COLLEGE OF TECHNOLOGY AND BUILT ENVIRONMENT

SCHOOL OF BUILT ENVIRONMENT

ASSESSING SPATIAL DISTRIBUTION, CHALLENGES AND PROSPECTS OF URBAN AGRICULTURE (VEGETABLE) IN ARADA SUBCITY, ADDIS ABABA; IMPLICATIONS FOR SUSTAINABILITY AND SPATIAL INTEGRATION

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN ENVIRONMENTAL PLANNING AND LANDSCAPE DESIGN

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Addis Ababa, Ethiopia

DECLARATION

I,the undersigned, hereby declare that this thesis with the title "**Assessing Spatial Distribution, Challenges and Prospect of Urban Agriculture (vegetables) in Arada Subcity, Addis Ababa: Implications for Sustainability and Spatial Integration**" is my original work. It has not been submitted previously for any degree or qualification at any other university or institution.

Any support I have received during the research process has been acknowledged.

I take full responsibility for the accuracy and originality of this work.

Declared by: Loza Teferi Girma

Signature: _________________

Date: _________________

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Abstract

Urban agriculture (UA) has been an important livelihood strategy for thousands of households in Addis Ababa. This study assesses the challenges and sustainability potential of vegetable urban agriculture in Arada Subcity, with implications for spatial integration. For this research, a mixed-methods design was used, combining surveys of 190 urban farmers, 16 key informant interviews, GIS mapping, and case study analysis as it focuses on Woreda 07. The results show that in the inner parts of the urban landscape, vegetable cultivation is highly practiced on structurally insecure lands, which are vacant lots (45%), institutional compounds (29%), and residential compounds (17%), with average plot sizes of just 10 m². Consequently, 83% of farmers lack secure land tenure, facing displacement threats from eviction (51%) and development projects (39%). Regarding gender, women comprise 75% of practitioners; however, they face systematic disadvantages as men are much more likely [8x] to use advanced farming methods (23% vs. 3%) and nearly twice as likely to have secure tenure (26% vs. 14%). Even though UA faces constraints, it still significantly contributes to food security, with 76% of harvest used for household consumption. A quantified case study analysis shows that a 365 m² sized farm can produce from 1,111 to 1,666 kg of vegetables annually, sufficient to meet the nutritional needs of 18–28 people. Given that current UA is spatially fragmented across high-eviction-risk sites (vacant lots and institutional compounds), while corridor development projects proceed regardless, this study concludes that spatial integration must formally recognize and protect existing productive zones rather than displacing them. Accordingly, the proposed framework prioritizes temporary use agreements, tenure arrangements for small plots (≥10 m²), and incorporation of UA into corridor planning, with rooftop agriculture on parking structures as one viable option where applicable. This research demonstrates that transitioning UA from informality to formal spatial integration is essential to realize its multifunctional potential within broader sustainable development goals.

Keywords: *Addis Ababa, food security, land tenure, spatial planning, vegetable urban agriculture,*

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Acronyms & Abbreviations

AACAFUADC: Addis Ababa City Administration Farmers and Urban Agriculture Development Commission

ETB: Ethiopian Birr (currency)

FAO: Food and Agriculture Organization

GIS: Geographic Information System

MoPD: Ministry of Planning and Development

MoA: Ministry of Agricultures

SDGs: Sustainable Development Goals

SPSS: Statistical Package for the Social Sciences

UA: Urban Agriculture

UN: United Nations

UN-Habitat: United Nations Human Settlements Programme

1 Chapter One: Introduction

1.1. Background of the Study

Urban agriculture (UA) refers to the growing of crops and raising of livestock within and around cities, including activities such as cultivation on vacant lots, institutional lands, residential compounds, and rooftops, as well as along riverbanks and roadsides (Mougeot, 2000). UA contributes to food security and household income across different world regions. Globally, in developed economies such as North America and Europe, UA is often framed as a tool for community building, food justice, and revitalizing post-industrial landscapes (Colasanti et al., 2012). In developing countries, particularly in Asia and Africa, UA functions more directly as a livelihood strategy for low-income households, providing both subsistence and supplementary income (Lee-Smith, 2010; Mougeot, 2000). Innovations in Singapore demonstrate how technology-enabled vertical and rooftop farming can overcome severe land constraints (Teng, 2013), a relevant model for dense urban cores.

Despite its benefits, UA faces persistent challenges globally. These include land tenure insecurity, lack of formal policy recognition, use of polluted water sources, and conflicts with urban development priorities (Drechsel & Keraita, 2014). In many African cities, farmers operate on temporary, informal arrangements, making them vulnerable to eviction.

How people practice UA spatially varies significantly across the world. In Latin American cities such as Havana, Cuba, UA is formally integrated into urban planning through state-supported organopónicos (raised-bed gardens) on publicly owned vacant land (Altieri et al., 1999). In European cities like Berlin, community gardens are legally recognized as temporary use of land awaiting development. In North American cities such as Detroit, UA occupies vacant lots and abandoned industrial sites through formal land banking arrangements. In Asian megacities like Bangkok and Singapore, UA is increasingly practiced vertically on rooftops and building facades due to extreme land scarcity. This diversity of spatial integration models demonstrates that UA can be accommodated through different planning mechanisms—from temporary use permits to permanent zoning designations.

Addis Ababa's potential for UA — Addis Ababa possesses several favorable conditions for urban agriculture. The city's highland climate (typically 15–25°C year-round) allows for nearly continuous vegetable production without extreme heat or frost constraints. The undulating topography with multiple stream valleys provides naturally irrigable low-lying areas. The city's demographic profile—over 5 million residents with significant low-income population reliant on daily food purchases—creates both a labor pool and a ready market for fresh produce. Additionally, the prevalence of undeveloped vacant lots (estimated at 30–40% of land within the inner city before recent development) offers potential cultivation sites, though these are increasingly under pressure.

Despite this potential, UA in Addis Ababa faces acute constraints. Rapid population growth—from 2.1 million in 1994 to over 5 million in 2023 (UN-Habitat, 2020)—has led to encroachment of built-up areas onto previously cultivated lands. Land lock (limited access to secure land) is a primary barrier, with most farmers relying on informal arrangements. Input constraints include limited access to certified seeds, organic fertilizers, and reliable irrigation water. Additionally, farmers face competition from imported vegetables and lack organized market linkages.

Two major initiatives are currently reshaping Addis Ababa's landscape. The Beautifying Sheger Initiative (launched 2019), also known as the Riverside Development Project, rehabilitates riverbanks along the Akaki River and its tributaries, creating green corridors, public parks, and promenades. While this project demonstrates UA's potential as multifunctional green infrastructure, it has also displaced traditional farming sites along riverbanks. The Addis Ababa Corridor Development Project transforms major arterial routes (e.g., Bole Road, Churchill Avenue) with upgraded infrastructure, sidewalks, lighting, and amenities. This project increases land values and often clears informal UA plots in high-pressure areas such as Arada Subcity.

Yelemat Trufat, the Ethiopian government's Yelemat Trufat (National Nutrition Program, launched 2016–2020 and extended) provides an alternative policy window for UA integration. Yelemat Trufat prioritizes household-level food production, including backyard gardens and school gardens, as a strategy to combat stunting and micronutrient deficiencies. While this program focuses primarily on rural and peri-urban areas, its logic extends naturally to urban settings, offering a policy framework that could accommodate UA as a nutrition-sensitive intervention rather than solely as an informal livelihood activity. This study thus positions UA not as an obstacle to urban development but as a potential partner aligned with both nutrition and green infrastructure goals.

This study addresses the tension between UA's demonstrated benefits and its ongoing displacement by large-scale urban transformations. By assessing UA's spatial practices, challenges, and sustainability contributions in Arada Subcity, it aims to propose actionable integration guidelines that can align UA with, rather than be displaced by, the Sheger Riverside and Corridor Development projects.

1.2. Problem Statement

It has been known that Urban agriculture in Addis Ababa is an important practice. Despite its contributions, UA faces existential threats and operational constraints that severely limit its potential to contribute to broader sustainable development goals.

First, UA is neglected in formal spatial planning frameworks .Following this the practice is most commonly seen on structurally unsafe lands that are vulnerable to displacement. These locations include vacant lots, roadside verges and riverbanks that have no secure land tenure. On the offcial spatial framwork riverbans are allocated for UA, however these places are mostly polluted, despite the currrent redevelopment project of clearing riverbanks, these places are not enirely propriate to cultivate vegetables yet. Thus the current practice is not well mapped or protected which would easily lead to eradication, ,which inturn limits scaling up the produce.

The map below illustrate the distribution of officially documented UA activities across various sub cities in Addis Ababa. And the chart data reflects the percentage of land dedicated to UA as recognized by formal zoning regulations.

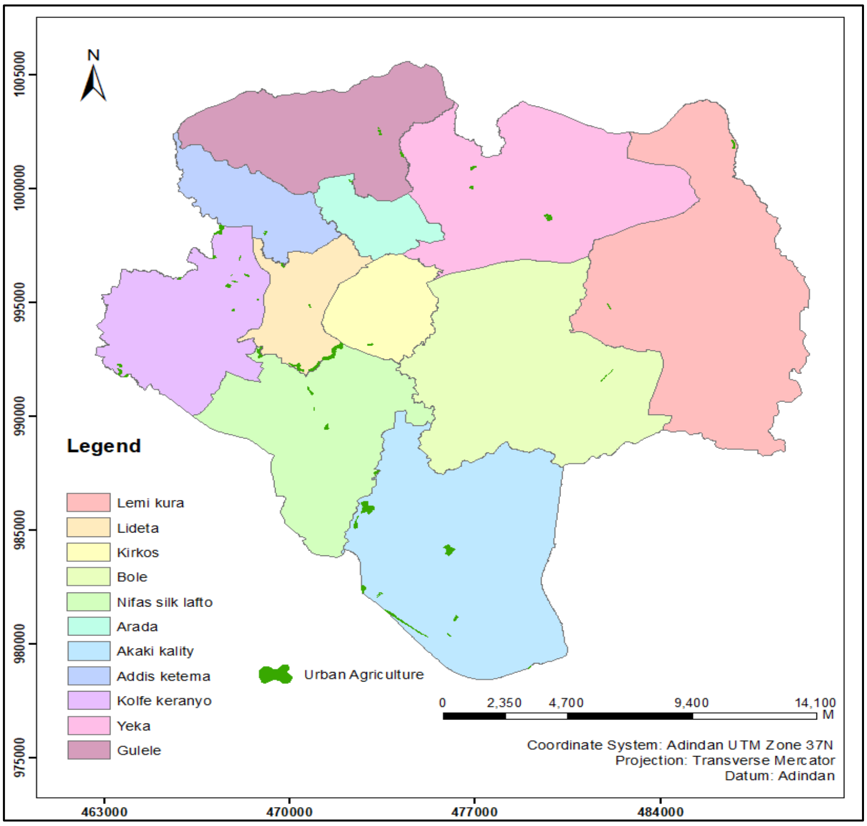


Figure 1:1: Map showing formal coverage of UA in Addis Ababa
Source :Addis Ababa Land Use map

Notably, Akaki Kality stands out with the highest share at 76%, while other subcities such as Arada, Bole, and Kirkos show minimal formal coverage. Arada, with less than **1%** of its land dedicated to such use reflects the subcity's dense urban fabric, limited open space, and prioritization of residential, administrative and institutional land use over agricultural activities.

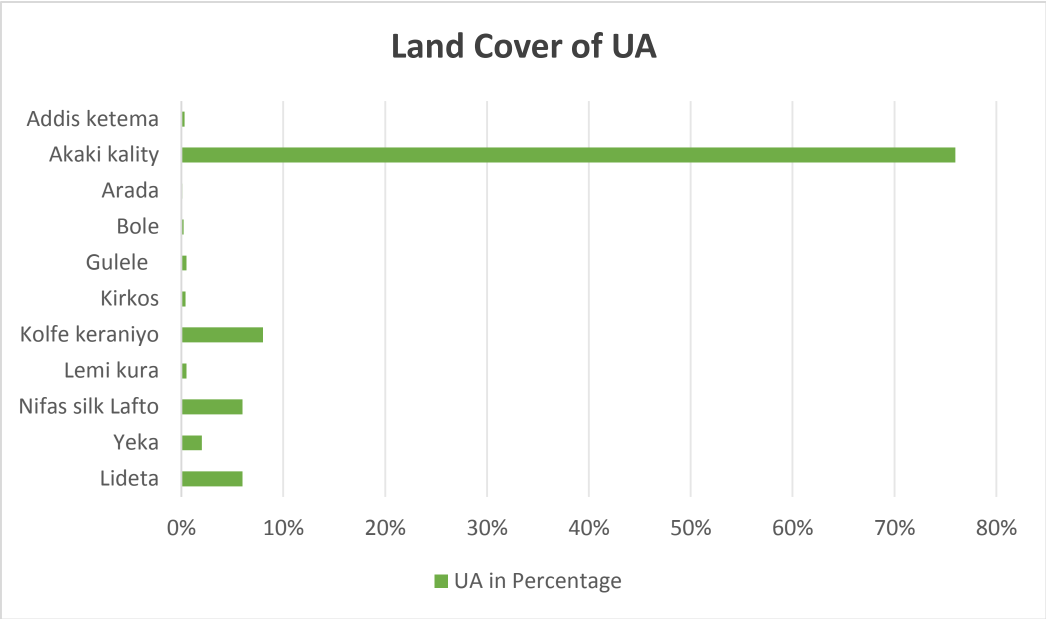


Figure 1:2: Chart showing percentage of UA coverage
Source :Addis Ababa Land Use map

Secondly, significant operational challenges hinder productivity and sustainability. Residents in Addis Ababa face with acute water scarcity, which leads some farmers to resorting polluted river water. They also have limited access to modern, space-efficient technologies like hydroponics or vertical farming. These constraints result in yields that are often low and variable, limiting UA's economic value and its capacity to reliably enhance household food security (SDG 2) at a significant scale.

Third, there is a critical disconnect between UA's practices and its potential as having multifunctional benefits. While UA inherently offers ecosystem services like urban cooling, biodiversity promotion, and waste recycling, directly contributing to SDG 11 (Sustainable Cities) and SDG 13 (Climate Action), these benefits are incidental and unoptimized. The current model, focuses on small-scale, ground-based cultivation, and is not designed to maximize these sustainability dividends.

Therefore, this study is motivated by the need to bridge this gap. There is a lack of comprehensive research that simultaneously assesses the spatial dynamics of inner-city vegetable cultivation, quantifies its productivity and sustainability potential, and translates these findings into practical spatial planning guidelines. This study addresses this gap by investigating how UA in Arada subcity is practiced, the challenges it faces, and how it can be strategically integrated into Addis Ababa’s urban fabric.

1.3. Research Objectives

1.3.1. General Objective

To assess spatial practices, challenges and prospect of urban agriculture in arada subcity, addis ababa and its implications for sustainability and spatial integration.

1.3.2. Specific Objectives

1.To assess the spatial practices of vegetable urban agriculture in Addis Ababa

2.To assess the challenges of urban agriculture in Arada subcity, Addis Ababa

3.To evaluate the productivity of urban agriculture to contribute to broader Sustainable Development Goals (SDGs).

4.To propose urban agriculture implementation guideline framework that enhance its integration into other urban land uses in Addis Ababa city.

1.4. Research Questions

1. .How are the spatial patterns and practices of vegetable urban agriculture in Arada subcity, Addis Ababa?
2. What are the key challenges constraining the productivity and sustainability of urban agriculture in Arada subcity, particularly regarding land access, water availability, and technological adoption?
3. To what extent does urban agriculture in Arada subcity contribute to Sustainable Development Goals (SDGs), specifically Zero Hunger (SDG 2), Sustainable Cities (SDG 11), and Gender Equality (SDG 5)?
4. How can urban agriculture be effectively integrated into Addis Ababa's spatial planning framework through actionable implementation guidelines?

1.5. Scope of the Research

1.5.1. Geographic Scope

This study focuses on Arada Subcity in Addis Ababa, selected as it’s an inner city, that despite having less than 1% of land formally allocated to UA, Arada has a high density of registered practitioners from the central sub cities of Addis Ababa.

Residents farm in vacant lots, institutions, backyards, and riverbanks. This gap between zoning and practice makes it ideal for studying.

Within Arada, **Woreda 7** was purposively selected for a primary unit of analysis and emperical data collection based on recommendations from the subcity's administration office.

That is because of the availability of registered and reported data, and the willingness of officers to contribute in this study made the Woreda a perfect candidate to be the primary unit of analysis.

Additionally Woreda 07 also faces challenges connected to land availability, tenure, zoning and regulations. All this combined enabled detailed spatial and socio-economic analysis while ensuring findings remain relevant to city-wide planning and policy contexts.

1.5.2. Thematic Scope

The study focuses on the following key themes, aligned with the research objectives and questions:

1. To asses the spatial practices of vegetable urban agriculture in Addis Ababa:

Mapping the locations and types of spaces used for vegetable farming and documenting the specific vegetables grown and the techniques employed

2. To asses the challenges of urban agriculture in Arada subcity, Addis Ababa:

Primary issues faced by urban farmers in Arada. focusing on why these challenges arise and their broader effects. This involves examining issues in tenure security , and land use competition. It also covers evaluating the limited adoption of space-efficient and water-saving technologies and the reasons behind it.

3. **To evaluate the productivity of urban agriculture to contribute to broader Sustainable Development Goals (SDGs)**

Assessment on impact of practice, focus on quantifiable and qualitative contributions to key sustainability goals:

Productivity and Food Security (SDG 2): evaluating contribution of farms to household nutrition and income,

Urban Environmental Benefits (SDG 11): Evaluating UA's role as green infrastructure, and greening of the inner-city environment.

Socio-Economic Dynamics (SDG 5): Analyzing the role of women in urban farming and the barriers they face regarding land ownership and economic empowerment.

4. **Framework for Spatial Integration in High-Density Areas:**

This final thematic area focused on generating practical recommendations for Arada's context. It-

Draw lessons from global case studies of UA integrated into dense urban settings

Develop a concise framework with actionable strategies for policymakers and planners.

1.6. Significance of the Study

The study contributes to the growing body of knowledge on urban agriculture, policy making, sustainability, and spatial planning, particularly in the context of rapidly urbanizing African cities. It also explores how urban agriculture can contribute to broader sustainability goals. Additionally, it emphasizes the importance of integrating urban agriculture into the city's spatial planning framework, ensuring its long-term viability and impact.

1.7. Limitations of the Study

Acknowledging the limitations of the research demonstrates transparency and helps set realistic expectations for the findings.

Financial Limitations - Limited financial resources restrict the scope of data collection and analysis. .

Data Limitations - Reliance on self-reported data from surveys and interviews could introduce bias. Secondary data from government reports and academic studies also have limitations in terms of accuracy and completeness.

1.7. Organization of the Paper

This study is organized into five chapters. Chapter 1 introduces the research problem, objectives, and significance of the study. Chapter 2 reviews existing literature on urban agriculture, sustainability, and spatial planning, identifying key gaps that this research addresses. Chapter 3 describes the research methodology, including the study area, data collection methods, and analysis techniques. Chapter 4 presents the findings of the study and discusses their implications for urban agriculture in Addis Ababa. Chapter 5 concludes the thesis by summarizing the key findings, providing recommendations for policymakers and urban planners, and suggesting directions for future research.

2. Chapter Two: Literature Review

2.1. Definition of Terms

2.1.1. Urban Agriculture

Urban agriculture refers to the practice of cultivating, processing, and distributing food in urban and peri-urban areas. It includes a wide range of activities, such as vegetable gardening, fruit orchards, livestock rearing, and aquaculture. Urban agriculture is often practiced on small plots of land, rooftops, balconies, and vacant lots, making it a flexible and adaptive strategy for addressing food security and sustainability in cities. In the context of Addis Ababa, urban agriculture is primarily practiced by low-income households as a means of supplementing their food supply and generating income (FAO, 2014)..

2.1.2. Emperical Review

Types of Urban Agriculture include Household Gardens, these types are small-scale gardens maintained by individual households for personal consumption. There are also community gardens, shared spaces where groups of people collectively grow food. Thirdly, commercial urban farms are larger-scale operations that produce food for sale in local markets. Finally there is vertical farming, the practice of growing crops in vertically stacked layers, often in controlled environments.

It also has various benefits Food Security being the first one Increases access to fresh and nutritious food (Mougeot, 2000; FAO, 2022) .
Economic Opportunities: Provides income-generating opportunities (Mougeot, 2000; FAO, 2022) & Environmental Sustainability: Enhances green spaces, improves air quality, and promotes biodiversity (Mougeot, 2000; Foster et al., 2022).

Benefits of Urban Agriculture in Addis Ababa Context

UA also offers several additional benefits. First, fresh food delivery and reduced food waste are achieved as local production eliminates transportation-related fuel consumption and reduces post-harvest food waste (FAO, 2022). Second, UA supports a sustainable lifestyle: as farmers gain direct benefits from their plants, this often leads to greater investment in cultivation knowledge and time, as well as household-level sustainability practices such as converting organic waste into compost (Fossy & Papenbrock, 2022). Third, UA fosters social cohesion, as community gardens and shared farming spaces create opportunities for social interaction and knowledge exchange, which in turn strengthens neighborhood ties (Simonetti & Amato, 2021; Foster et al., 2022). Finally, UA supports the current redevelopment project. As rivers and riverbanks are being cleared and cleaned, and setbacks (up to 50 m) are being employed, UA can be a good candidate for integration within the riverbanks of Addis Ababa's urban landscape, as it also gives these green spaces a multifunctional value (Foster et al., 2022).

