifood System

The integrated interpretation of actors' perceptions across technical, economic, institutional, and market dimensions is summarized in Table 5. The dominance of positive–fair perceptions across all dimensions indicates that hydroponic urban farming is viewed as feasible and beneficial, yet constrained in its capacity to generate broader agrifood system impacts.

Table 5. Summary of perception dimensions within the urban agrifood system

Dimension	Dominant Perception	System-Level Interpretation
Technical	Positive–Fair	Technically feasible for urban settings
Economic	Fair	Limited but potential contribution to livelihoods
Institutional	Positive–Fair	Strong program support, moderate sustainability
Market integration	Fair	Weak linkage to urban food markets

This synthesis reinforces the view that hydroponic urban farming functions as a complementary component of the urban agrifood system rather than a standalone solution. Figure 1 conceptually illustrates how perceptions at the actor level reflect interactions between production practices, institutional frameworks, and urban markets. Such a system-oriented interpretation is

consistent with international agrifood system studies that frame urban agriculture as a resilience-enhancing strategy rather than a substitute for rural food production (Charatsari et al., 2022; Schuster et al., 2024).

### **Implications for Urban Agrifood System Sustainability**

As an outcome, this study demonstrates that hydroponic-based urban farming contributes to urban agrifood system sustainability primarily by enhancing local food access, promoting efficient resource use, and supporting household-level food security. However, the moderate perceptions related to economic viability and market integration indicate that sustainability gains remain limited without strategic interventions that strengthen value chains and institutional continuity.

These findings highlight the importance of transitioning urban farming programs from technology-focused initiatives toward system-oriented strategies that integrate production, markets, and governance. By aligning actor capacities with urban food demand and policy support, hydroponic urban farming can play a more substantial role in strengthening resilient and sustainable urban agrifood systems.

## **CONCLUSION**

This study demonstrates that hydroponic-based urban farming is perceived by urban farming actors as a technically feasible and institutionally supported agricultural practice within the urban agrifood system. Positive perceptions regarding spatial suitability, production efficiency, and household food provision indicate that hydroponic farming effectively responds to urban constraints, particularly land scarcity. However, the findings also reveal that its role remains largely complementary, with limited perceived capacity to generate substantial income or to function as a fully market-integrated agrifood enterprise.

From a systems perspective, the results highlight that the contribution of hydroponic urban farming extends beyond production outcomes to include its positioning within interactions among technology adoption, institutional support, and urban food markets. The dominance of moderate perceptions related to economic viability and market access suggests that sustainability outcomes are shaped not only by production technology but also by the degree of integration across agrifood system components. This underscores the importance of viewing urban farming as a system-embedded activity rather than an isolated livelihood intervention.

As an outcome, the study suggests that strengthening the sustainability of hydroponic-based urban farming requires a strategic shift from short-term program support toward system-oriented development pathways. Policies and interventions that enhance market connectivity, institutional continuity, and actor capacity building are critical to enabling urban farming to contribute more effectively to resilient and sustainable urban agrifood systems. Future research should extend this perception-based analysis by incorporating longitudinal data and system-level performance indicators to further elucidate the evolving role of urban agriculture in urban food system transformation.

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