Modern Urban Agriculture

Modern urban agriculture is the innovative cultivation of food within city environments using advanced, space-efficient, and sustainable techniques. It integrates technology, community engagement, and eco-friendly practices to produce fresh food close to where people live. (FAO, 2022)

Key Components:

Vertical Farming : This method allows space maximization as it minimizes land use.It is about growing crops in stacked layers inside climate-controlled buildings (Fussy & Papenbrock, 2022)

Figure 2.1: Vertical agriculture

- **Aquaponics**: Is an integrated system combining fish farming (aquaculture) with plant cultivation (hydroponics), where fish waste nourishes plants. Aquaponics offers several advantages, including water conservation, reduced fertilizer use, and faster plant growth (Fussy & Papenbrock, 2022)
- **Rooftop Gardens**: Consists utilizing building rooftops for growing vegetables, fruits, and herbs, improving insulation and urban biodiversity(Fussy & Papenbrock, 2022)
- **Hydroponics**: Is soilless farming where plants grow in nutrient-rich water, ideal for dense urban settings and faster production.(Fussy & Papenbrock, 2022)
- **Automation and Robotics**: Uses sensors, AI, and robotics to monitor, manage, and optimize crop growth, reducing labor and increasing efficiency.

2.1.3. Spatial Planning

Spatial planning is the process of organizing land use, infrastructure, and resources to achieve sustainable development. It involves space allocation for various urban functions, such as housing, transportation, industry, and green spaces. As to make sure urban development is balanced, equitable, and environmentally sustainable (UN-Habitat, 2016).

When considering urban agriculture, spatial planning in urban areas plays a great role in parceling suitable land, integration of green spaces into the urban fabric, establish zoning laws supporting UA and promoting sustainable land use practices (FAO, 2022).

Fundamentals of Spatial Planning

- Sustainability: Ensuring that development meets the needs of the present without compromising the ability of future generations to meet their own needs (UN-Habitat, 2016).
- Equity: Promoting fair access to resources and opportunities for residents (Foster et al., 2016).
- Resilience: Enhancing the ability of urban systems to withstand and recover from shocks and stresses (FAO, 2022).

Sustainable Development Goals (SDGs):

The Sustainable Development Goals (SDGs) are a set of 17 global goals adopted by the United Nations in 2015 to promote sustainability and address pressing global issue. The SDGs provide a framework to achieve social, economic, and environmental sustainability by 2030 (United Nations, 2015). Below is a discussion on few SDGs that mainly benefit from urban agriculture:

SDG 1: No Poverty

Urban agriculture can reduce poverty by providing opportunities that generate income and improving access to affordable food(Drechsel & Keraita, 2023).

SDG 2: Zero Hunger

UA increases the availability of fresh and nutritious food in urban areas, thus contributing to food security (UN- Habitat,2022).

SDG 5: Gender Equality

Provides opportunities for women, such as income generation, family support and leadership in community projects (UN Women, 2021).

SDG 8: Decent Work and Economic Growth

Urban agriculture creates jobs and supports local economies(ILO, 2021).

SDG 11: Sustainable Cities and Communities

Urban agriculture enhances the sustainability of cities by creating green spaces, improving air quality, and promoting community resilience. (Foster et al., 2022)

SDG 13: Climate Action

Urban agriculture can mitigate climate change by sequestering carbon, reducing the urban heat island effect, and enhancing urban resilience. Local food production also reduces the environmental impact of food transportation (Foster et al., 2022).

SDG 15: Life on Land

Promotes biodiversity and sustainable land use practices, directly contributing to the conservation of terrestrial ecosystems (Fussy & Papenbrock, 2022) .

2.2. Theoretical Review

The theoretical framework for this study is grounded in three key areas: urban agriculture, sustainability, and spatial planning. These areas provide the conceptual foundation for understanding the role of urban agriculture in promoting food security, environmental sustainability, and sustainable urban development. Below, we discuss the relevant theories and concepts that inform this research (Pickett et al., 2020; Cullingworth & Nadin, 2023; Smit et al., 2021).

2.2.1. Urban Agriculture Theories

Urban agriculture is often analyzed through the lens of **urban ecology** and **food systems theory**.

Urban Ecology: emphasizes the importance of integrating green spaces, such as urban farms and gardens, into the urban fabric to enhance ecosystem services and promote sustainability (Pickett et al., 2001).

Food Systems Theory: role of urban agriculture in creating localized food systems that reduce dependence on external food supplies and enhance food security (Smit et al., 1996).

2.2.2. Sustainability Theories

Sustainability is a central theme in this study, and it is informed by the **Sustainable Development Goals (SDGs)**.

Sustainable Development Goals (SDGs):

As discussed above, urban agriculture has the potential to contribute to multiple SDGs. This study uses the SDGs as a guiding framework to evaluate the sustainability of urban agriculture in Addis Ababa.

2.2.3. Spatial Practices

The concept of spatial practices draws from Lefebvre's (1991) which focuses the production of space. It distinguishes space planned by authorities and lived spaces, that is shaped by inhabitants. In urban agriculture, spatial practice represents the lived space, how farmers produce agricultural plots within the landscape of formal city.

2.2.4. Spatial Planning Theories

Spatial planning is vital for integrating urban agriculture into the urban landscape. **Land use planning** and **green infrastructure planning** are some of the relevant theories

Land Use Planning:

Land use planning involves the allocation of land for various urban functions, such as housing, transportation, and agriculture. It emphasizes the need for equitable and sustainable land use practices that balance the competing demand for land (Cullingworth & Nadin, 2006).

Green Infrastructure Planning:

Green infrastructure planning focuses on the integration of natural systems, such as parks, green roofs, and urban farms, into the urban fabric (Benedict & McMahon, 2006).

2.3. Global and Local Perspectives on Urban Agriculture

2.3.1. Global Perspectives on Urban Agriculture

Urban agriculture is practiced in cities around the world, from developed countries like the United States and Germany to developing countries like Kenya and India.

Urban agriculture plays a critical role in enhancing food security by increasing access to fresh and nutritious food. It also contributes to environmental sustainability by reducing the carbon footprint of food production, and transportation promoting biodiversity, and enhancing ecosystem services.

2.3.2. Local Perspectives on Urban Agriculture in Addis Ababa

This section reviews the evolving policy landscape governing urban agriculture in Ethiopia.

Previous Guidelines

Ethiopia's agricultural development has been shaped by successive national frameworks, including the Plan for Accelerated and Sustained Development to End Poverty (**PASDEP**, 2005-2010) and the Agricultural Development Led Industrialization (**ADLI**) strategy, which emphasized agricultural commercialization and rural development (World Bank, 2007). While these frameworks did not specifically address urban agriculture, they established the policy foundation for recognizing agriculture's role in poverty reduction and food security.

Horticulture Strategy (2017) - The national Horticulture Strategy positioned vegetable production within broader agricultural commercialization efforts.

However, the strategy treated urban agriculture peripherally, primarily as an extension of peri-urban horticulture rather than a distinct urban land use. Emphasis on exported commercial crops overshadowed inner-city vegetable farming for local use. It also received minimal policy attention (MoA, 2017).

Pilot Projects and NGO Initiatives (2015-2023)

Parallel to national policy, development partners including Farm Africa, FAO, and local NGOs implemented pilot projects promoting household-level vegetable gardens in Addis Ababa.

These initiatives targeted low-income households, particularly women-headed families and they demonstrated potential for food security improvement

Figure 2:1- Pilot project of Farm africa
Source ; Field photograph

However, evaluations consistently identified systemic barriers like land scarcity, unreliable water access, and weak institutional coordination (Farm Africa, 2020). These pilot projects revealed that without supportive policy frameworks, project gains were unsustainable.

Current Guidelines (2026 -)

Urban agriculture development strategy is Ethiopia's first explicit UA development strategy (2026, Ministry of Agriculture). The strategy formally recognizes inner-city vegetable farming as integral to Addis Ababa's food system

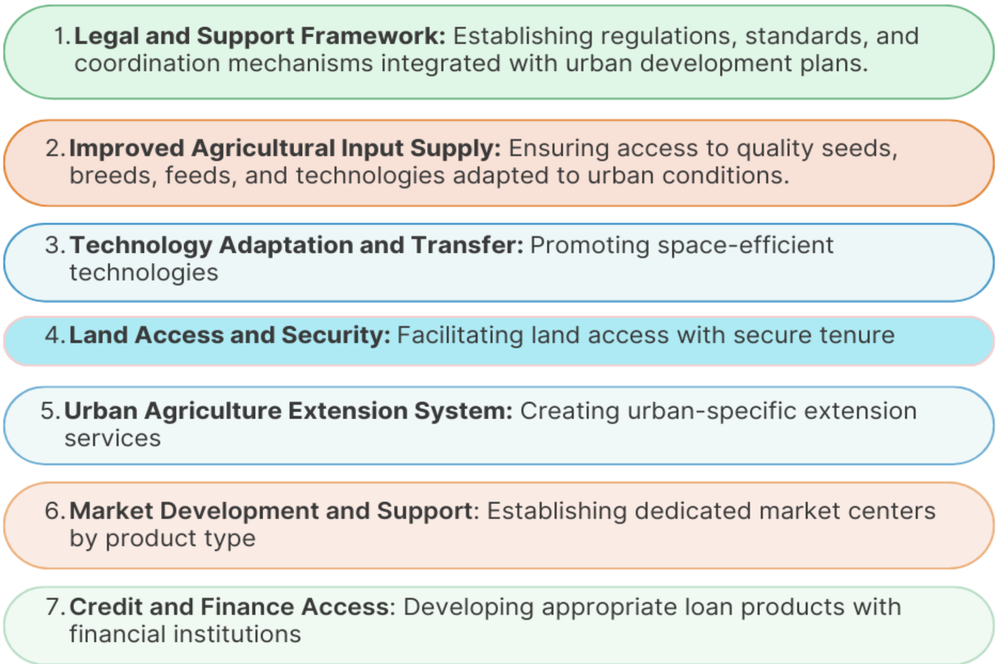


Figure 2:2 - Pillars of UA development strategy in Ethiopia (2018/19 G.C.).
Source - Ministry of Urban Development and Construction.

The strategy also addresses cross-cutting areas including water supply management (rainwater harvesting, wastewater treatment), education and training (curriculum integration, TVET programs), gender and social inclusion (targeting women, youth, and vulnerable groups), health and environmental safety, and incentive systems (tax exemptions, reduced utility rates).

2.3.3. Theoretical Framework

This study is guided by a framework that integrates global theories with the local reality of Addis Ababa.

The framework proposes that the sustainability contributions (SDGs) of urban agriculture are not automatic. They are mediated by the **spatial practices of farmers** and, most critically, by the **spatial planning framework of the city.**

Therefore, for UA to realize its full potential, it must transition from an informal livelihood strategy to a **formally recognized and planned component of the urban fabric**. Spatial planning is the essential mechanism to facilitate this transition.

2.4. Case Studies of Successful Urban Agriculture Integration

The following case studies explain how other cities have integrated urban agriculture into their spatial planning frameworks:

Case Study 1: Singapore:

Singapore has embraced urban agriculture as a key component of its sustainable urban development strategy. The city-state has implemented vertical farming initiatives, such as Sky Greens, which use high-rise buildings to grow vegetables and reduce the city's dependence on imported food (Teng, 2013).

3 ways Singapore's urban farms are improving food security

a. Urban farms using hydroponics on parking structure roofs :

Figure 2:3: Quartz, Google Street View, Citiponics

Source:Singapore Public Data

b. Installing urban farms into existing buildings : Outside and inside the building where Sustenir's indoor vertical farm is located.

Sustenir Agriculture has created an indoor vertical farm that can retrofit into existing buildings (including office buildings). The company grows foods that can't be produced locally, displacing imports and cutting carbon emissions.

c. Building a better greenhouse for urban farms in tropical climates Natsuki's Garden in the former schoolyard, now filled with greenhouses.

Natsuki's Garden is a greenhouse in the center of the city, occupying reused space in a former schoolyard.

Case Study 2 : Lem Plants - Local Case Study

Lem Plants is a herbal farming initiative in Gullele Subcity that integrates medicinal plant cultivation with rabbit and bird breeding. Operating since 2020 GC, this micro-enterprise has developed a circular economy model within a constrained urban space. The farm cultivates over ten species of herbal plants, including lemon verbena, rosemary and lavender serving both medicinal and culinary markets. What makes it notable is its adaptive use of vertical space and community negotiations to overcome typical urban farming constraints.

Figure 2:4: Lem plants / Cleaning plantations
Source : Field photograph

Lem plants employs space maximizing cultivation techniques, integrated livestock-plant production, and community oriented land use. For cultivation, they used hanging pots, rooftop gardens, and vertical farming structures to optimize its plot.

Figure 2:5: Rabbit placement and their house setting
Source : Field photograph

The rabbits are placed on a wooden box arranged vertically, where plants are suspended above them. The waste from the rabbits is then used as a fertilizer while the urine is used as a pesticide.

Through an informal agreement with the local Woreda administration and neighborhood committee, the farm has expanded its growing area by placing container plants in public spaces surrounding its compound, effectively creating community green spaces.

Despite its innovation, Lem Plants faced constraints common to urban agriculture. First, its location being deep within residential areas limits customer accessibility and visibility, forcing reliance on social media marketing as its primary sales channel. Second, water scarcity cause an ongoing challenge, with the operation depending entirely on seasonal rainwater harvesting supplemented by tanker water during dry periods. These constraints are barriers facing urban agricultural enterprises: inadequate infrastructure support and lack of formal recognition in urban planning frameworks.

The operation demonstrates multiple urban sustainability benefits. Environmentally, it transformed a previously underutilized urban space into a productive green area while implementing closed-loop waste systems. Socially, it fostered cooperation between private enterprise and local residents through its public-space container gardens. Economically, it showed the viability of plant cultivation in the dense urban area. Perhaps most significantly, the case reveals how informal agreements with local authorities can enable urban farming despite the absence of formal zoning provisions.

This case offers important insights:- First, it proves that micro-scale operations can achieve commercial viability through innovative design and product specialization. Second, it demonstrates how community negotiations can temporarily overcome institutional gaps in urban farming support. Third, it reveals the critical need for municipal policies addressing water access and urban land use rights for agricultural purposes. The farm's success with vertical systems and waste recycling provides replicable models for other urban farmers, while its ongoing challenges underscore the limitations of purely entrepreneurial solutions without institutional support

2.5. Research Gap

While urban agriculture has been widely studied, several gaps in the existing literature remain that this research seeks to address, particularly relevant to the context of Addis Ababa and the broader goals of sustainability and spatial planning.

First, much of the existing literature focuses on UA's role in food security and livelihoods, with limited attention to its spatial practices. Scholars such as Opitz et al. (2016) and Poulsen et al. (2015) have noted that while the benefits of UA are well-documented, empirical studies of where and how UA is practiced within densely urbanized inner-city contexts remain scarce. Similarly, McClintock (2010) observed that spatial dimensions such as land access, plot location, and proximity to infrastructure are often treated as secondary variables rather than central analytical categories. This gap is particularly pronounced in African cities, where Lee-Smith (2010) and Drechsel & Keraita (2014) have called for more detailed spatial documentation of UA practices. Second, a significant gap in the literature is the lack of research on how UA can be integrated into formal spatial planning frameworks. While some studies have demonstrated the importance of spatial planning for UA (Lovell et al., 2010), there is limited empirical evidence on effective strategies for achieving this integration. Horst et al. (2017) and Zasada (2011) have argued that policy-relevant frameworks for UA integration remain underdeveloped, while Pourias et al. (2016) specifically identify the absence of case studies that translate UA's multifunctional potential into actionable land-use policies. Furthermore, the intersection of UA with contemporary urban transformations—such as riverbank rehabilitation and corridor development—remains underexplored, especially in the East African context (UN-Habitat, 2020). This study therefore addresses these gaps by documenting spatial practices in Arada Subcity and proposing a spatial integration framework responsive to ongoing redevelopment.

3. Chapter Three: Methods and Materials

3.1. Description of Study Area

The study focuses on Arada, a sub city found within Addis Ababa, Ethiopia. Arada is one of the central subcities of Addis Ababa.

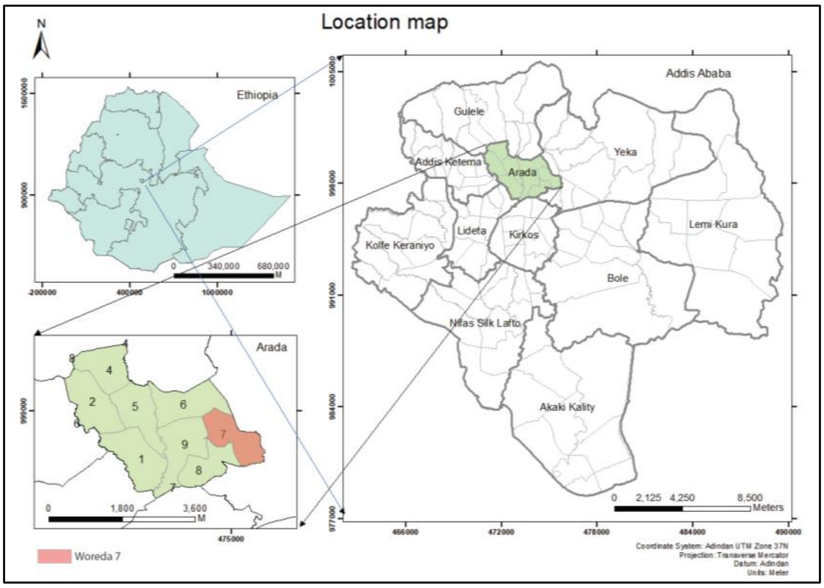


Figure 3:1 Location map of study area
Source: Generated using GIS software

Within Arada Woreda 07 represents a microcosm of Arada's urban dynamics, covering approximately 1.1km^2 of total area with a population of 4,898 residents (before evacuation).

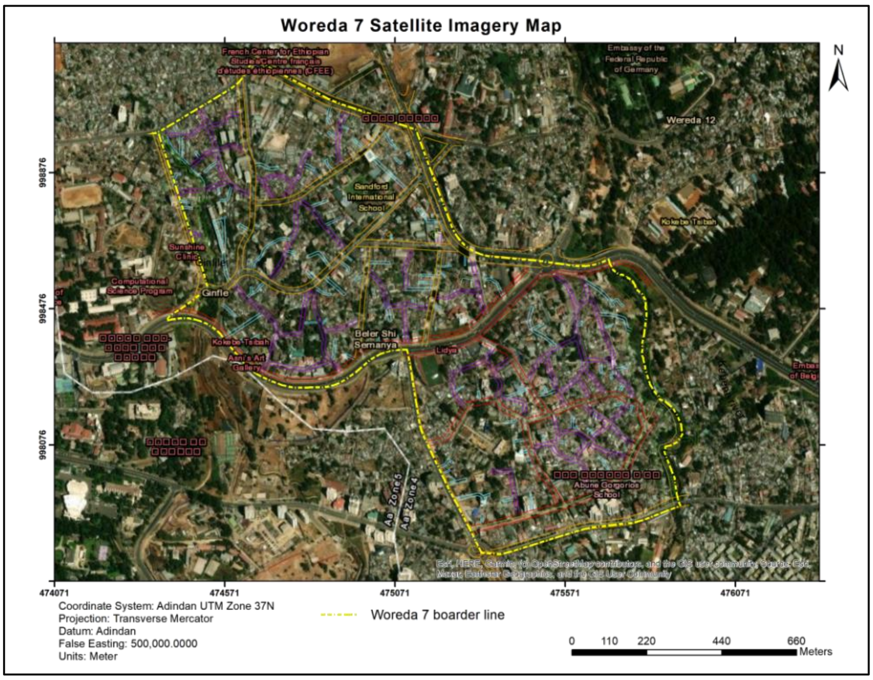


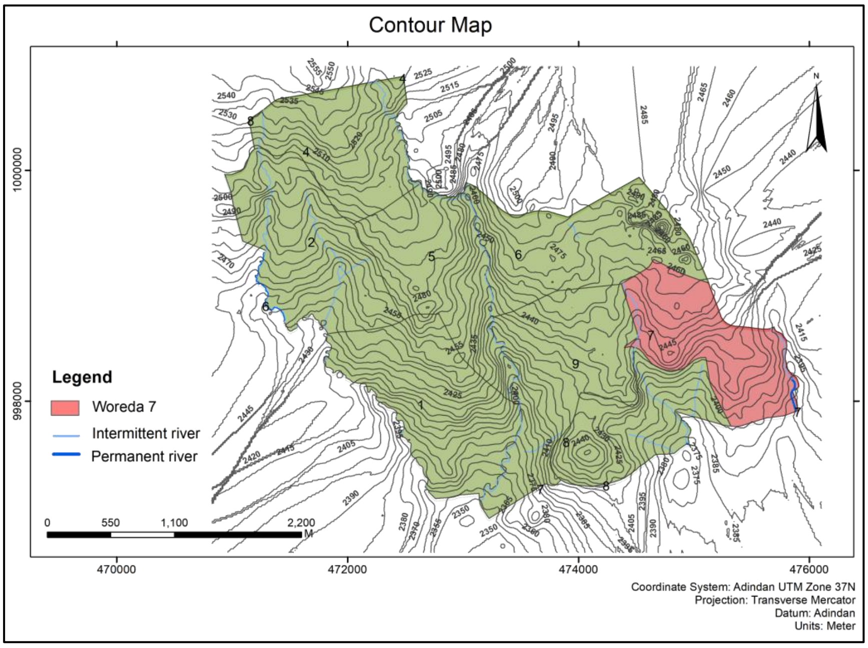
Figure 3:2 Areal map of study area
Source: Generated using GIS software

The subcity's proximity to the Sheger Beautifying project and the Corridor Development Project. is a contextual factor, facing both displacement and new opportunities for formalization. As green infrastructure is given attention, being included widely in commercial zones as shown in the smart parking below, is the first step ahead to including UA as well.

Figure 3:3. Corridor development projects with green infrastructure in Arada subcity
Source; Field photograph

3.1.1. Topography and Microclimates

The area has distinct wet and dry seasons, with dry season from December to April and heavy rainfall occurring from June to September. Average annual temperatures range between 12°C and 24°C, with a long-term mean of around 18.4°C.(Wubneh 2013). Its central location and elevation makes mild to hot daytime temperatures and cooler nights.



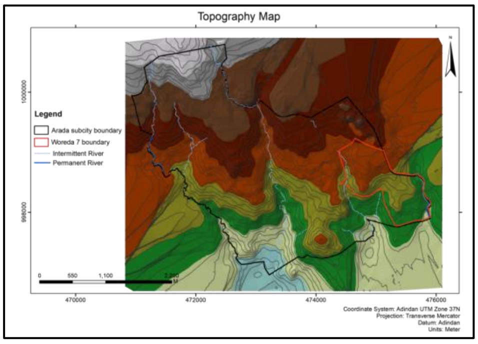


Figure 3.4: Map showing contour and river line of Arada subcity

Source: Generated using GIS software

Arada's topography is varied, with an elevation range from approximately 2,300 to 2,444 meters above sea level. This variation creates distinct microclimates that influence agricultural potential.

South-facing slopes receive more sunlight, making them marginally more favorable for certain vegetables. However, steeper slopes, particularly those exceeding 15-20%, are prone to erosion and are less suitable for traditional farming without terracing, a practice not commonly observed due to cost and labor requirements (Moges et al, 2018).

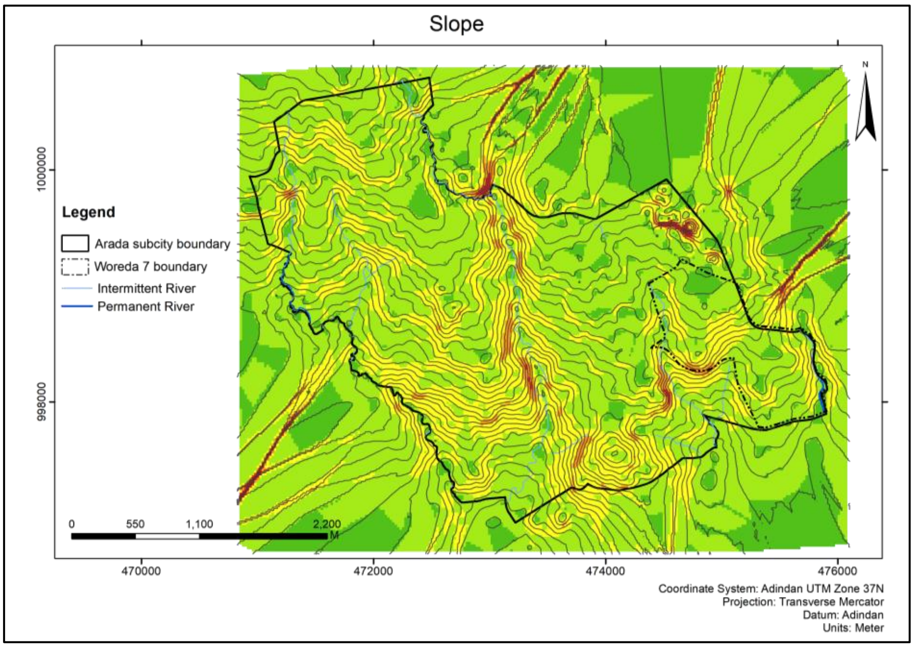


Figure 3.5: Map showing slope of Arda subcity
Source : Generated from SRTM DEM data using GIS software

Lower-lying areas, particularly those along the riverbanks, are more susceptible to cold air drainage and ice during winter, which aligns with farmer reports of winter crop damage from iced rains. This climatic constraint pushes urban farming to almost completely stop during the winter season .

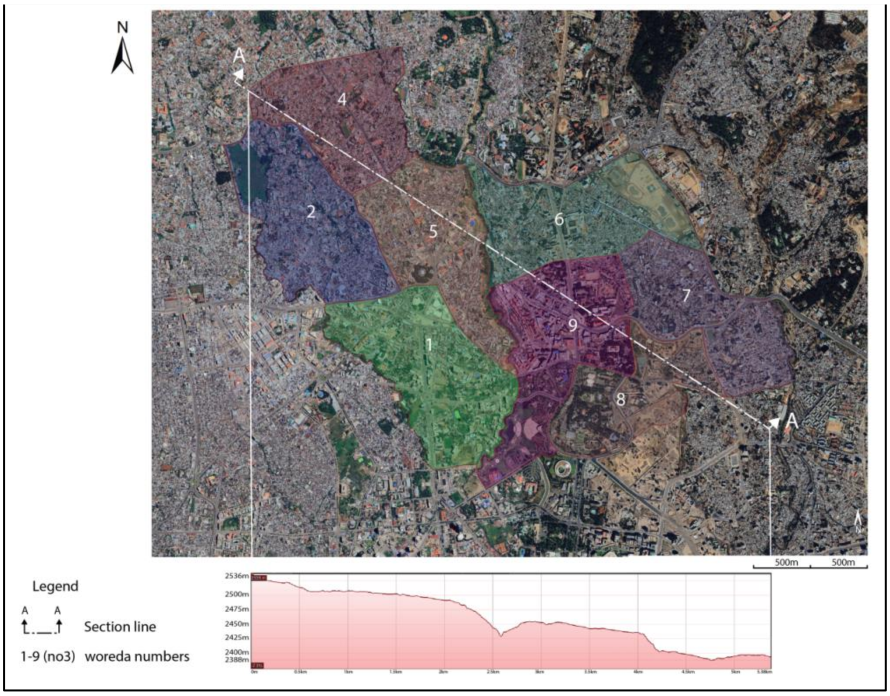


Figure 3.6. Map showing section of Arada subcity
Source: Generated using Google Earth Pro

Gentle slopes can be leveraged for gravity-fed irrigation systems in redesigned landscapes. It is critical for watershed management and planning rainwater harvesting systems to supply these modern facilities

3.2.2. Woreda 07: Case Study Area

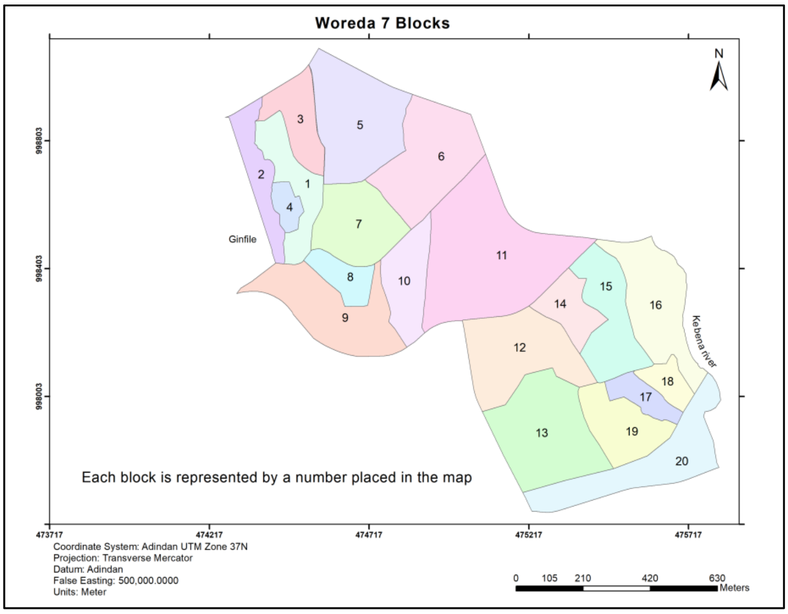


Figure 3.7. Map showing blocks of Woreda 07, Arada subcity

The Woreda contains 20 residential blocks with varying landuse pattern. Some blocks significantly larger than others.

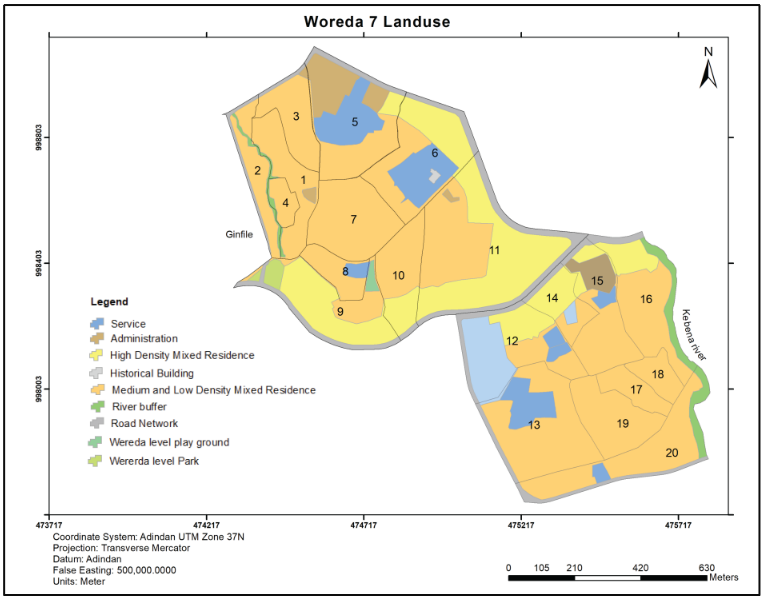


Figure:3.8. Map showing Landuse
Source: Addis Ababa land use map

The Woreda is currently going through corridor development along main transportation routes, including BRT setbacks.

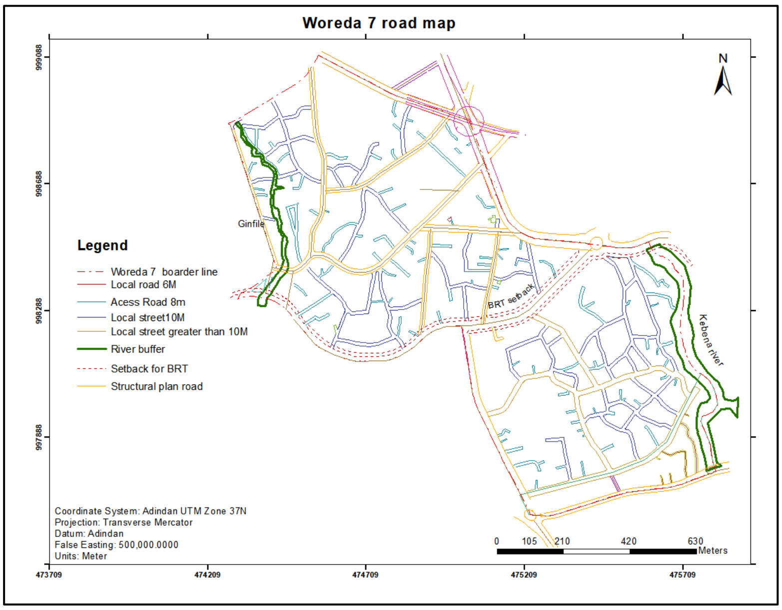


Figure 3.9. Map showing key infrastructure (roads, rivers, strategies) Add institutions
Source: Arada subcity administration office

The high-density development, as Woreda 07, and central location creates a paradox: it places UA activities close to a large consumer market but also in direct competition with the highest-value land uses in the city.

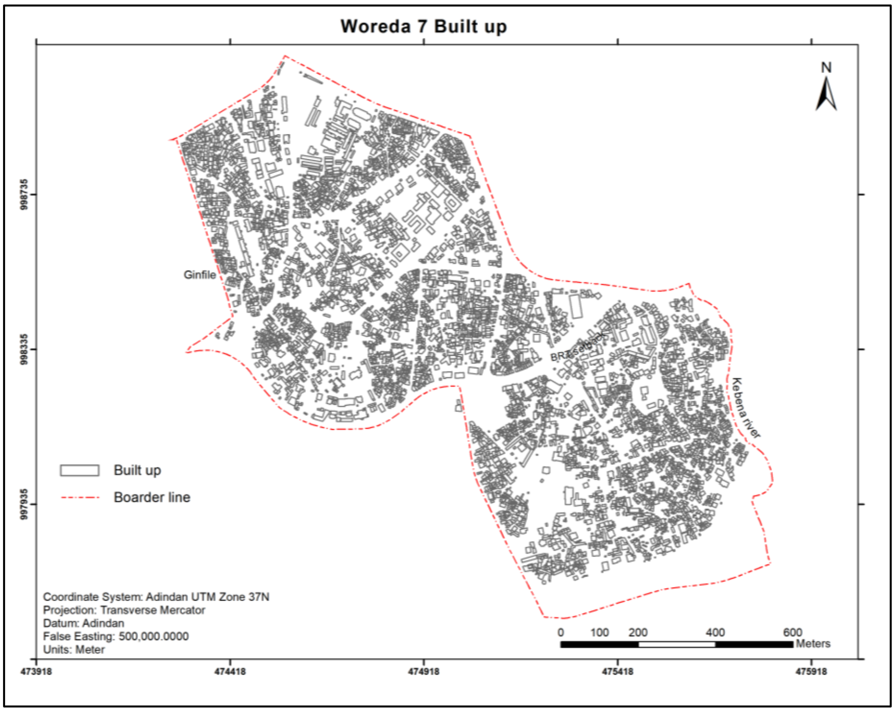


Figure: Map showing Built up environment of Woreda 07
Source: Generated using GIS software

3.2. Research Design

The research adopts Mixed-Method Design. In this design, qualitative and quantitative data are collected. The results are then merged or compared to provide a more complete understanding of the research problem.

3.3. Data Type and Data Source

The study uses both **primary** and **secondary data** to address the research objectives. Below is a detailed breakdown of the data sources and types for each objective.

Table 3:1: Data sources and types for each objective

Research Objective	Primary Data Sources	Secondary Data Sources	Data Type
1. spatial practices	GPS coordinates of farm plots / Field observation notes & photos	• GIS base maps (Arada Subcity) / Satellite imagery / Official land use plans	Spatial data (primary and secondary)
2. challenges	Structured surveys & interviews with	Woreda 07 urban farm report Ministry of	Spatial data (primary and secondary)

	farmers	Agriculture reports Ministry of Urban Development and Construction.	
3. productivity & SDGs	yield surveys / case studies of successful projects	reports, UN SDG indicator databases.	Quantitative performance data (primary = numeric yields; secondary = indicator metrics)
4. integration framework	Key informant interviews	Spatial planning documents, Best-practice case studies	Qualitative policy & narrative data (primary = interview transcripts; secondary = policy texts)

Source: Computed by the author 2026

3.4. Population and Sampling Technique

Target Population

All registered urban vegetable farmers in Woreda 07, Arada Subcity. According to **data obtained from the Woreda 07, registered UA practioners,** Urban Agriculture Office, this constitutes a finite population of **N = 1,473 farmers.**

Additionally there is a separate group of experts and officials involved in urban agriculture policy and planning.This population targets key informants from relevant institutions, which includes, **planners** (from the Arada Subcity Urban Planning Office), **policymakers** (from Addis Ababa City Administration Farmers and Urban Agriculture Development Commission (AACAFUADC) and Ministry of Agriculture)**, and representatives** (from NGOs supporting urban agriculture in Addis Ababa) .

3.4.1. Sampling Technique

A multi-stage sampling strategy was employed to ensure both breadth and depth of data:

For Urban Farmers **a proportional sampling** was used, divided into strata with blocks. The sample size is proportional to the total number of practitioners that are found within a Woreda. Blocks with higher practitioner density received proportionally larger samples, ensuring the survey captured adequate representation across all 20 blocks. Within each block, households were selected using systematic random sampling, where every nth household from a sorted list of known UA practitioners was chosen until the block's quota was reached.

For Key Informants **Purposive Sampling technique** was used. Participants were selected specifically for their expertise and role in urban agriculture policy, planning, and support to ensure interviews capture insights from individuals with the most relevant knowledge and experience.

3.4.2. Sample Size

The sample size for the survey of urban farmers was determined scientifically using the standard sample size formula for a finite population (Krejcie & Morgan, 1970).

$n = N / (1 + N(e)^2)$

Where: n= required sample size

N= total population size

e= desired margin of error (7% or 0.07)

$n = 1473 / (1 + 1473 * (0.07)^2)$

$n = 1473 / (1 + 1473 * 0.0049)$

$n = 1473 / (1 + 7.2177)$

$n = 1473 / 8.2177$

$n \approx 179$

A 7% margin of error was selected due to time and resource constraints, which made the conventional 5% margin (requiring n=306) infeasible within the study's schedule.

This calculation yielded a minimum sample size of 179 farmers. To account for potential non-response, the study targeted 190 (added 5%) respondents. Following this, respondents were allocated across the 20 blocks of Woreda 07 using proportional sampling method based on practitioner density on each block:

Respondents per block = (practitioner per block % × Total practitioner)

For Key Informant Interviews: In qualitative research, sample size is not determined statistically but by the principle of data saturation, the point where new interviews no longer provide new themes or insights.It is anticipated that interviewing 8-12 key informants will be sufficient to reach saturation.

Respondents = Practitioner % × 190

Table 3:2 Respondent Sampling by Block

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Source : Data collected from woreda 07 UA office, registry report

3.5. Data Collection Methods

In this section the methods and tools used to collect data are outlined, a comprehensive approach to address research objectives.

Primary Data Collection Methods

Field Surveys- Structured questionnaires are used to collect data from practicioners on farming practices, challenges, and spatial distribution to gather quantitative data on the scale and scope of urban agriculture in Addis Ababa.

Interviews- Semi-structured interviews are conducted with key stakeholders, including urban farmers, policymakers, NGOs, and planners. Interview guides with open-ended questions is used to explore perspectives on urban agriculture, sustainability, and spatial planning to collect qualitative data on the challenges, opportunities, and potential of urban agriculture.

Secondary Data Collection Methods

Government Reports- Reports from the Ministry of Agriculture, Addis Ababa City Administration, and other relevant agencies is reviewed to collect data on urban agriculture policies, land use, and sustainability indicators.

Academic Studies- Peer-reviewed articles, theses, and books on urban agriculture, sustainability, and spatial planning is reviewed to gather theoretical and empirical insights to inform the research.

Spatial Maps- GIS maps from government agencies and academic institutions was obtained. Tenure status was derived from **house number data in ward office records**, categorized as: (1)Tenants: entries marked 'Tenant' or equivalent; (2) Informal: entries marked 'New', 'Shelter', or blank.

3.6. Analytical Framework

The framework, summarized in the table below, specifies the data sources, analytical methods, and theoretical concepts that are applied to address each objective.

Research Objectives → Data Sources → Methods → Theoretical Lens

Table 3:3 : Analytical Framework for the Study

Research Objective	Data Sources	Analytical Methods	Theoretical Lens / Concepts
1. Assess spatial practices	• GIS maps • Field survey data • Field observations & photos	• Spatial analysis (location, density, clusters) •Descriptive statistics (crops, techniques)	• Spatial Planning (form vs. informality)
2. Assess challenges & their	• Survey data (challenges, yields) • Interview transcripts	• Correlation analysis (challenge vs. yield) • Thematic analysis	• Resource Access

effects	(farmer experiences) • Secondary data (land use)	(causes, barriers)	Theory (constraints)
3. Evaluate productivity & SDG contribution	• Yield survey • Interview data on benefits • Secondary SDG indicators	• Productivity calculation (using formula: production kg → people fed/ nutrient gain) • Thematic analysis (social/environmental co-benefits)	• SDG Framework
4. Propose integration guidelines	• Synthesis of Objectives • Case studies (Singapore, Lem Plants) • Interviews with planners/policymakers	• Comparative case study analysis (best practices) • Synthesis & scenario building	• Spatial Planning (zoning, land use integration) • Green Infrastructure Planning (multifunctional design)

Source : Computed by the author 2026

3.7. Data Analysis Methods

This section describes the methods and tools used to analyze the collected data, ensuring a robust and systematic approach to addressing the research objectives.

Quantitative Data Analysis

Statistical Analysis: Statistical tools such as Excel and SPSS are used to analyze survey data to identify trends and patterns in urban agriculture practices,

Spatial Analysis: GIS software, ArcGIS is used to map urban agriculture sites and assess their integration into the urban landscape.

To learn specific SPSS and GIS functions, the author used Ai tools.

Productivity and SDG Impact Analysis

To objectively assess the contribution of urban agriculture to sustainable development goals, a standardized productivity analysis is conducted using the following formula

a) Formula for Nutritional Output of an Urban Farm

Number of People Fed = (Total Annual Yield (kg)) / 60 kg

Where:-

- **Total Annual Yield (kg)** is the farmer's reported or estimated annual production.
- **60 kg** is the midpoint of the annual per capita vegetable consumption recommendation (50-70 kg) by the World Health Organization (WHO, 2020).

For farmers who reported their plot size but not their yield, production is estimated using **standard yield coefficients**

b) Formula for Estimated Yield from Plot Size

Total Annual Yield (kg) = Plot Area (m^2) x Crop Yield Coefficient (kg/m^2/year)

Where:-

Crop Yield Coefficients are derived from a combination of -

a) Farmer-reported estimates (where available and reliable).

b) Standard average yield tables for traditional agriculture (e.g., Ministry of Agriculture or FAO sources) for common crops like Ethiopian kale, Swiss chard, and potatoes.

These calculations assume optimal harvest utilization. Actual food security contribution may be lower due to post-harvest losses (estimated at 15-20% for leafy greens in Addis, FAO, 2020)

Qualitative Data Analysis

Thematic Analysis: This is used to identify key themes and patterns from interviews and case studies. The purpose is to explore the challenges, opportunities, and potential of urban agriculture in Addis Ababa.

Interview data was coded using an Excel framework with columns for challenges, benefits, policy suggestions, quotes, and thematic analysis

Case Study Analysis: Case studies are analyzed to identify best practices and lessons learned for integrating urban agriculture into spatial planning. The purpose is to provide actionable insights for policymakers and urban planners.

3.8. Method of Data Presentation

This section explains how the findings are presented and communicated, ensuring clarity and accessibility for diverse audiences.

Quantitative Data Presentation

GIS maps were used to visually represent the spatial distribution of urban agriculture in Addis Ababa. The purpose is to focus on key areas for future development and integration into spatial planning. Bar charts, pie charts, and line graphs were used to present statistical data on urban agriculture practices, challenges, and sustainability indicators. The purpose is to provide clear and concise visualizations of key findings. Tables were used to summarize survey data, such as crop types, farming techniques, and challenges. The purpose is to ensure that data is well-organized and easy to interpret.

Qualitative Data Presentation

Narrative descriptions were used to present the findings from interviews and case studies. The purpose is to show key themes, such as challenges, opportunities, and best practices. Direct quotes from interviewees were included to provide firsthand insights into urban agriculture in Addis Ababa. Case examples are used to illustrate successful urban agriculture projects and their relevance to Addis Ababa. And infographics and diagrams are used to summarize key qualitative findings.

3.9. Validity and Reliability

Validity was ensured through triangulation of data sources (surveys, interviews, GIS maps, official reports) to cross-verify findings. Reliability was achieved by using a structured questionnaire documentation of the research process, ensuring the study is consistent and replicable.

3.10. Ethical Consideration

All participants provided informed consent, with verbal consent obtained for interviews. Participation was voluntary and anonymous, with no personal identifiers collected. Data is kept confidential and used solely for academic purposes, with measures taken to avoid any harm to participants.

3.11. Conceptual framework

This study is guided by a conceptual framework that links the existing conditions of urban agriculture (UA) in Arada subcity to its potential outcomes through a process of analysis and strategic intervention. The framework is illustrated below in the as discussed in following logic

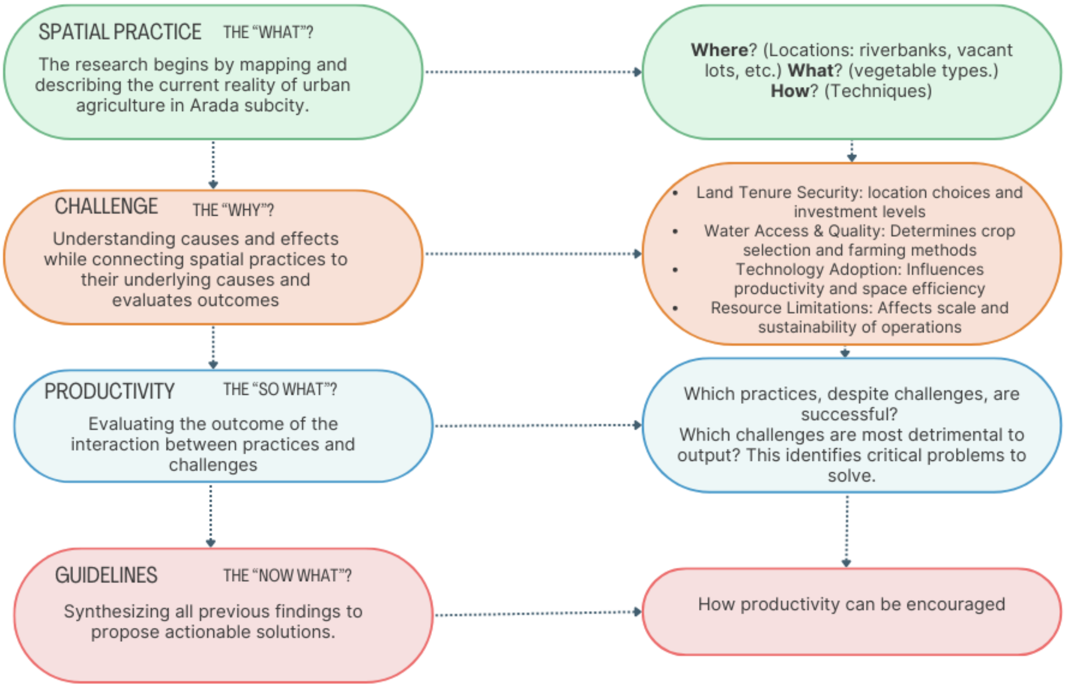


Figure 3:3: Conceptual framework
Source : Computed by the author

4. Chapter Four : Findings and Discussion

4.1. Assessment of Spatial Practices of Vegetable Urban Agriculture

4.1.1. Spatial Distribution and Land Use Context

Arada, being the smallest subcity in Addis Ababa, exemplifies the tension between urban redevelopment and urban agriculture (UA). Analysis of the 1,473 registered practitioners reveals uneven distribution across Woreda 07's 20 blocks, with concentrations in Blocks 11 (149 practitioners), 6 (140), and 5 (128). Heat map (Figure 4.1) layered with surveyed data shows these concentrations align with marginal lands rather than planned agricultural zones.

While comprehensive visual mapping of urban farms is challenging due to their informal and often temporary nature, the following heat map shows concentrations of both informal and formal settlers practicing UA. Along the intermittent Ginfile River, residents living on or near the riverbanks cultivate plots there. The Kebena River is also used for farming; however, this section flows through a steep cliff area, making the banks less suitable for traditional farming unless terracing is employed, a method that requires greater labor, tools, and financial input (Int05).

A base map of Woreda 07 containing georeferenced house numbers was obtained from the Arada Subcity Administration Office. Separately, a list of registered UA practitioners with their house numbers was obtained from the Woreda 07 Urban Agriculture Office. These house numbers were imported as point data into GIS and overlaid onto the base map. Only points that successfully matched existing house numbers on the base map were retained. A heat map was then generated using rasterization (kernel density estimation) to visualize zones of high practitioner concentration.

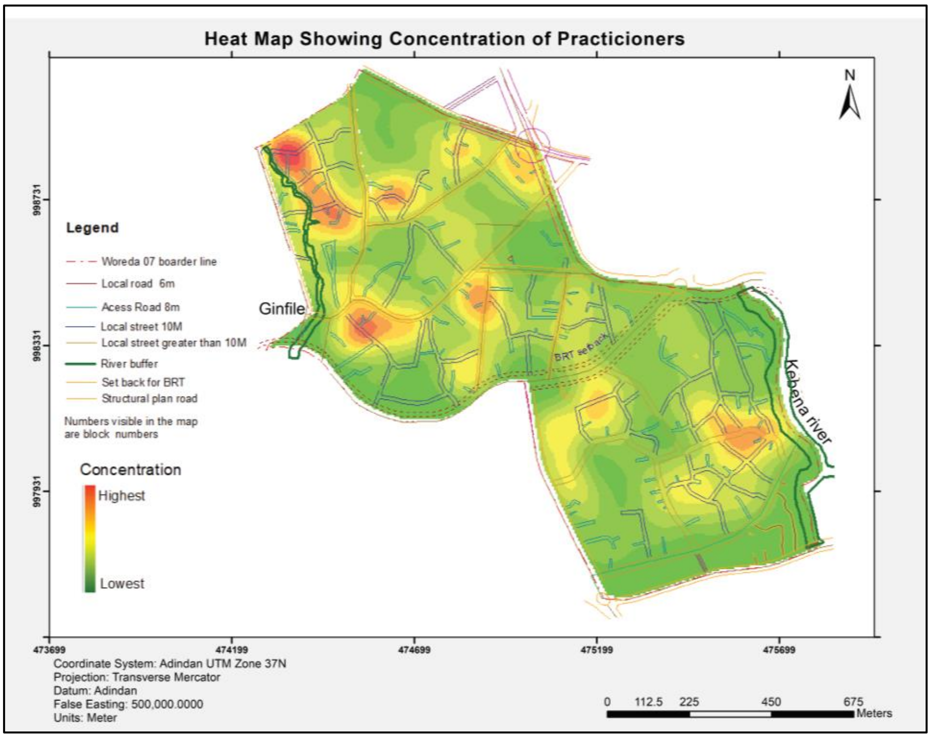


Figure 4:1: Heat map showing concentrated zones of urban farm practitioners as of 2025
Source: Author's compilation from Arada Subcity Ward Office Registry (2026)

Figure 4:2: Street side(concentrated zone) vegetable cultivation in Woreda 07
Source: Field Photograph

Among the respondents for this survey, location of UA persists along vacant lots, and within institutional compounds (e.g., schools and government offices) as shown in the table below.

Table 4:1: Spatial Distribution of Urban Agriculture Plots by Location Type (n=190)

Farming Location	Farm concentration (%)
Vacant lot farm location	44.7%
Institutional compound farm location	28.9%
Residential compound farm location	17.4%
Riverside farm location	8.9%
Rooftop farm location	0.1%
Other farm location	.00

Total	100.%

Source: Survey data analysis using SPSS (Author, 2025)

As shown in Table 4.1, nearly half of all farming plots (44.7%) are located on vacant lots, temporary spaces awaiting development. This result suggests that urban agriculture in Arada Subcity is highly dependent on marginal and temporarily available land. Which leads to a structurally insecure system that is vulnerable to displacement due to ongoing urban redevelopment.

As officers from Arada Administration office noted "There are still farms in riverbank areas, as the development has not reached there yet, however they are planting vegetables as long as they get evicted." Int6

In contrast, the newly built Public Parks, incorporates herbal plants such as rosemary, lavender, and rue, signaling municipal acceptance of productive landscaping.

Figure 4:3: Herbal plants [Rue & Rosemary in Ginfile park, Lavender on roadside]
Source; Field Photograph

Rooftop farming method shows the lowest percentage which is 0.1%, this implies lower use of vertical space and structural instability of homes.

From the table below (**Error! Unknown switch argument.**) it can be understood that plot sizes can depend on location. Residential compounds relatively have the largest average plots (14.45 m²), while vacant lots provide the smallest (7.22 m²).

Table 4:2: Plot Size Characteristics by Location Type

Location Type	Mean Plot Size (m²)	Standard Deviation	Minimum (m²)*	Maximum (m²)*
All locations	9.9	4.28	5	25
Residential compounds	14.45	4.24	5	25
Riverside areas	12.82	4.8	5	15

Institutional compounds	10.4	2.81	5	12
Vacant lots	7.22	2.76	5	15
Rooftops	1	1	1	1

Source: Survey data analysis using SPSS (Author, 2025)

A.Institutional plot B. residential plot C. Vacant lot

Figure 4:4 : Plot size comaprison by location
Source: Field photograph

The persistent use of marginal lands in the inner city reveals that land is very scarce. On this practice, scaling production is not in the picture as this is a survival strategy following land constraints.

However this practice and spatial organization of UA also has positive sides. It exemplifies what Bryld (2003) terms “opportunistic urban agriculture,” where residents creatively utilize marginal, interstitial spaces in response to land scarcity, whaever land that is available for them, not land that is planned for them. Although there isn't any coordinated land use, residents adapt to their available spaces and resources to cultivate and make use of what they already have.

Consequently, as UA spaces create a cluster, as visible in the heat map analysis, they'd turn in to a semi-formal practice. Where local authorities get involved. These clusters represent what Mougeot (2000) describes as “invited spaces” where UA gains provisional recognition from local authorities.

There is a visible fluctuation in tenure security, mostly depending on location of the plot. Vacant lots and riverbanks are highly vulnerable to eradication, residential plots seem to have better security, a dynamic also noted by Drechsel and Keraita (2014) in their studies of urban farming on contested lands. Meanwhile, the extremely limited use of rooftop spaces or technological methods leads to what Teng (2013) identifies as a “technology adoption gap” in resource-constrained urban contexts.

4.1.2. Crop Typology and Farming Techniques

4.1.2.1. Crop Types

Urban farmers in Arada Subcity demonstrate selective cultivation focused on leafy vegetables that are suitable for small-scale urban cultivation. As shown in **Error! Unknown switch argument.**, the most commonly grown crops are Swiss chard, lettuce , and green collard . The prevalence of quick-growing leafy vegetables reflects adaptation to spatial constraints and high market demand for fresh produce.

Table 4:3: Most Commonly Grown Vegetable Crops (Multiple Response Analysis)

Crop	Farmers Growing (%)	Primary Season	Key Characteristics
Swiss chard	84.7%	Year-round	Fast-growing, nutrient-dense
Lettuce	81.1%	Dry season	Quick harvest, high water needs
Green collard	70%	Year-round	Cultural preference, hardy
Carrots	62.6%	Winter	Deep-rooted, storage capability
Beets	58.9%	Winter	Tolerant of cooler temperatures

Source: Survey of 190 farmers, multiple response analysis

This pattern indicates that urban agriculture is primarily oriented towards immediate consumption.


Figure 4:5: Collard green plantation at MoPD
Source: Field photograph

Herbal plants are grown by about 5 out of 10 households. The most common are:

Rue - traditional medicinal plant

Rosemary - cooking and medicinal uses

Damakase (Ocimum lamiifolum) - popular home remedy

These herbs represent cultural preservation within urban agriculture. The following image shows these herbal plants existing at the same place, which indicates often use. Int2

Residence

Communal Garden

Figure 4:6: Common herbal plants
Source: Field photograph

4.1.2.2. Techniques Used

The survey reveals **three** clear patterns in farming methods:

- Traditional soil-based farming dominates, with 63% of farmers using only traditional ground plots.
- Adaptive mixed methods are used by 30% of farmers who combine traditional plots with container/ terraced gardening, that is popular in residential compounds
- Advanced method, which is vertical farming in this case, is used by only 8% of farmers.

Table 4:4: Farming Methods by Location Type

Location	Traditional Only		Traditional + Containers		Other Methods	Total from n=119
	Per	Freq.	Per.	Freq.		
Riverside(n=17)	88.2%	15	11.8%	2	0%	9.1%
Residential (n=32)	43.8%	14	31.3%	10	25%	17%
Institutional(n=55)	65.5%	36	34.5%	19	0%	29%
Vacant lot(n=52)	65.9%	54	29.3%	24	4.9%	43%

Source: Survey data analysis using SPSS (Author, 2025)

Location - where farmers grow affects **how they grow:**

Riverside farmers (9% of total) use almost **exclusively** traditional methods (88%)

Residential farmers (18% of total) show the most innovation with mixed methods

Institutional farmers (29% of total) stick mainly to traditional approaches due to larger ground space

Vacant lot farmers (43% of total) primarily use traditional methods

This spatial pattern suggests that **innovation correlates with land security** and proximity to dwelling. Residential compound farmers, with more secure tenure (57.6%), demonstrate greater willingness to invest in time and finance.

Figure 4:7: Residential compound farm, image indicating higher time and financial investment
Source: Field photograph

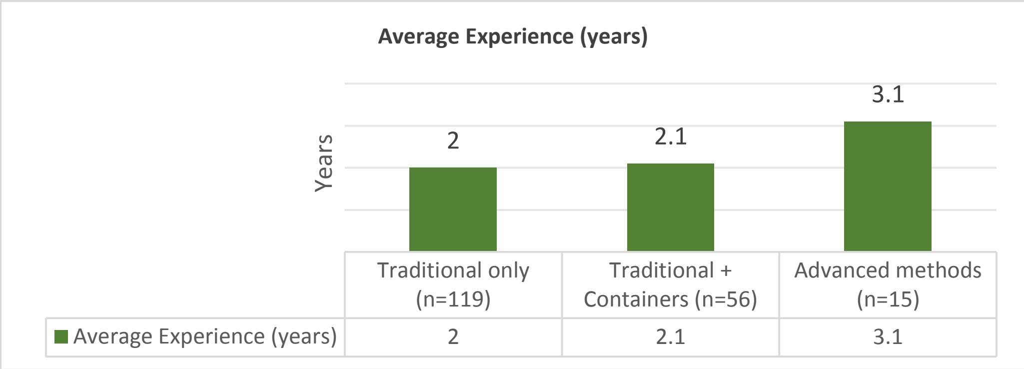
Looking at vacant lots, despite being temporary, these vacant lots keep the streets clean, While using organic waste as fertilizers, they also clean the street verges, as they also spend most of their time on it. Gaining food and income from these places give purpose for unemployed residents.

Why traditional methods dominate

1. Advanced systems **require investment** that most farmers can’t afford. Gender differences also play a role 23% of men use advanced methods women only 3% use advanced methods. This suggests unequal access to resources and technical knowledge.

2. Farmers with more experience are more likely to adopt advanced methods. Those using "other methods" (including vertical farming) average 3 years of experience, compared to 2 years for traditional-only farmers. This implies that the more experienced farmers are the more they tend to experiment.

Figure 4:8 Chart showing average farming experience cross-tab with farming method



Source: Survey data analysis using excel (Author, 2025)

4.1.3. Profile of Urban Farmers

In the following table the, demographic and socio-economic characteristics of urban farmers is provided , as it is an essential unit to understand challenges and practices.

Table 4:5: Demographic Profile of Urban Farmers in Woreda 07

		Count	Column N %	Mean ± SD	Range
Gender	Male	47	24.7%		
	Female	143	75.3%		
Age Categories	20-29	14	7.4%		
	30-39	70	36.8%		
	40-49	58	30.5%		
	50-59	34	17.9%		
	61+	14	7.4%		
Years of farming experience	1 year	87	45.8%		
	2 years	33	17.4%		
	3 years	50	26.3%		
	4+ years	20	10.5%		
plot size in square meters				9.90 ± 4.28 m²	5-25 m^2
Has secure land	No	158	83.2%		
	Yes	32	16.8%		

Source: Survey data analysis of n=190 using SPSS (Author, 2025)

In Woreda 07 women compose 75% of urban farm practitioners. This noticeable distinction in gender implies that UA is a survival strategy among women in the sub city. When looking at 'age' most of the farmers, 67%, are **middle aged**, from 30-49 years old. Young pople, between 20-29 years old however show low engenement.

Despite older ages, experience is low, as most practitioners, 63%, are new farmers, as they have been farming for one to two years. This implies the current attention UA is gaining in the city, the new policy implementation, as well as resource distribution, like seedlings and small plots of lands, and encouragements done by the sub city officers.

Although residents get support from local authorities, land is still the main issue, with average plot sizes of 9.90 m² (range: 5-25 m²). Additionally farmers are highly insecure, that is 83%. These lands of practitioners are dispersed among the woreda, small plots that are found across the sub city. This reveals , when layered on a map as follows, high level of informality, variations in available space, and population density. This in general creates vulnerability to displacement and limits investment in land improvements.

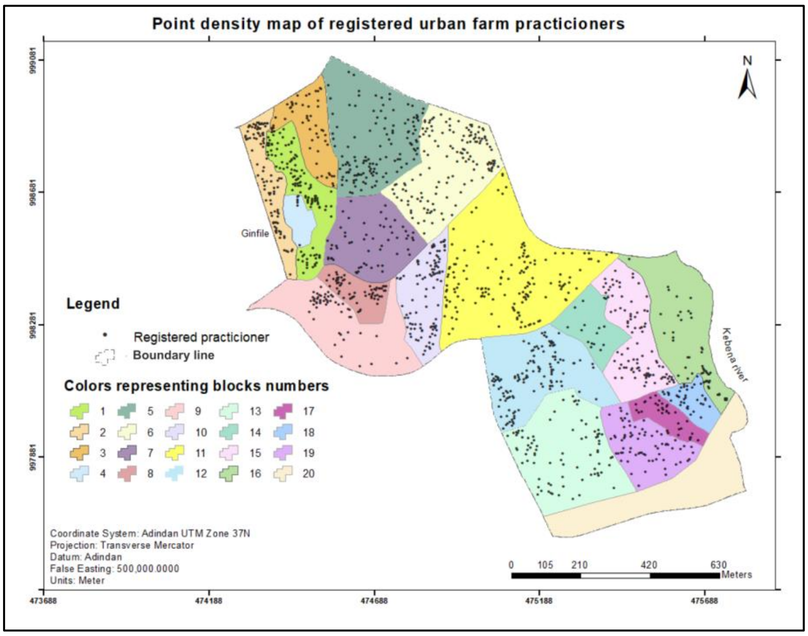


Figure 4:9: Map showing spatial distribution of registered UA practitioners within Woreda 07
Source: Author's compilation from Arada Subcity Ward Office Registry (2024)

Point density analysis of practitioner locations reveals **clustering in central and northern blocks**, with lower densities in peripheral areas. This pattern corresponds with available marginal lands and institutional compounds that accommodate farming activities.

4.2. Assesment of Challenges of Urban Agriculture in Arada Subcity

Challenges in Arada are layered and distinct, arising from pressures the woreda is facing. Ranking the challenges using ranked challenge methodology based on severity is the first step to analyze challenges depending on their appearanace and repetitiveness.

Table 4:6: Challenges faced ranked

Challenge	Total mentions (Freq.)	Composite Score (% of respondents, n=190)
Land access	111	52.6%
Water access	100	33.7%
Pests/Diseases	66	58.4%
Theft/Damage	64	27.3%
Money to invest	63	33.1%
Labor	52	34.8%
Tools	27	13.7%
Technical knowledge	26	10.5%
Flood	20	14.2%
Soil quality	14	7.4%
Seeds/Fertilizer	9	4.7%
Total	Multiple response	3 mentions

Source: Survey data analysis using SPSS (Author, 2025)

Main themes emerged in interview data

Land insecurity appears in 82% of interviews

Water issues in 71%

Financial barriers in 53%

All interviews connect directly to survey findings (83.2% land insecurity, 20% water issues, gender pattern)

See appendix B, Table B.1 for detailed reference

Findings represent conditions at time of survey which was dry season. Seasonal challenges may be **underreported**.

4.2.1. Land Tenure Insecurity and Competition

Land insecurity remains the most pressing constraint for urban agriculture in Arada Subcity as shown in the chart below, higher portion(83.2%) of respondents have no secure land.

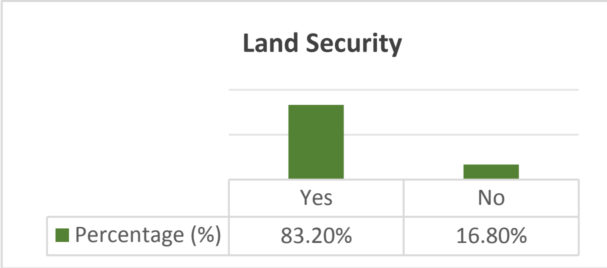


Figure 4:10 :Chart showing secure land percentage among respondents
Source: Source: Survey data analysis using excel (Author, 2025)

Cross-tabulation reveals dramatic variations in tenure security (**Error! Unknown switch argument.**). Residential compound farming provides the **highest** security (57.6%), aligning with property ownership patterns. In contrast, institutional compounds show surprisingly low security (7.3%), despite their formal appearance and motivating local residents by occasionally providing land access. As regarding the Ministry of Planning and Development farm, the urban agriculture practice was forced to stop mainly because of the corridor development and staff reallocation.(Int3) **Ethiopia National Primary and Secondary School** and **Arada Manufacturing College** are also examples.

When looking at tenure volunerability, vacant lots, showing security of 9.4%, and riverside sreas, having 5.9%, are most vulnerable, their status can be marked as **temporary, contested spaces**. This finding aligns with policy dialogue insights "In Addis Ababa, traditional urban farms generate much less income than a high rise building, therefore investors preferred building commercials than keeping a farm nearby the urban."

Table 4:7: Land Tenure Security by Location Type

Location Type	Secure Tenure (Yes)	Insecure Tenure (No)	Total	% Secure
Residential compounds	19	14	33	57.6%
Institutional compounds	4	51	55	7.3%
Vacant lots	8	77	85	9.4%
Riverside areas	1	16	17	5.9%
Total	32	158	190	16.8%

Source: Survey data analysis using SPSS (Author, 2025)

Spatial Vulnerability and Development Pressures

The connection between spatial distribution, plot size and tenure insecurity, implies that UA is practiced in marginal and small lands with limited long term security

Figure 4:11 :Vulnerable site [Woreda7] to a redevelopmet project
Source : Field photograph

As illustrated in the bar chart below, for those without secure land tenurethe dominant threat causing the insecurity is mainly eviction, mentioned by 51% of respondents , next comes development projects that coveres approximately 39% of the response. The last and the minimal threat is rent issues.

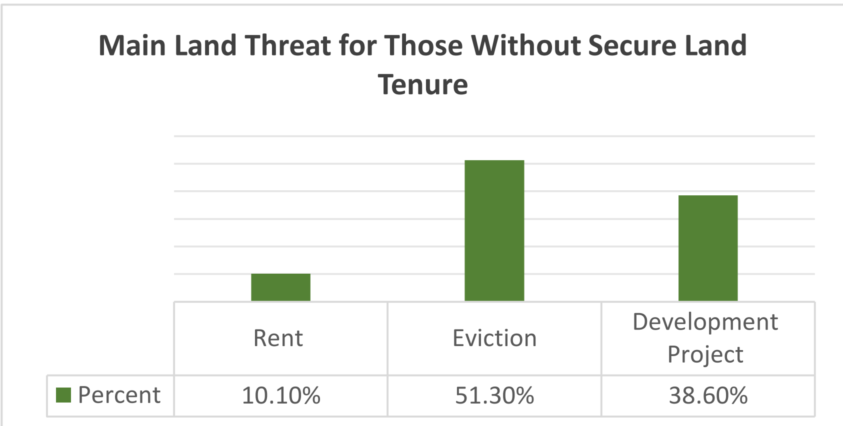


Figure 4:12 : Chart showing main land threat for those without secure land
Source: Survey data analysis using excel (Author, 2025)

This tenure insecurity is accelerated by urban transformations. As lead executive at Ministry of Agriculture noted:"Constructing buildings can easily generate more income relative to urban agriculture... we need to show people the methodologies that this can be done." Int4

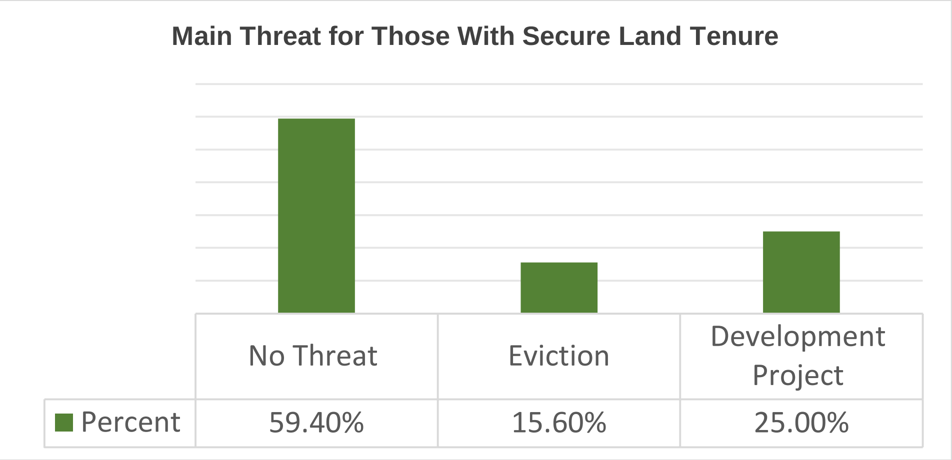


Figure 4:13: Chart showing main land threat for those with secure land
Source: Survey data analysis using SPSS (Author, 2025)

For those with formal land tenure, development project is still a threat, at 25% of respondents mentioned it. This indicates legal status doesn't fully protect lands and urban farmers from being evacuated.

These quantified pattern also corresponds with qualitative data, that is interview from Basha Wolde condominium. Farmers in the communal living space mentioned about small fragmented land and competing land uses like parking area and playground.

Figure 4:14: Basha wolde condominium parking and playground
Source : Field Photograph

Spatial practices are the main variable that create a success story for sustainable outcomes. however, land tenure is also a mediating factor as most farmers are facing tenure insecurity. Because of this farmers are unable to invest and scale up their farming practice or plant for the long term. Analysis of constraints is illustrated by the threat hierarchy eviction > rent. This ordering reflects Bryld's (2003) conceptualization of urban agriculture as existing in "temporal niches" within urban land cycles, where farming persists only until higher-value uses materialize.

Here the gap between potential and what is practiced on the ground is reveled. even when farmers find a way to creatively adapt to their situations and available lands, the thought of being evacuated and relocation prevents this capacity.

The main cause of this insecurity is the neglect UA faces., the lack of formal integration in zoning practices. Which leaves farmers' access subject to informal agreements and vulnerable to shifting administrative priorities.

4.2.2. Water Scarcity and Access

Water access in Arada is a relatively minor constraint. Despite interview data qualitative data shows that it is a managable constraint. In the challenge methodological ranking, water is ranked #2 but with low severity. .

Table 4:8: Water source

Aspect	Measure	Finding
Primary Source	City piped water	100% of farmers
Alternative Sources	River water	0% use
	Groundwater/ borehole	8.4% use

Source: Survey data analysis using SPSS (Author, 2025)

There is a 100% access to city piped water, though it might not be consistently available. Urban farmers don't always depend on city piped water, as demand for sanitation can be high, specially in institutions, therefore farmers use adaptive strategies like borehole and spring water. Menelik school staff members use a **spring water**, as shown in the figure below, with consistent water access gained

Figure 4:15: Spring as a water source in Menelilk Secondary School
Source: Field photograph

Table 4:9: Detailed Challenge Distribution

Challenge Level	Availability		Cost		Quality	
	Perc. %	Freq.	Perc. %	Freq.	Perc. %	Freq.
No challenge	33.7%	64	32.6%	62	97.4%	185
Mild challenge	54.7%	104	65.3%	124	2.6%	5
Moderate challenge	11.6%	22	2.1%	4	0%	0
Severe challenge	0%	**0**	0%	**0**	0%	**0**
	Mean- 1.78 (Mild)		**Mean- 1.69 (Mild)**		**Mean- 1.03(No challenge)**	

Source: Survey data analysis using SPSS (Author, 2025)

Other challenges that are rated low like water availability (**Error! Unknown switch argument.**) in availability (mean=1.78), cost (mean=1.69), and quality (mean=1.03). Interviews mentioned that people expect water pipes to be inconsistent so they prepare beforehand for it with saving water tank. But some **leave out** farming when they don't get access to city water.

4.2.3. Economic and Resource Constraints

Table 4:10:Composite Economic Challenges Mention

Economic Constraint	Ranked 1st (%)	Ranked 2nd (%)	Ranked 3rd (%)	Total Mentions (%)
Labor availability	5.8%	3.7%	**25.3%**	**34.8%**
Money to invest	2.1%	**18.9%**	12.1%	**33.1%**
Tools/equipment	2.1%	0%	11.6%	**13.7%**
Seeds/fertilizer	0.5%	1.6%	2.6%	**4.7%**
Combined economic	**10.5%**	**24.2%**	**51.6%**	**86.3%**

Source: Survey data analysis using SPSS (Author, 2025)

Labor emerges as a predominantly tertiary constraint (25.3%), this suggests that thought it is not the most critical concern, it becomes significant after main challenges mentioned like land, water, pests challenges. UA is not mostly practiced as a main source for income, but as a side part-time activity people use to cover up for their costs and food security, therefore labor competes with other livelihood activities and old age.

Ranked 2nd by approximately 19% financial constraint becomes a secondary barrier becoming a concern once other need have been met. This reflects nature of farming investments as farmers face capital limitations for inputs, tools, and technology upgrades. As the Ministry expert noted: "Start up fund is **very high** for technologies like used in hydroponics, greenhouses and aeroponics."

Tool becomes the tertiary constraint mentioined by nearly 12% of surveyed respondents, this suggests that it is not of of the fundamental barriers. it also reflects the low technology use and gap of spatial practice

Seeds/fertilizer constraints are minor constraints (4.7%). This represents a positive outcome suggesting effective resource distribution systems. It matches with the description of urban agriculture officer in Arada subcity, about the Woreda support saying, "The Woreda organize these residents... and land is sectioned in plots and given to every individual... The follow up is based on the availability of space/pots, soil and materials to plant." The government's seedling distribution programs appear to be addressing this need effectively. Additionally farmers have reported reduced cost of seeds.

Economic Constraints Patterns

A. Labor Challenges by Age

Table 4:11 : Labor Challenge Prevalence by Age Group

Age Group	Labor Challenge (%)	No Labor Challenge (%)	Total (%)	Key Finding
20-29 years	**0%**	100%	100%	**Youngest farmers report NO labor issues**
30-39 years	17.1%	82.9%	100%	Low labor concern
40-49 years	41.4%	58.6%	100%	Moderate concern
50-59 years	**58.8%**	41.2%	100%	**High concern peaks**
60+ years	**71.4%**	28.6%	100%	**Highest concern**

Source: Survey data analysis using SPSS (Author, 2025)

Statistical Significance: $\chi^2 = 35.153$, $p < 0.001$

Labor challenges show a clear **age-graded** pattern, increasing steadily from 0% among 20-29 year-olds to 71.4% among farmers 60+. This suggests physical capacity limitations become more significant with age, or that older farmers rely more on family labor that may be less available. The complete absence of labor challenges among the youngest farmers (0%) may reflect greater physical capacity or different farming intensity levels.

This implies that -

20-29 year-olds face no labor constraints, suggesting potential for scaling production

Older farmers (50+) need labor-saving technologies or community labor models

Farming practices may need adaptation as farmers age

B. Investment Constraints by Land Security

Table 4:12 : Money Challenges by Land Tenure Security

Land Security	Money Challenge (%)	No Money Challenge (%)	Total (%)	Statistical Finding
Secure land	**18.8%**	81.3%	100%	Lower investment constraint
Insecure land	**36.1%**	63.9%	100%	**Nearly double the constraint**

Source: Survey data analysis using SPSS (Author, 2025)

Statistical Significance: $\chi^2 = 3.604$, $p = 0.058$ (marginal); Likelihood Ratio: $p = 0.048$

Farmers without secure land tenure report money challenges at a nearly double rate compared to those who have secure tenure . This is a **marginally significant** relationship ($p = 0.058$). It supports the theoretical link between tenure insecurity and being reluctant to invest . The pattern aligns with the explanation of an officer from Ethiopian Development Bank Ethiopia regarding collateral requirements- financial institutions hesitate to lend without secure assets. As the Policy Dialogue noted, "Traditional urban farms generate much less income than a high rise building, therefore investors prefer building commercials than keeping a farm", a dynamic that disproportionately affects tenure-insecure farmers.

This implies that land security has to come before financial support. Secondly there need to be an innovative financing that doesn't require owning a land and it becomes clear that land security can become an essential support for investment increase.

The cross-analyses of quantified data reveals that, labor challenges clearly increase with age (0% to 71.4%), as financial investment constraints relate with tenure insecurity (18.8% to 36.1%). These findings indicate, **youth engagement is vital for labor-intensive expansion, tenure security essential for investment ,** and **age-appropriate technology packages**. The marginally significant land-money relationship (p = 0.058), while not definitive, aligns strongly with theoretical expectations and qualitative evidence mentioned above.

4.2.4. Environmnetal and Biophysical Challenges

UA as it is part of the environmntal landscape, it is largely affected by these natural challenges such as environmental and biophysical challenges. In the case of Woreda 07, pest and diseases are the most outspread issues faced by farmers. these issues have an effect on yield, and crop health

Overall Environmental Challenge Prevalence

Table 4:13: Composite Environmental Challenge Mentions

Environmental Constraint	Ranked 1st (%)	Ranked 2nd (%)	Ranked 3rd (%)	Total Mentions (%)
Pests/Diseases	**18.9%**	**23.2%**	**16.3%**	**58.4%**
Flood	0%	5.3%	8.9%	14.2%
Soil quality	0%	5.8%	1.6%	7.4%
Combined environmental	**18.9%**	**34.3%**	**26.8%**	**80%**

Source: Survey data analysis using SPSS (Author, 2025)

4.2.4.1. Pests and Diseases

The higher frequency of pests and diseases (58.4%) creates a visible barrier to consistent productivity and scaling up . This challenge however showed varying patterns across different locations and crops, which will be discussed in detail below.

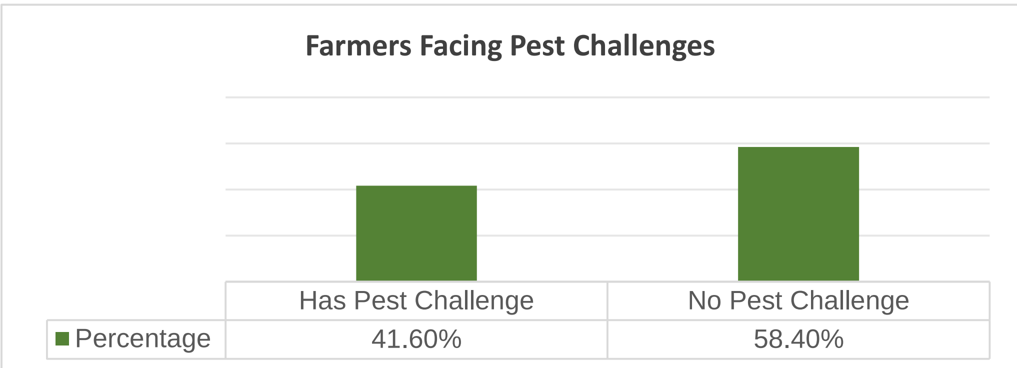


Figure 4:16: Chart showing farmes facing pest challenges
Source: Survey data analysis using SPSS (Author, 2025)

A. Location-Specific Vulnerability

Institutional farms show 100% pest presence. This may result from larger, less diverse plots that facilitate pest spread. On the contrary, rooftop farms (25%) and vacant lots (32%) show lower percentages, This can possibly be due to physical isolation from each other, which limits transfer or pests from one plot of land to the other, which serves as a natural pest control.

Table 4:14: Location-Specific Vulnerability

Location Type	Pest Challenge (%)	No Pest Challenge (%)	Total (%)
Institutional compounds	100%	0%	100%
Riverside areas	64.7%	35.3%	100%
Residential compounds	56.3%	43.8%	100%
Vacant lots	31.7%	68.3%	100%

Source: Survey data analysis using SPSS (Author, 2025)

B. Crop-Specific Vulnerability Patterns

Table 4:15 :Crop specific vulnerability pattern

Crop	Growers with Pest Challenges (%)	Key Vulnerability Level
Onion	82.4%	Very high
Chili	70%	High
Beetroot	67.9%	High
Tomato	67.9%	High
Carrot	63%	Moderate-high
Cabbage	54.8%	Moderate
Swiss chard	50.9%	Moderate
Lettuce	48.7%	Moderate
Collard	48.1%	Moderate

Source: Survey data analysis using SPSS (Author, 2025)

Rooted vegetables (like onion, beet, carrot) and fruit vegetables (like tomato, chili) face the highest pest vulnerability (63-82%), while leafy greens (collard, lettuce, Swiss chard) show moderate levels (48-51%).

This also shows that pest challenges lead to crop abandonment and how pest pressure influences crop selection decisions, potentially limiting diversification.

C. <u>Experience Level and Pest Management</u>

Table 4:16 :Farming Experience by Pest Challenge Status

Pest Challenge Status	Mean Experience (years)	Standard Deviation	Cases (n)
No pest challenge	2.54 years	1.26	79
Has pest challenge	1.82 years	1.23	111
Total	2.12 years	1.29	190

Source: Survey data analysis using SPSS (Author, 2025)

Farmers without pest challenges have, on average, 2.5 years of experience. And farmers with pest challenges on average have 1.8 years of experience. This suggests that knowledge accumulation enables better pest management. This experience result may explain why only 2.1% ranked "technical knowledge" as their primary challenge, as experienced farmers develop coping strategies over time.

4.2.4.2. Flood Vulnerability

A. <u>Location Analysis of Flood Risk</u>

Table 4:17 : Flood Challenge Vulnerability by Location Type

Location Type	Flood Challenge (%)	No Flood Challenge (%)	Total (%)	Flood Challenge (%)
Residential compounds	21.9%	78.1%	100%	21.9%
Vacant lots	17.1%	82.9%	100%	17.1%
Riverside areas	5.9%	94.1%	100%	5.9%
Institutional compounds	7.3%	92.7%	100%	7.3%

Source: Survey data analysis using SPSS (Author, 2025)

Riverside farms showed the lowest occurrence of flooding (5.9%), this is most likely a direct benefit of the Beautifying Sheger project's riverbank revitalization which improved drainage to storm water. The Woreda 07 officer [Int6], also mentioned that the project considerably reduces flooding which has caused a problem during heavy rain. In the case of Woreda 07, residential compounds reported the highest flood vulnerability that is approximately 22%, which indicates why some farmers are adopting to rooftop and container methods precisely as an coping strategy to move their crops away from flood, as seen with Int03, who shifted to pots after ground plots were destroyed.

This issue indicates that in inner cities flooding is an infrasturucture and surface permeability issue (Jha, Bloch, & Lamond, 2012). , which is also supported by farmers response about flood coming from no proper drainage line.

B. Block Analysis of Flood Risk

A statistically significant relationship has been found between flood challenges and some blocks within Woreda 07. The following map shows the risk is highly localized., and the table below shows blocks where flood challenges affect a substantial portion of surveyed farmers.

Table 4:18 : Flood Challenge vulnerability by block

Block Number	Total Farmers Surveyed	Farmers Reporting Flood Challenge	% of Block Farmers Affected
18	5	3	60%
5	16	6	37.5%
15	12	4	33.3%
Other Blocks	157	14	< 15%

Source: Survey data analysis using SPSS (Author, 2025)

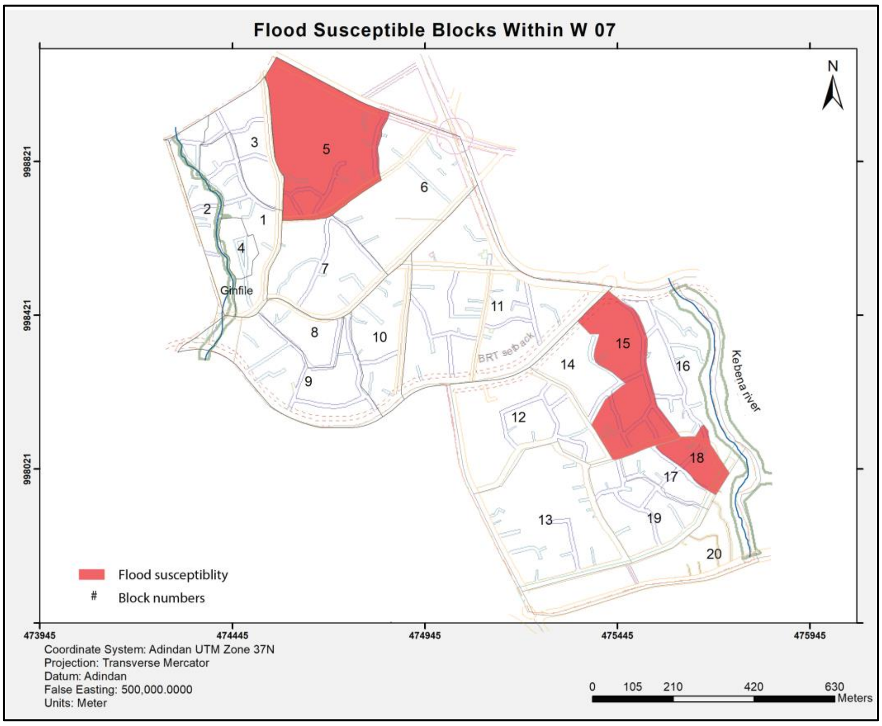


Figure 4:17: Map showing location of flood vulnerable areas
Source: Author's compilation from survey

Figure 4:18: Farm destroyed by flood
Source : Field photograph

This issue of flood relates to topography and local drainage infrastructure deficiencies. For instance, Block 5's high rate of flood aligns with the experience of Int03, who described severe flooding destroying crops despite existing drainage line. This finding is critical for spatial planning, such as improved drainage or promoting raised-bed/container gardening, need to be targeted at these flood susceptible zones. While statistical analysis showed no significant overall link between farming method and flood reports, the qualitative data reveals changing method as a key adaptive tactic. The case of Int03 (shifting to pots) and the use of terracing by other farmers (Int05) greatly demonstrate that one can change their techniques in response to environmental threats.

Figure 4:19: Terraced farm as flood adaptation
Source : Field photograph

4.2.4.3. Soil Quality Challenges

Soil challenges were the least cited challenge but it has a spatial concentration, a problem faced by specific farming methods.

Table 4:19 : Soil Quality Challenge Distribution by Location

Location Type	Soil Challenge (%)	No Soil Challenge (%)	Total (%)
Vacant lots	9.8%	90.2%	100%
Residential compounds	6.3%	93.8%	100%
Riverside areas	5.9%	94.1%	100%
Institutional compounds	0%	100%	100%

Source: Survey data analysis using SPSS (Author, 2025)

Rooftop and container farming depends entirely on imported soils. This soil, unless replaced constantly, can degrade and become compacted. In contrast, institutional compounds likely benefit from plots that are on the ground, with better natural soil structure and resources for amendment.

A "legacy effect" of urban development mentioned by Pouyat, Yesilonis, & Nowak, (2006) corresponds with moderate soil challenges on vacant lots (9.8%) arising from their status as disturbed urban lands, usually from compaction, contamination, or poor fertility.

4.2.5. Technological and Knowledge Gaps

On direct survey responses only 2.1% of farmers ranked "lack of technical knowledge" as their biggest challenge (1st rank), with a total composite score of just 10.5% (**Error! Unknown switch argument.**). This outcome suggests farmers may focus on the more tangible pressures they face like land access and financial limitations as more pressing. However, knowledge gaps often manifest indirectly through poor pest management, soil degradation in containers, or sub-optimal yields, which were identified as major challenges.

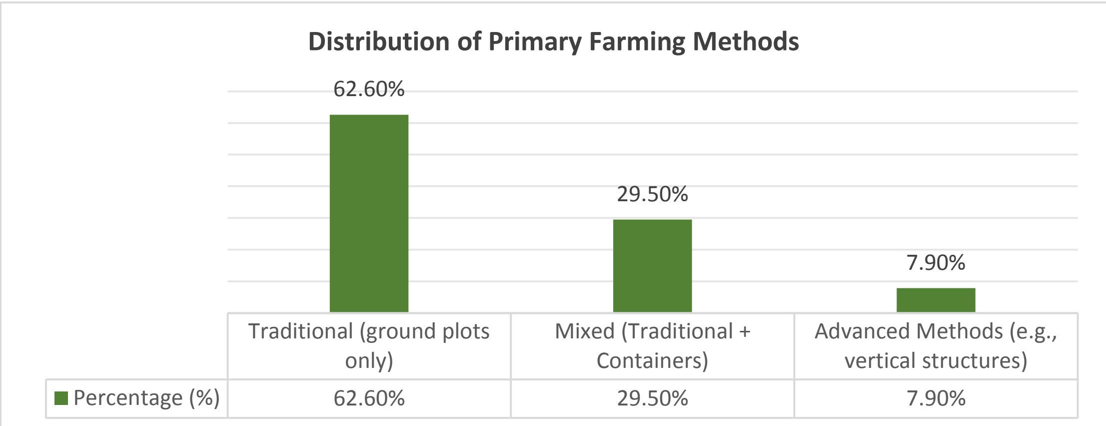


Figure 4:20: Chart showing distribution of Primary Farming Methods

Source: Survey data analysis using excel (Author, 2025)

The dominance of traditional methods (62.6%) is an indication of limited use of technological practice. The 29.5% using mixed methods represent an important adaptive ways, sometimes using containers to complement ground plots, as seen in residential compounds. Following this, the farmers using advanced methods, such as vertical farming cover approximately 8% of the farming population, revealing the steep climb in the adoption curve.

A. Experience and Technological Experimentation

A main stem creating distinction between these groups is accumulated practical knowledge, measured as years of farming experience.

Table 4:20 : Farming Method by Years of Experience

Farming Method Category	Mean Years of Experience	Std. Deviation	Statistical Comparison
Traditional only	2 years	1.23	Baseline
Mixed (Traditional + Containers)	2.3 years	1.35	Slightly higher
Advanced/Other Methods	3.1 years	1.29	Significantly higher

Source: Survey data analysis using SPSS (Author, 2025)

This demonstrates a clear correlation technological sophistication increases with time spent farming.

B. Practical- and Financial-Knowledge Gap

The consequences of the knowledge gap are not theoretical; they directly affect productivity and can dramatically reduce technological investment. While UA is included in school curricula and some subcities offer training, adult practitioners often lack technical support. Farmers and staff member at Menelik school described challenges with pest control. Agronomists were required to check harvest readiness due to limited farmer knowledge. In MoPD's compound, vertical farm produce was destroyed due to issues with compost ratios, and vertical farming maintenance. The following figure illustrates what had happened to the soil after inappropriate/ untreated compost was applied


Figure 4:21 : Challenges in MoPD
Source : Field photograph

However, the gap is not merely informational; it is fundamentally a financial-knowledge nexus. Farmers are aware of alternatives but perceive formal technologies as inaccessible. The expert from the Ministry of Agriculture explicitly identified the"start up fund is very high for technologies like used in hydroponics, greenhouses and aeroponics." This creates a paralyzing cycle -

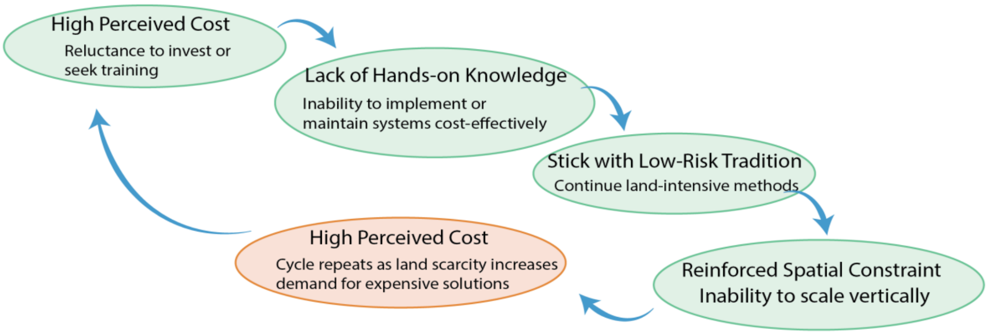


Figure 4:22: Image showing how knowledge gap creates a paralyzing cycle
Source : Computed by author

To overcome these challenges AACAFUADC found “Agricultural demonstration and resource multiplication center”. In this center local community can get access to knowledge and practice. This include paste control methods, organic composting etc are covered

Figure 4:23: Agricultural demonstration and resource multiplication center
Source : AACAFUADC office

In conclusion, the technological landscape in Arada is not static but evolving. The low explicit concern for technical knowledge obscures a deeper "adaptive innovation gap." Farmers are adaptive, they use various methods as theyface challenges like shifting to pots to avoid floods, terracing slopes. However their innovation is bounded by financial constraints, a reliance on slow, experimental learning, and a limited and targeted technical support for more complex systems.

4.3. Evaluation of Productivity of UA to Contribute to Sustainable Development Goals

This section demonstrates how urban agriculture (UA) in Arada Subcity delivers tangible and quantified contributions to global sustainability frameworks

4.3.1. Contribution to Food Security (SDG3)

Analysis of harvest distribution patterns and productivity metrics demonstrates a significant, though variable, contribution to SDG 2- Zero Hunger.

Harvest Distribution

The primary function of urban agriculture in Arada is direct household food providing. Survey data reveals that farmers use the majority of their harvest to family consumption.

Table 4:21 : Distribution of Harvest Use (n=190)

Use	Mean Percentage (%)	Std. Deviation
Household Consumption	75.9%	± 22.3
Sold for Income	21.4%	± 23.4
Given to Others	2.6%	± 7.8

Source: Survey data analysis using SPSS (Author, 2025)

Land and Productivity

While a weak negative correlation exists between plot size and consumption ($r = -0.155$, $p = 0.033$), suggesting a slightly larger plots may dedicate a relatively smaller percentage to home use.

Table 4:22: Household Consumption by Plot Size Category

Plot Size Category	N	Mean % Consumption	Std. Deviation

Small (5-10 m²)	139	76.6%	± 22.4
Medium (11-20 m²)	43	70.5%	± 22.5
Large (21-25 m²)	8	92.5%	± 4.6

Source: Survey data analysis using SPSS (Author, 2025)

This finding indicates farmers with Medium-sized plots may be the most commercially oriented, using their relatively secure output to generate necessary income. In contrast, farmers with the largest plots (Large category) achieve such substantial absolute yields that they can satisfy household needs almost entirely (92.5%) while still having some to sell or share. This proves absolute yield is key to food security. Securing even a moderately larger plot can transform UA from a supplement to a primary food source.

Case studies to quantifying urban farmer's productivity,

Case study 1 - Mr. Alemu's 365 m² farm within the Ministry of Planning and Development (MoPD) compound has a significant productive potential. Despite using traditional methods and facing soil and water challenges, his operation achieves an estimated annual yield of 1,111-1,666 kg of vegetables (**Error! Unknown switch argument.**)

Figure 4:24: MoPD farming site
Source : Field photograph

Based on harvest estimates provided by Mr. Alemu, his annual production can be approximated as follows-

Estimated annual yield from a 365 m² traditional urban farm

Leafy Vegetable Yield

- Per harvest : 300 bundles
- Average weight per bundle : ~0.5 kg
- Yield per harvest : 300 × 0.5 = 150 kg

Assuming 4-6 harvests per year (typical for leafy greens in Addis Ababa):

Annual yield:

- 4 harvests → 150 × 4 = 600 kg/year
- 6 harvests → 150 × 6 = 900 kg/year

Rooted Vegetable Yield

Table 4:23: Location-Specific Vulnerability Estimation based on area allocation and compost-enhanced productivity:

Crop	Area (m²)	Yield Range (kg/m²)	Estimated Yield (kg/year)
Potatoes	~100 m²	3-4.5	300-450
Carrots	~50 m²	2.5-3.5	125-175
Beets	~35 m²	2-3	70-105

Source : Key informant survey analysis

Total rooted vegetable yield: 495-730 kg/year

Soybean Yield (Supplementary Crop)

Soybeans are grown on a small portion (~20-30 m²) and yield modestly:

Yield range: 0.8-1.2 kg/m²

Estimated yield: ~16-36 kg/year

Table 4:24.Estimated annual yield of 1,111-1,666 kg of vegetables

Crop Type	Estimated Yield (kg/year)	Percentage of Total
Leafy Vegetables	600-900	54%
Rooted Vegetables	495-730	44%

Soybeans	16-36	2%
Total	1,111-1,666 kg/year	100%

Source : Key informant survey analysis

This shows that Mr. Alemu's urban farm, even with partial organization, can contribute meaningfully to SDG 2: Zero Hunger by feeding up to 28 individuals annually.

Productivity Assessment

Farm area = 365 m^2

Yield = 1,111–1,666 kg/year

Productivity -

1,111 ÷ 365 = 3.04 kg/m^2/year

1,666 ÷ 365 = 4.56 kg/m^2/year

In terms of land productivity, the farm generates approximately 3.04–4.56 kg of vegetables per square meter annually. This falls within the range reported by FAO (2022) for productive urban vegetable farming systems. The findings indicate that urban agriculture can efficiently utilize limited urban land resources while making a meaningful contribution to local food production and food security.

Calculation: Using the WHO benchmark of 60 kg of vegetables per person per year, it can be estimated:

Number of People Fed = Total Annual Yield ÷ 60 kg

Minimum yield (1,111 kg) → ~18 people

Maximum yield (1,666 kg) → ~28 people

This shows that Mr. Alemu’s urban farm, even with partial organization, can contribute meaningfully to SDG 2: Zero Hunger by feeding up to 28 individuals annually.

Significance - This output far exceeds his household's needs, allowing him to sell the surplus. This case proves that a single, medium-sized urban farm can significantly impact local food security (SDG 2).

However, this case also shows the constraints that limit sustainability:

- This productive output requires a large plot (365 m^2), which is very rare in land-scarce Arada.

- The farm's existence is subject to larger urban plans, as nearby structures were removed for corridor development.
- The contrasting failure of an NGO-initiated vertical farm on the same compound, attributed to poor-quality inputs and lack of maintenance knowledge, underscores that technological solutions alone are insufficient without adequate support and secure land tenure.

Figure 4:25: Challenged farming sites at MoPD

Case study 2 - Arada Manufacturing College

Arada Manufacturing College gave 800 m² of its land to 20 staff members for farming. Each person got a plot, varying from 5m² to 20m², scattered around the compound. The college wanted to help staff grow food and set an example for students. However only a few members of the staff kept their plot active as most of the parcels are neglected due to various challenges.

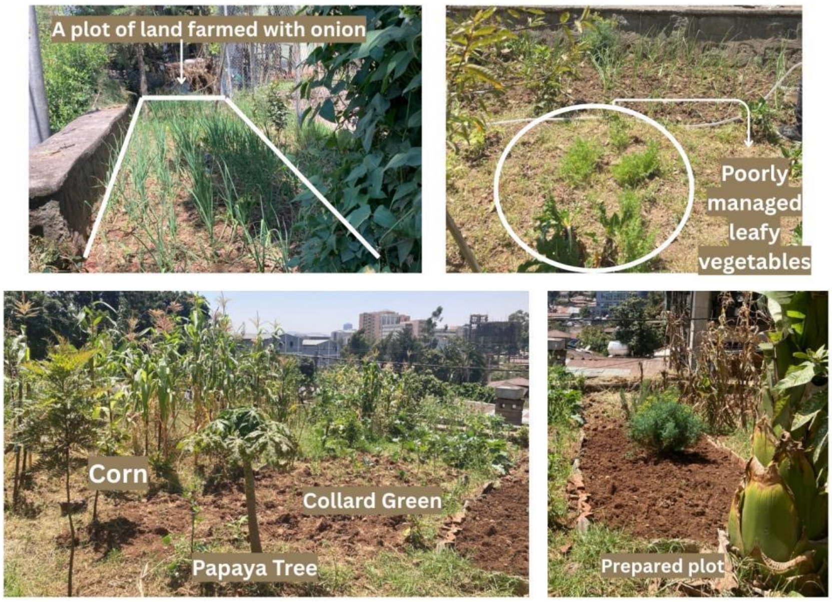


Figure 4:26: Farming site of Arada Manufacturing College
Source : Field Photograph
Table 4:25 : Crops at Arada MAnufacturing College

<table>
<tr><th>Crop</th><th>Area</th><th></th><th>Negligent Crops</th></tr>
<tr><td>onion</td><td>25 m^2</td><td rowspan="4"></td><td rowspan="4">Collard green , Papaya tree, Lettuce, Herbal plants (rue & rosmary), false banana</td></tr>
<tr><td>Corn</td><td>10 m^2</td></tr>
<tr><td>Garlic</td><td>8 m^2</td></tr>
<tr><td>Avocado</td><td>7 trees</td></tr>
</table>

Challeges practicioner staff memebers were facing

Water Shortage, Labor Constraints - balancing professional and agricultural labor, the time burden often exceeds capacity., Tenure Insecurity - Teachers who invest in establishing plots risk losing access to their land if transferred to another institution, a common occurrence within Ethiopia's civil service system.

Productivity Assessment

Active cultivated land = 33 m^2 Yield = 70–103 kg

Productivity:

70 ÷ 33 = 2.12 kg/m^2/year - 103 ÷ 33 = 3.12 kg/m^2/year

The actively cultivated plots achieve productivity levels of approximately 2.12–3.12 kg/m^2/year. Although lower than the MoPD case study, the results indicate that urban agriculture remains productive despite significant management and infrastructure constraints. The findings suggest that water availability, labor inputs, and tenure security have a greater influence on productivity than land availability alone.

Onion (25 m^2):

Typical yield estimation : 2.5-3.5 kg/m^2

Estimated annual production: 62.5-87.5 kg

Household contribution: 1-2 families could be supplied annually

Corn (10 m^2):

Potential yield: 1.5-2 kg/m^2 - Potential annual production: 15-20 kg

Avocado Trees (7 trees, immature):

Full production estimation (in 5-7 years): 50-100 kg per tree

Total potential: 350-700 kg annually

People fed at full production: 6-12 people

The current state reveals that there are deep constraints only 33 m² (4% of the land) is actively cultivated, producing just 70-103 kg of vegetables annually from single harvests of onion and garlic, enough to feed only 1-2 people for a year, . The remaining 767 m² sits empty due to **water shortages, labor demands** on full-time teachers, and **tenure insecurity** from staff transfers.

This demonstrates that land provision alone is not **sufficient** without labor support investments in water infrastructure, and secure tenure policies.

4.3.2. Contribution to Sustainable Cities (SDG 11)

Besides food production, urban agriculture in Arada contributes to sustainable urban development through economic resilience at household level, the creation of multifunctional green spaces, and the strengthening of community bond (United Nations, 2015).

A. Enhancing Household Economic Resilience - Survey data indicates that urban farming is seen as a buffer against economic vulnerability, an element of sustainable communities. As shown in the table below, majority of farmers reported substantial benefit from as they improved their household food security and reduced costs on food bills.

Table 4:26 : Perceived Household Benefits of Urban Agriculture

Perceived Benefit	% Reporting "High Benefit"
Improved household food security	85.3%
Saved money on food bills	14.7%

Source: Survey data analysis using SPSS (Author, 2025)

Data also show while food security benefits are acknowledged universally, the economic benefits gained are recognized highly by a smaller group of practitioners. This is potentially from the limited income generated from urban agriculture, and that it functions primarily as a supplementary strategy rather than a primary economic activity.

B. Enhancing Green Infrastructure - UA in Arada performs vital ecosystem services that contribute directly to urban sustainability.

Nearly half that is 45% of farms are located on vacant lots. Cases like the corridor garden (Int 02) and Lem Plants' use of public verges demonstrate how informal agreements can create linear green spaces. These spaces enhance walkability, provide visual relief, and foster a sense of communal ownership and environmental stewardship.

Figure 4:27: UA on vacant lots, indicating cleaner streets and occupying amenities
Source: Field photograph

Althought it is limited, rooftop and vertical farming are present. And this points to the beginning adoption of space efficient farming strategies critical for dense urban cores like Arada.

Figure 4:28: Roof top farming

Source: Field photograph

C. Strengthening Social Fabric and Community Livability

UA supports social cohesion, that is a main indicator of sustainable communities under SDG 11. The common practice of sharing harvests, which is a common practice among farmers, strengthens social networks. Shared gardening spaces become informal hubs for knowledge exchange and social interaction, building capital that encourages community resilience to shocks and stressors.

For UA to evolve, the current model of "opportunistic greening" (Bryld, 2003) on marginal lands is **insufficient**. To fully grasp its potential as a contribution to SDGs, UA must be integrated through formal planning mechanisms as a legitimate, multifunctional form of "essential green infrastructure" within the urban landscape.

In conclusion, urban agriculture in Arada demonstrates a clear, potential for advancing the goals of sustainable cities. It enhances household economic resilience, in particular when supported by appropriate technology; transforms empty spaces into productive green infrastructure; and strengthens community bonds. However, these contributions are currently limited by the informal nature of the practice.

4.3.3. Contribution to Gender Equality (SDG 5)

UA provides economic and social support for women. The domination of female workers in UA offers economical support and empowerment As evidenced by initiatives like the MoPD's project that trained 50 low-income women from Gullele to manage vertical farms and use from these farms too, either for selling or consumption.

Table 4:27 : Gender Distribution of Urban Farmers in Woreda 07

Gender	Count (n)	Percentage (%)
Female	143	75.3%
Male	47	24.7%
Total	190	100%

Source: Survey data analysis using SPSS (Author, 2025)

This female majority (3 out of 4 farmers) aligns with patterns observed across East Africa, where UA often serves as a vital means of food supplementation and income generation for women, particularly in low-income households (Lee-Smith, 2010). However, when it is compared alongside limited access to resources, it also reflects underlying gender inequalities within the sector. This demographic also shows that policies and interventions targeting UA in Arada will impact women's livelihoods and well-being.

A. Technique and Gender Division

A Chi-Square analysis reveals a **highly significant** relationship between gender and farming method ($\chi^2 = 28.635$, $p < 0.001$). The distribution of method adoption reveals a technology gap between male and females.

Table 4:28 : Farming Method and Gender

Gender	Traditional Only (%)	Traditional + Containers (%)	Advanced Methods (%)
Female (n=143)	60.8%	36.4%	2.8%
Male (n=47)	68.1%	8.5%	23.4%

Source: Survey data analysis using SPSS (Author, 2025)

Men are more likely to use advanced methods than women (23.4% vs. 2.8%), in this case eight times more likely. On the other side, women are heavily concentrated in traditional and container based methods (36.4% vs. 8.5% for men). This pattern reflects that women usually have less access to capital, and technical training, needed to adopt innovative technologies (FAO, 2011). This division limits women's potential to achieve higher productivity and income.

B. Economic Return and Land Security

An independent samples t-test confirms that men gain significantly higher economic benefits from UA than women ($t(188) = 2.93$, $p = 0.004$). The effect size (Cohen's $d = 0.49$) indicates a moderate difference in savings.

C. Dual Role Constraint For Women

UA provides women with a source of income, improves household nutrition , and can enhance their status as providers. The act of managing a productive space builds skills, confidence, and social networks.

However at the same time, it adds to women's existing given reproductive labor For instance, childcare, domestic work etc. On top of that operating with a limited technology the yields they produce is lower compared to the hour invested. This reflects the concept of the "feminization of responsibility and obligation" (Chant, 2008), where women absorb increasing productive work to compensate for systemic constraints and household needs, without a proportional increase in power or resource control.

The findings present , on one hand, UA is a sector dominated by female as it offers pathways for income, food security, and skill-building. On the other, women couldn't avoid to face systematic disadvantages that limits the potential of their labor and may worsen burdens.

Therefore for UA to become a genuine engine for gender equality, interventions must move beyond viewing women just as participants and instead bringing equity into the picture and eradicate the barriers they face from different parts of their lives.

5. Chapter Five : Conclusion, Recommendations, and Integration Framework

5.1. Conclusion

This study assesses the spatial practices, challenges, and prospects of urban agriculture (UA) in Arada Subcity, Addis Ababa, and to examine its implications for sustainability and spatial integration. Through a convergent parallel mixed methods , which combines quantitative survey data, qualitative interviews, and spatial analysis.

The findings reveal that urban agriculture in Arada Subcity functions as a structurally informal system, shaped by land scarcity, and limited institutional support. Rather than being integrated into formal spatial planning frameworks, UA is practiced across small plots scattered across the subcity Those are vacant lots, institutional compounds, residential plots, and riverbanks. This reflects a pattern of opportunistic spatial practice, where farmers utilize whatever land that is immediately available and temporarily accessible, rather than land that is formally designated or protected for agricultural use.

In relation to the first objective, the study demonstrates that the spatial practices of UA are characterized by extreme spatial limitation and adaptability. With average plot size of approximately 10 m^2, farmers prioritize fast-growing, high-yield crops such as leafy vegetables. Methods that are mainly used are traditional ways, that is soil based. The low presence of advanced methods, those are rooftop and vertical farming, indicates a limited use of vertical urban space, knowledge and financial constraints being the main cause.

Coming to the second objective, the study identifies that tenure insecurity as the most pressing challenge affecting urban agriculture. As 80% of farmers reported this issue, saying the threat is being displaced to development projects mainly in areas going through rapid urban transformation. Limited access to water, financial resources, and technical knowledge are other issues that add up to the current land constraint . These challenges are not isolated but interconnected, collectively limiting farmers' ability to invest in improved techniques or scale their production.

Finally while addressing the third objective, the findings show that urban agriculture makes a tangible contribution to household level, often small scale, food security. As challenges addressed in the objectives above, its contribution to broader sustainability goals is limited due to its small scale, informality, and lack of integration into city systems. Additionally this study highlights a gap between male and female practices, even though women account for the majority of practitioners they have significantly less access to advanced farming methods and secure land, indicating structural inequalities in resource access and capacity development.

Overall, the study concludes that urban agriculture in Arada Subcity exists in pressures and constraints. it is highly valuable as a livelihood and food security strategy, but at the same time it is neglected and unsupported with implementation guidelines. Without a purposive integration into spatial planning frameworks, UA will continue to function as a temporary and vulnerable activity.

5.2. Implementation Guidelines for Spatial Integration of UA

This is built on the results and findings. It proposes a set of spatially grounded and practitioner specific implementation guidelines that aim at transitioning urban agriculture from informal practice to an integrated component of Addis Ababa's urban system.

5.2.1. Household-Level UA

Household urban agriculture represents adaptable form of practice in Arada Subcity, benefiting from a closer proximity to daily household needs. Strengthening this category is essential for enhancing food security and improving sustainability outcomes at the micro-scale.

Implementation Guidelines-

Promoting use of container and vertical farming methods to maximize productivity with limited spaces

Encourage small scale composting systems to convert food scrapes and organic waste into agricultural inputs

Support small scale rainwater harvesting solutions during winter

Provide training programs, particularly for women, to improve access to advanced farming methods to close the gap of technological barriers

5.2.2. Condominium and Communal Housing Spaces

These spaces offer relatively secure tenure and the potential for shared farming management, making them suitable for scaling food production in dense urban areas.

Implementation Guidelines-

Integrate urban agriculture within from the start of residential developments

Make use of rooftops, courtyards and balconies as multi-functional spaces for urban agriculture

Introduce lightweight and standardized farming systems suitable for buildings and structural support

Establish management systems based on the community to create shared agricultural activities

5.2.3. Institutional UA

Despite being formal, institutional compounds currently have low tenure security and receive low legal support.

Implementation Guidelines-

Establish land-use agreements between institutions and urban farmers to ensure continuity, even if farmers relocate [transportable methods]

Formally Integrate urban agriculture into institutional land-use and landscape planning frameworks

Develop demonstration and training sites within institutions with large and small area to promote modern agricultural practices in both cases

Align urban agriculture activities with educational, social, and environmental functions of institutions to promote its long term livability

5.2.4. Transitional and Marginal Urban Spaces

Vacant and transitional spaces support a large section of UA but they are vulnerable to development pressures. Recognizing these spaces as temporary yet valuable resources is critical for inclusive urban planning.

Implementation Guidelines-

Introduce temporary land-use policies that allow interim agricultural use of vacant land

Promote mobile and flexible farming systems that can adapt to displacement

Recognize urban agriculture as a legitimate interim land use, rather than an informal or transitional activity

Integrate UA into corridor development and riverbank rehabilitation projects as productive green infrastructure

5.2.5. Policy and Institutional Measures

To support implementation across all spatial categories, broader institutional and policy-level interventions are required.

Implementation Guidelines-

Incorporate UA into formal spatial planning and zoning frameworks

Develop incentive mechanisms to support adoption of space-efficient and water-saving technologies

Improve access to water through decentralized systems such as rainwater harvesting and treated wastewater reuse

Establish gender-responsive programs to address disparities in access to land, finance, and knowledge

Strengthen coordination among relevant institutions and agencies involved in UA and urban planning

5.2.6. Commercial UA

Alongside other recent urban redevelopment initiatives in Addis Ababa, corridor development projects, have introduced various infrastructures including multi-level parking structures as an urban feature that is being built in almost every subcity .

Given their structural capacity, accessibility, and the visible proximity to high-demand markets, parking structures can be resorted for larger scale, technologically supported farming systems, moving beyond survival production to commercial activites.

Implementation Guidelines-

Designate rooftop levels and upper decks of parking structures for commercial urban agriculture, particularly for high-value crops such as leafy greens and herbs

Introduce hydroponic, aquaponic, or vertical farming systems that maximize productivity while minimizing soil and water requirements

Integrate structural considerations like load-bearing capacity, waterproofing, and drainage systems into the design phase of new parking facilities.

Promoting market linkages by connecting production to nearby demand into the city

Incorporate renewable energy solutions, for example solar panels to support energy-intensive farming systems especially for vertical farming

Aligning it with urban green infrastructure strategies to enhance environmental benefits such as urban cooling and air quality improvement

Using a transformative planning and strategy UA can shift from informal survival strategy to a strategically integrated urban component. Following this, putting spatial practices hand in hand with supporting policies, integrating design strategies, and institutional frameworks, UA can become an essential part of our urban landscape while supporting broader sustainable goals.

5.3. Directions for Future Research

Tracking the impact of tenure security and technology adoption on UA productivity and household resilience over time.

Investigating the safety of UA produce grown in contaminated soils or with polluted water to have more understanding of health and risk.

Quantify the value of UA’s contributions to climate regulation, biodiversity, and social capital.

Examine UA integration models in other Ethiopian cities (e.g., Bahir Dar, Hawassa) to identify transferable lessons and thechnologies.

Evaluate the effectiveness of UA policies that are implemented and institutional arrangements in achieving sustainability goals.

References

Barthel, S., Parker, J., & Ernstson, H. (2015). Food and green space in cities: A resilience lens on gardens and urban environmental movements. Urban Studies, 52(7), 1329-1348.

Benedict, M. A., & McMahon, E. T. (2006). Green infrastructure: Linking landscapes and communities. Island Press.

Bryld, E. (2003). Potentials, problems, and policy implications for urban agriculture in developing countries. Agriculture and Human Values, 20(1), 79-86.

Colasanti, K. J. A., Hamm, M. W., & Litjens, C. M. (2012). The city as an "agricultural powerhouse"? Perspectives on expanding urban agriculture from Detroit, Michigan. Urban Geography, 33(3), 348-369.

Cullingworth, B., & Nadin, V. (2023). Town and country planning in the UK (15th ed.). Routledge.

Drechsel, P., & Keraita, B. (2023). Irrigated urban vegetable production in Africa: Characteristics, benefits and risks. International Water Management Institute (IWMI).

Dubbeling, M., de Zeeuw, H., & van Veenhuizen, R. (2010). Cities, poverty, and food: Multi-stakeholder policy and planning in urban agriculture. Practical Action Publishing.

Elkington, J. (1997). Cannibals with forks: The triple bottom line of 21st century business. Capstone.

Food and Agriculture Organization (FAO). (2014). Growing greener cities in Africa. FAO.

Food and Agriculture Organization (FAO). (2022). Urban and peri-urban agriculture sourcebook: From production to food systems. FAO.

Foster, J. P., Borgman, M., & Meerow, S. (2022). Ecosystem services of urban agriculture and prospects for scaling up production: A study of Detroit. Cities, 125, 103663.

Fussy, A., & Papenbrock, J. (2022). An overview of soil and soilless cultivation techniques—Chances, challenges and the neglected question of sustainability. Plants, 11(9), 1155.

International Labour Organization (ILO). (2021). World employment and social outlook: Trends 2021. ILO.

Lee-Smith, D. (2010). Cities feeding people: An update on urban agriculture in equatorial Africa. Environment and Urbanization, 22(2), 483-499.

Ministry of Urban Development and Construction. (2019). Urban agriculture development strategy (2011 E.C.). Addis Ababa, Ethiopia.

Moges, A., Beyene, A., & Amare, T. (2018). Urban agriculture in Addis Ababa: Challenges and opportunities for sustainable development. Journal of Urban Planning and Development.

Mougeot, L. J. A. (2000). Urban agriculture: Definition, presence, potentials, and risks. In N. Bakker et al. (Eds.), Growing cities, growing food (pp. 1-42).

Mougeot, L. J. A. (2021). Growing better cities: Urban agriculture for sustainable development. IDRC.

Pickett, S. T. A., Cadenasso, M. L., & Grove, J. M. (2020). Urban ecological systems: Scientific foundations and a decade of progress. In The Routledge handbook of urban ecology. Routledge.

Pickett, S. T. A., Cadenasso, M. L., Grove, J. M., Nilon, C. H., Pouyat, R. V., Zipperer, W. C., & Costanza, R. (2001). Urban ecological systems: Linking terrestrial ecological, physical, and socioeconomic components. Annual Review of Ecology and Systematics, 32, 127-157.

Simonetti, L., & Amato, F. (2021). Can urban agriculture be used to improve green infrastructure and social well-being? Journal of Urban Regeneration and Renewal, 15(1).

Smit, J., Ratta, A., & Nasr, J. (2021). Urban agriculture: Food, jobs and sustainable cities (Updated ed.). Urban Agriculture Network.

Tesfaye, A., Negatu, W., & Brouwer, R. (2016). Urban agriculture in Addis Ababa: A socio-economic analysis. African Journal of Agricultural Research, 11(5), 345-356.

Teng, P. (2013). Urban agriculture in Singapore: From rooftop farms to vertical gardens. International Journal of Agricultural Sustainability.

United Nations. (2015). Transforming our world: The 2030 agenda for sustainable development. UN.

UN-Habitat. (2016). Urbanization and development: Emerging futures. UN-Habitat.

UN-Habitat. (2021). Strategic plan 2020-2023. UN-Habitat.

UN-Habitat. (2022). World cities report 2022: Envisaging the future of cities. UN-Habitat.

UN Women. (2021). Women and sustainable development goals. UN Women.

World Bank. (2007). Ethiopia: Accelerating equitable growth, country economic memorandum. World Bank.

Appendicies

Appendix A

Respondents per block = (Block's practitioner percentage × Total sample size)

total sample size is 190, the calculation for each block is:

Respondents = Practitioner % × 190

Table A.1 : Respondent Sampling by Block

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]		[illegible]	[illegible]

Survey Questionnaire

1. Woreda/Kebele: ________________
2. Age: ________________
3. Gender: [ ] Male [ ] Female
4. Years of experience in urban farming: ________________

5. Location of farm: (Please check all that apply)

[ ] Riverside

[ ] Residential compound

[ ] Institutional compound (e.g., school, office)

[ ] Vacant lot

[ ] Rooftop

[ ] Other (please specify): ________________

6. Approximate size of your plot ________________ (in square meters)

7. What main vegetables do you grow?(e.g., Kale, Lettuce, Tomato, Swiss Chard)

1. ________________ 2. ________________ 3. ________________

8. What farming method do you use?

[ ] Traditional ground plot

[ ] Containers/Pots

[ ] Small-scale vertical structure (e.g., stacked pots)

[ ] Other: ________________

9. How do you access water for farming?

[ ] City piped water

[ ] River

[ ] Well/Borehole

[ ] Rainwater harvesting

[ ] Purchased tanker water

10. How would you describe your challenges with water? (Please rate from 1-No challenge to 5-Very severe challenge)

Availability (enough water) [1] [2] [3] [4] [5]

Cost [1] [2] [3] [4] [5]

Quality (cleanness) [1] [2] [3] [4] [5]

11. Do you have secure, long-term access to this land? [ ] Yes [ ] No

If No, what is the main threat?

[ ] Rent

[ ] Development projects eviction

[ ] No formal agreement

[ ] Other: ________________

12. What are your biggest challenges? (Please rank the top 3: 1 = biggest challenge)

[ ] Access to land

[ ] Access to water

[ ] Access to quality seeds/fertilizer

[ ] Soil quality

[ ] Pests/Diseases

[ ] Lack of technical knowledge

[ ] Lack of money to invest

[ ] Theft or damage to crops

13. What do you do with your harvest?(Estimate the % for each)

___________% for my family's consumption

___________% sold for income

___________% given to friends/neighbors

14. How has farming improved your household's situation? (Please rate from 1-Not at all to 5-Very much)

Improved food security (more to eat) [1] [2] [3] [4] [5]

Saved money on food bills [1] [2] [3] [4] [5]

Provided a source of income [1] [2] [3] [4] [5]

Thank you for your valuable time!

Table A2: How farmers can identify ratings:

How farmers identify ratings		
1	No challenge	I don't have any problem with this
2	Mild Challenge	It's a small problem, I can manage easily
3	Moderate Challenge	It's a noticeable problem, but I cope
4	Severe Challenge	This is a serious problem affecting my farming
5	Very severe Challeneg	This problem might make me stop farming

Appendix B: Interview Data Coding Framework

Table B.1: Summary of Key Informant Interviews on Urban Agriculture in Arada Subcity, Addis Ababa

Interviewee ID	Category / Position	Key Challenges Mentioned	Benefits / Opportunities Described	Key Policy/Strategy Suggestions	Illustrative Quote for Thesis
Int1	Policymaker AACAFUADC Deputy Commissioner	• Land relocation issues • Limited farmer financial capacity • Inter-agency coordination gaps	• Rapid growth in UA practitioners • Demonstration center training	• 50% grant + 50% loan model (0% interest) • Minimal-fee public land access • Association-based support	*"Traditional urban farms generate much less income than a high-rise building, therefore investors prefer commercials over farms."*
Int2	Expert Ministry of Agriculture	• High startup costs for technology • Public awareness deficit • Policy-strategy implementation gap	• Widespread practice (8/10 households) • Successful composting in Gullele • Technology potential	• Focus on peri-urban large-scale areas • Technology adoption incentives • Research-driven compost methods	*"Startup fund is very high for technologies like hydroponics, greenhouses, and aeroponics."*
Int3	Officer MoPD Women & Social Affairs [UA representative]	• Displacement by corridor development • Institutional water scarcity • Poor compost quality/knowledge	• Women's empowerment (50 employed) • Organic produce for staff • Income for low-income women	• Reuse plastic bottles for planting • Vertical farming in condos • Healthy eating promotion	*"The compost was made of human waste, not treated well... drastically killed the plants."*
Int4	Policymaker Ministry of Agriculture	• Land competition with buildings • Water infrastructure gaps	• Green infrastructure potential • Digital agriculture opportunities	• Affirmative action for UA • Rainwater harvesting promotion	*"Constructing buildings can easily generate more income than urban*

	Advisor	• Public undervaluation of UA benefits	• Circular economy advantages	• Digital sensor integration	*agriculture... we need to show people the methodologies."*
Int5	Administrator Arada Subcity UA Office	• Odor complaints from neighbors • Limited farmer agronomy knowledge • Space constraints in dense areas	• Environmental cleanliness • 16 Sunday markets with lower prices • 1,400+ employed in UA	• Block-based training programs • Public-private partnerships • Institutional compound utilization	*"In Woreda 02, crops are sold and ground at lower prices, supporting food access."*
Int6	Field Officer Woreda 07 UA Office	• Severe space limitations • Seasonal water shortages • Vegetable diseases (April-May)	• Growing registration (1,600+ farmers) • Riverbank development reduces flooding • Waste-to-compost conversion	• Door-to-door awareness • Farmer-to-farmer extension • Seed distribution systems	*"River side development reduces flooding, which is a problem during heavy rain for the Woreda."*
Int7	NGO Representative Farm Africa	• Winter crop damage from iced rain • Seasonal production limits • Climate vulnerability	• Seasonal crop specialization • Deep-rooted vegetables thrive in winter	• Season-appropriate planting calendars • Protected cultivation methods • Crop rotation systems	*"Iced rain destroys leafy vegetables easily in winter, while root vegetables like potatoes thrive."*
Int8	Financial Institution Development Bank of Ethiopia	• Land freezing during court disputes • High collateral requirements • Feasibility assessment gaps	• Priority sector lending for agriculture • Lower interest rates • Post-disbursement monitoring	• Court protection for agricultural lands • 25% equity requirement • Continuous project follow-up	*"If land is needed for development, agriculture has equal chance of winning in court."*
Int01	Farmer	• Eviction threats from	• Healthy lifestyle adoption	• Landscape engineering for	*"I'm not sure about the farm's*

	Household (45 years)	redevelopment • Seasonal flooding damage • Pest infestation	• Nutritious food access • Supplemental income	drainage • Manual pest management • Community support systems	*security after a year because of eviction from redevelopment."*
Int02	Farmer Communal Garden (30 years)	• Temporary land access only • Development displacement imminent • Limited indoor space	• Street cleanliness improvement • Community safety enhancement • Social space creation	• Portable container systems • Community land use agreements • Redevelopment coordination	*"We use the land as long as we can, and plan to move pots into our compound when needed."*
Int03	Farmer Private Garden (57 years)	• Severe flooding destroys crops • Labor shortage for terracing • Inadequate drainage	• Educational value for children • Wide cultivation area available	• Container gardening adaptation • Terracing for slopes • Improved drainage systems	*"Children learn about farming in school, increasing their interest in home gardening."*
Int04	Farmer Condominium Resident	• Cliff terrain limits riverbank use • Corridor development displacement • High terracing costs	• Community farming potential • Riverbank irrigation access	• Adapted slope farming methods • Community resource sharing	*"Kebena is cliffy here, we can't farm without expensive terracing."*
Int05	Farmer MoPD Employee	• Water supply cut due to development • Poor-quality compost killed plants • Budget shortages	• Feeds household plus sells surplus • 15 years of experience • Sells to staff and cafeteria	• Animal waste as fertilizer • Maintenance knowledge needed • Water source diversification	*"The soil brought by the organization was dry and rocky... killed all the plants."*
Int06	Entrepreneur Lem Plants Herbal Farm	• Location not easily accessible • Summer water shortages • Limited market exposure	• Circular economy with rabbit waste • Community green space	• Social media marketing • Rainwater harvesting systems • Community space agreements	*"The Woreda allowed us to keep plants outside our compound as long as we keep it clean."*

			provision • Neighbor cooperation		
Int07	Practitioner Menelik School Teacher	• Water shortage (solved by spring) • Winter rain damage • Lack of sheltered spaces	• Feeds participating staff • Sells surplus to staff • Educational value for students	• Spring water utilization • Staggered planting schedules • School curriculum integration	*"Urban agriculture can drastically reduce food expenses and increase food security."*
Int08	Farmer Group Basha Wolde Condominium	• Summer water shortages • Rocky, poor-quality soil • Limited land per household	• Covers 50% of family food (8 people) • Soil improvement through composting • Female-dominated participation	• Soil importation systems • Water storage solutions • Space optimization techniques	*"Whenever we plant, we must bring soil from other places due to poor local soil."*

Interview Guide 1: Urban Farmers & Practitioners

1. Can you describe a typical day on your farm? (: activities, time spent, helpers).

2. Tell me the story of how you got access to this land. Do you feel secure that you can farm here next year? Why or why not?

3. What is your single biggest struggle in farming here? (Probe for details on water, soil, conflicts).

4. Can you describe a time when you lost crops or faced a major problem? How did you handle it?

5. How has farming changed your life and your family's life? (Probe for specific benefits: food, income, health, happiness).

6. If the city government wanted to help you, what is the one thing they could do that would make the biggest difference?

Interview Guide 2: Policymakers & Planners (e.g., from AACAFUADC, City Planning Bureau)

1. How is urban agriculture currently recognized in Addis Ababa's formal policies and spatial plans?

2. In your view, what are the main benefits of UA for a dense city like Addis Ababa? And the main problems it creates?

3. What are the biggest institutional or policy-related challenges to promoting and integrating UA?

4. Projects like "Beautifying Sheger" and the "Corridor Development" are changing the city. How can UA be designed to be a part of these new landscapes, rather than be displaced by them?

5. **([Show them image of a vertical farm on a parking garage])** What would it take to implement innovative models like this in Addis? What are the barriers?

6. Is there a role for the city in supporting resource issues like water access or soil testing for farmers?

Interview Guide 3: Community Representatives & NGO Staff

1. How do you perceive the urban farms in your neighborhood? Do they add value or cause issues?

2. From your observation, who is involved in farming? (Probe: gender, age, income level).

3. Have you seen any conflicts related to urban farming? (e.g., land use, smell, water access).

4. How could urban farms be better designed to benefit the entire community, not just the farmer?

5. What role can organizations like yours play in bridging the gap between farmers and the city government?

Appendix C

Table C.1: Complete Crop Types by Farmer

Crop type grown		Count	Column N %
Grows green collard	No	57	30%
	Yes	133	70%
Grows lettuce	No	36	18.9%
	Yes	154	81.1%
Grows swiss chard	No	29	15.3%
	Yes	161	84.7%
Grows cabbage	No	106	55.8%
	Yes	84	44.2%
Grows carrot	No	71	37.4%
	Yes	119	62.6%
Grows beets	No	78	41.1%
	Yes	112	58.9%
Grows tomato	No	134	70.5%

	Yes	56	29.5%
Grows chilli	No	130	68.4%
	Yes	60	31.6%
Grows onion	No	156	82.1%
	Yes	34	17.9%
Specify other vegetables if any	0	137	72.1%
	1	2	1.1%
	Avocado	19	10%
	Orange	2	1.1%
	Potato	2	1.1%
	Zucchini	28	14.7%

Annex ; Manuscrit

Challenges of Urban Agriculture : How Land Insecurity, Gender Gaps, and Adaptive Limits Constrain Sustainability in Addis Ababa

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Abstract

Urban agriculture (UA) has been widely promoted as a strategy for food security, gender equity, and green infrastructure in cities. Yet, in many rapidly urbanizing African cities, it remains informal, spatially marginalized, and neglected from planning frameworks. This study employed a convergent parallel mixed-methods design in Arada Subcity, Addis Ababa, Ethiopia, a high-density area with less than 1% of land formally zoned for agriculture however hosting thousands of active farmers. The data included structured surveys of 190 urban farmers using stratified random sampling, 16 key informant interviews, and GIS-based spatial analysis. Quantitative data were analyzed using descriptive and inferential statistics, which includes Chi-square, t-tests, ANOVA, while qualitative data underwent thematic coding. Findings reveal that 83% of farmers lack secure land tenure, with eviction and development projects as primary threats. Women constitute 75% of practitioners but they face systematic disadvantages as men are eight times more likely to use advanced farming methods (23.4% vs. 2.8%, $\chi^2 = 28.635$, $p < 0.001$) and nearly twice as likely to have secure tenure (25.5% vs. 14.0%). Contrary to expectations, water access is a manageable constraint (100% access to city piped water), while pests and diseases affect 58% of farmers. Riverside farms report lower flooding (6%) than residential compounds (22%) due to infrastructure improvements. Therefore as a conclusion Urban agriculture in Addis Ababa is trapped in a cycle where tenure insecurity prevents investment, which perpetuates low-technology practices and gender disparities. Without deliberate spatial planning integration, including secure land access, technology transfer, and recognition of UA as legitimate green infrastructure, its potential for sustainable urban development will remain largely unrealized.

Keywords: *Addis Ababa; food security; land tenure insecurity; spatial planning; urban agriculture;*

1. Introduction

Urban agriculture (UA) has increasingly been recognized as a multifunctional urban practice that contributes to household food security, livelihood diversification, and urban resilience, particularly within rapidly urbanizing cities of the Global South. In many low-income urban contexts, UA serves as an adaptive response to rising food costs, unemployment, and limited access to formal economic opportunities. However, despite its recognized potential, the sustainability of UA remains highly dependent on access to land, water, infrastructure, institutional support, and integration within formal urban planning systems. Experiences from cities such as Singapore and Detroit demonstrate that urban agriculture can become more productive and spatially integrated when supported through planning frameworks, technological innovation, and coordinated governance. In rapidly transforming African cities, however, urban agriculture continues to operate largely within informal and spatially marginalized conditions, making it highly vulnerable to redevelopment pressures and displacement.

Despite its growing importance, urban agriculture in rapidly urbanizing cities often operates under conditions of spatial insecurity and institutional neglect. In many African cities, UA practices are concentrated within vacant lots, riverbanks, roadside verges, and other transitional urban spaces that remain highly vulnerable to redevelopment pressures. Limited access to secure land tenure, water infrastructure, financial resources, and technical support constrains both productivity and long-term sustainability. As cities continue to expand and redevelop, these pressures increasingly threaten the continuity of informal agricultural practices within inner-city areas.

In Addis Ababa, ongoing redevelopment initiatives, corridor development projects, and rapid urban transformation have intensified pressure on informal land uses, including urban agriculture. Within Arada Subcity, one of the city's densest and most spatially constrained areas, urban agriculture persists as an important livelihood and food security strategy despite severe land limitations and increasing redevelopment pressure. However, the practice remains largely excluded from formal spatial planning frameworks, resulting in highly fragmented and temporary forms of agricultural activity.

Although urban agriculture has received increasing scholarly attention in recent years, much of the existing literature focuses primarily on its environmental and food security benefits, with comparatively limited attention given to the structural constraints affecting its long-term sustainability in dense African urban contexts. In particular, empirical evidence regarding land tenure insecurity, gender disparities in access to advanced farming systems, and the spatial implications of redevelopment pressures remains limited in Addis Ababa. This creates a significant gap in understanding how urban agriculture functions under conditions of rapid urban transformation.

Arada Subcity was selected for three reasons. First, with <1% of land formally zoned for UA, it represents extreme spatial marginalization. Second, despite this, it has among the highest densities of registered practitioners (N=1,473 in Woreda 07). Third, it is at the epicenter of the Corridor Development Project, making research timely.

This article provides empirical evidence on the mechanisms, particularly land tenure insecurity, that constrain UA sustainability in dense urban contexts. Additionally, it reveals a striking gendered technology gap that has not been previously documented in Ethiopian UA research. It also offers actionable insights for spatial planners, moving beyond problem diagnosis to propose integration pathways.

2. Materials and Methods

2.1 Study Area Description

The research was conducted in Woreda 07, Arada Subcity, Addis Ababa, Ethiopia (Figure 1). Woreda 07 covers 1.1 km² at 2,300-2,444 m elevation. Climate is subtropical highland with wet (June-September) and dry (December-April) seasons. Mean annual temperature ranges 12-24°C. Land use is predominantly residential with mixed commercial and institutional functions.

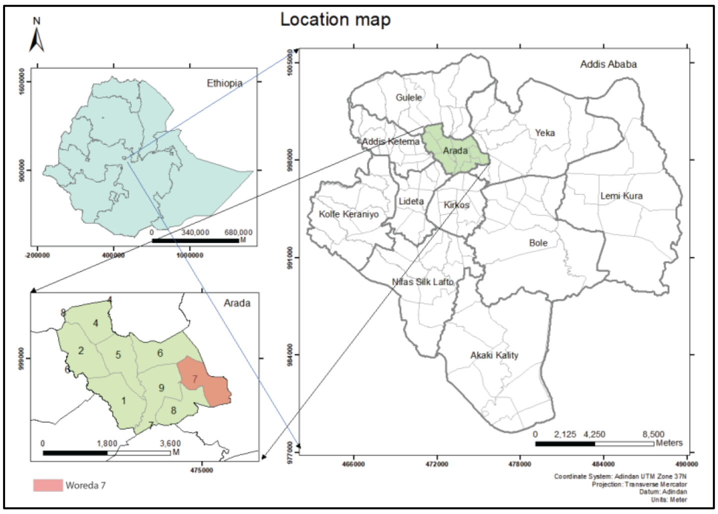

Figure 2:1 Location map of study area
Source: Generated using GIS software

2.2 Research Design

A convergent parallel mixed-methods design (Creswell & Plano Clark, 2017) was employed, with quantitative and qualitative data collected simultaneously.

2.3 Population and Sampling

The target population comprised all registered UA farmers in Woreda 07 (N=1,473). Sample size was calculated using Krejcie and Morgan (1970): n = 179, rounded to 190 to account for non-response. Stratified random sampling allocated respondents proportionally across 20 blocks based on practitioner density.

Purposive sampling selected 16 key informants: policymakers (4), planners (4), NGO representatives (2), and farmers (6).

2.4 Data Collection Methods

A structured survey captured demographics, spatial practices, challenges (ranked 1st-3rd), and harvest use. Semi-structured interviews (45-90 minutes) explored barriers and adaptation strategies. GPS coordinates were collected for spatial analysis using ArcGIS.

2.5 Data Analysis Methods

Quantitative data were analyzed using SPSS (Version 26) with descriptive statistics, Chi-square tests, t-tests, and ANOVA. Qualitative data underwent thematic analysis (Braun & Clarke, 2006). Spatial analysis generated heat maps of practitioner density and flood vulnerability mapping.

2.6 Ethical Considerations

The protocol was approved by Addis Ababa University IRB. Informed consent was obtained from all participants..

3. Results

3.1. Spatial Practices Challenge for Context

Among 190 surveyed farmers, plots are located on vacant lots (44.7%), institutional compounds (28.9%), residential compounds (17.4%), and riverside areas (8.9%). Rooftop farming is negligible (0.1%). Mean plot size is 9.90 m^2 (SD=4.28, range:5-25 m^2).

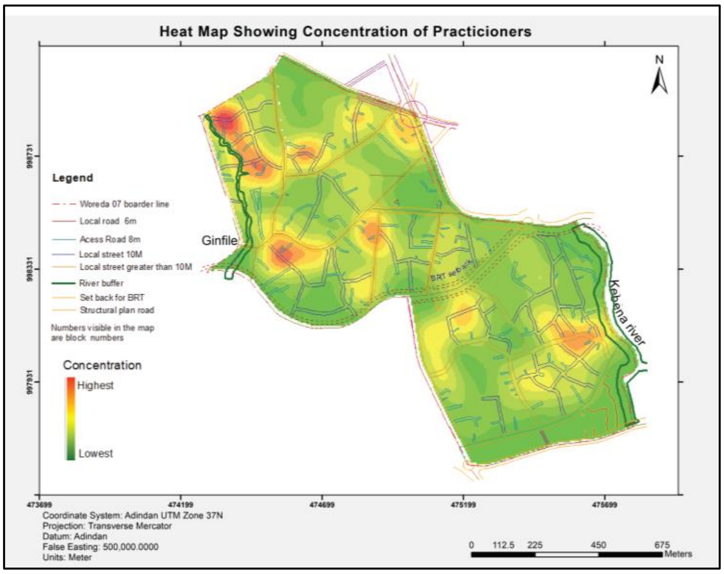

Figure 3:2: Heat map showing concentrated zones of urban farm practitioners
Source: Author's compilation from Arada Subcity Ward Office Registry (2024)

3.2 Land Tenure Insecurity: The Primary Constraint

83.2% of farmers (158 of 190) lack secure land tenure. Table 1 shows dramatic variation by location.

Table 1: Land Tenure Security by Location Type

Location Type	Secure (%)	Insecure (%)
Residential compounds	57.6	42.4
Institutional compounds	7.3	92.7
Vacant lots	9.4	90.6
Riverside areas	5.9	94.1
Overall	16.8	83.2

Source: Household survey (Author, 2025)

This reveals that UA operates under conditions of structural temporariness. The 2:1 security differential between residential (57.6%) and vacant lots (9.4%) demonstrates that tenure security, not location per se, determines stability.

3.3 Gendered Dimensions of Challenges

Women comprise 75.3% of practitioners (143 of 190) compared to 24.7% men. However, this numerical majority does not translate into equitable access to resources or technology.

Table 2: Farming Method Adoption by Gender

Gender	Traditional Only	Traditional + Containers	Advanced Methods
Female (n=143)	60.8%	36.4%	2.8%
Male (n=47)	68.1%	8.5%	23.4%

$\chi^2 = 28.635$, $p < 0.001$

Men are more likely to use advanced farming methods women are heavily concentrated in transitional "Traditional + Container" methods. This pattern reflects unequal access to capital, technical training, and social networks.

This suggests gender inequality in UA extends beyond participation rates to differential access to innovation, productivity-enhancing systems, and long-term adaptive capacity. Women are concentrated in transitional "Traditional + Container" methods (36.4% vs. 8.5% for men), a pattern reflecting unequal access to capital, training, and secure land.4. Discussion

3.4 Water Access: Available but Economically Constrained

All farmers (100%) have access to city piped water, a policy success. No farmer rated water quality or availability as "severe" or "very severe." However, equipment costs (pipes, pumps) remain prohibitive for some households.

Interpretation: Water is "available but economically constrained", a more nuanced finding than either "crisis" or "no problem."

3.5 Environmental Challenges

Pests affect 58.4% of farmers. Root vegetables show highest vulnerability (63-82% of growers affected). Farmers without pest challenges average 2.5 years experience vs. 1.8 years for affected farmers ($p<0.001$), suggesting knowledge accumulation improves management.

Figure 3.2: Farm destroyed by flood
Source : Field photograph

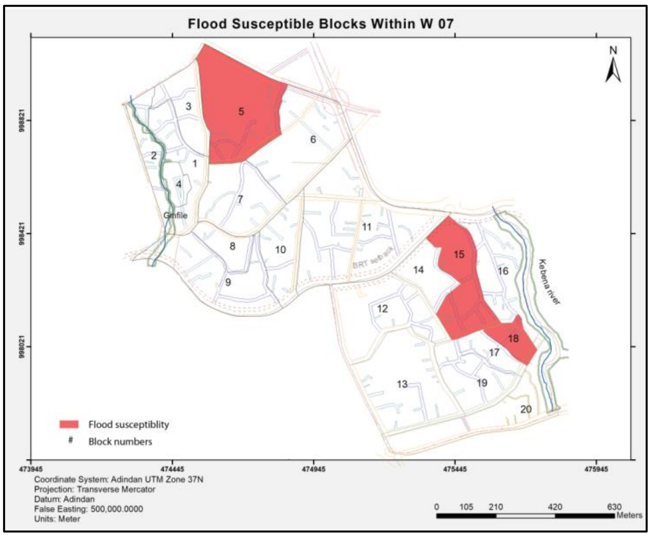

Figure 3:3 Map showing location of flood vulnerable areas
Source: Author's compilation from survey

Counter-intuitive flood pattern: Riverside farms report less flooding (5.9%) than residential compounds (21.9%). This reflects Beautifying Sheger project's riverbank rehabilitation. As a Woreda officer confirmed: "River side development reduces flooding" (Int6). However, flood risk is localized: Blocks 18 (60%), 5 (37.5%), and 15 (33.3%) have significantly higher vulnerability (χ^2=18.42, p=0.005).

3.6 The Adaptive Innovation Gap

Traditional methods dominate (62.6%). Advanced method users average 3.1 years experience vs. 2.0 years for traditional-only (F=8.24, p<0.001). This reveals an adaptive innovation gap: farmers can innovate given time and security, but most are displaced before reaching the experience threshold.

4. Discussion

This study assessed challenges constraining UA in inner-city Addis Ababa.

Land tenure insecurity is the primary structural constraint. The 83.2% insecurity rate aligns with East African patterns (Lee-Smith, 2010; Drechsel & Keraita, 2014). However, this study advances beyond documentation by demonstrating how insecurity functions as a mediating variable. The comparison between residential (57.6% secure, 25% advanced methods) and vacant lot farmers (9.4% secure, 4.9% advanced) reveals a causal chain: insecurity → no investment → low technology → vulnerability. This supports Bryld's (2003) concept of UA in "temporal niches", persisting only until higher-value uses materialize. Even secure-tenure farmers face development threats (25%), indicating tenure regularization alone is insufficient; explicit zoning protection is required.

Gendered technology gap also represents a contribution. Previous Ethiopian studies (Tesfaye et al., 2016; Moges et al., 2018) documented women's predominance but not technology differentials. This finding complicates narratives of UA as empowering. While UA provides income and food, women face systematic barriers to capital, training, and land rights (FAO, 2011). This reflects Chant's (2008) "feminization of responsibility", women absorb productive work without proportional resource control.

Additionally, counter-intuitive flood patterns demonstrate infrastructure's dual role. Riverside farms report less flooding than residential areas due to Beautifying Sheger, suggesting UA could be proactively integrated into green infrastructure. However, localized flood vulnerability in specific blocks indicates systemic drainage issues (Jha, Bloch, & Lamond, 2012).

The findings support resource access theory: sustainability outcomes are shaped less by individual effort than by unequal access to land, capital, and institutional recognition, illustrated as follows - the vicious cycle

LAND TENURE INSECURITY (83.2%)

↓

RELUCTANCE TO INVEST

(36.1% for insecure tenure)

↓

LOW TECHNOLOGY ADOPTION

(62.6% traditional only)

↓

LOW PRODUCTIVITY & PERSISTENT INFORMALITY

↓

DISPLACEMENT BEFORE EXPERIENCE THRESHOLD (2.5+ years)

↓

RETURN TO LAND INSECURITY

Gender inequality intersects at every level.

Limitations: Cross-sectional design; dry-season data collection (may underreport flooding); single woreda focus.

5. Conclusion

The core barrier to urban agriculture sustainability in Addis Ababa is structural insecurity, not farmer capacity or willingness. With 83% of farmers lacking secure tenure, women facing an 8x technology gap despite constituting 75% of practitioners, and displacement accelerating under corridor development, UA remains trapped in a vicious cycle.

Answering the research question: the key constraints are not technical or biophysical, water is universally available, soil concerns affect only 7.4%, but institutional: insecure land tenure, gender-disparate resource access, and spatial planning frameworks that treat UA as temporary rather than legitimate.

Policy implications: Tenure security must precede other interventions. Gender-responsive programs targeting women's technology access are urgently needed. Infrastructure projects should integrate rather than displace UA. And extension services must protect farmers from premature displacement, recognizing that experience enables innovation (advanced users average 3.1 years vs. 2.0 years).

Without these changes, UA's potential for food security, gender equity, and sustainable urban development will remain unrealized, not because farmers lack skill, but because the structural conditions for success are absent.

References

Barthel, S., Parker, J., & Ernstson, H. (2015). Food and green space in cities: A resilience lens on gardens and urban environmental movements. *Urban Studies, 52*(7), 1329–1348.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101.

Bryld, E. (2003). Potentials, problems, and policy implications for urban agriculture in developing countries. *Agriculture and Human Values, 20*(1), 79–86.

Chant, S. (2008). The "feminisation of poverty" and the "feminisation" of anti-poverty programmes: Room for revision? *The Journal of Development Studies, 44*(2), 165–197.

Colasanti, K. J. A., Hamm, M. W., & Litjens, C. M. (2012). The city as an "agricultural powerhouse": Perspectives on expanding urban agriculture from Detroit, Michigan. *Urban Geography, 33*(3), 348–369.

Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.

Drechsel, P., & Keraita, B. (2014). *Irrigated urban vegetable production in Africa: Characteristics, benefits and risks.* International Water Management Institute (IWMI).

Food and Agriculture Organization (FAO). (2011). *The state of food and agriculture 2010–11: Women in agriculture – Closing the gender gap for development.* FAO.

Food and Agriculture Organization (FAO). (2022). *Urban and peri-urban agriculture sourcebook: From production to food systems.* FAO.

Foster, J. P., Borgman, M., & Meerow, S. (2022). Ecosystem services of urban agriculture and prospects for scaling up production: A study of Detroit. *Cities, 125,* 103663.

Jha, A. K., Bloch, R., & Lamond, J. (2012). *Cities and flooding: A guide to integrated urban flood risk management for the 21st century.* World Bank.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*(3), 607–610.

Lee-Smith, D. (2010). Cities feeding people: An update on urban agriculture in equatorial Africa. *Environment and Urbanization, 22*(2), 483–499.

Lefebvre, H. (1991). *The production of space* (D. Nicholson-Smith, Trans.). Blackwell Publishing. (Original work published 1974)

Moges, A., Beyene, A., & Amare, T. (2018). Urban agriculture in Addis Ababa: Challenges and opportunities for sustainable development. *Journal of Urban Planning and Development, 144*(3), 05018012.

Mougeot, L. J. A. (2000). Urban agriculture: Definition, presence, potentials, and risks. In N. Bakker, M. Dubbeling, S. Gündel, U. Sabel-Koschella, & H. de Zeeuw (Eds.), *Growing cities, growing food: Urban agriculture on the policy agenda* (pp. 1–42). German Foundation for International Development.

Smit, J., Ratta, A., & Nasr, J. (2001). *Urban agriculture: Food, jobs and sustainable cities* (2nd ed.). The Urban Agriculture Network.

Teng, P. (2013). Urban agriculture in Singapore: From rooftop farms to vertical gardens. *International Journal of Agricultural Sustainability, 11*(3), 281–284.

Tesfaye, A., Negatu, W., & Brouwer, R. (2016). Urban agriculture in Addis Ababa: A socio-economic analysis. *African Journal of Agricultural Research, 11*(5), 345–356.

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development.* United Nations.

United Nations Environment Programme (UNEP). (2014). *Urban agriculture in Addis Ababa: A livelihood strategy in a changing urban environment.* UNEP.