IFRC Global Disaster Preparedness Center

RESEARCH PAPER

Effectiveness of Urban Agriculture as a Nature-Based Solution for Urban Climate Resilience in Mutare, Zimbabwe

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Abbreviations

AUREC Committee	Africa University Research and Ethics
FGD	Focus Group Discussions
IUCN Nature	International Union for Conservation of
KIIs	Key Informant Interviews
NbS	Nature-based Solutions
SDG	Sustainable Development Goals
ZIMVAC Committee	Zimbabwe Vulnerability Assessment

Abstract

Urban communities are increasingly vulnerable to climate change and the impacts of climate change, and these challenges are compounded by rapid urbanization, economic downturns, and limited access to adaptive infrastructure. Despite the growing prevalence of urban agriculture in Mutare, there is limited empirical evidence on the effectiveness of urban agriculture in enhancing urban climate resilience. Therefore, this study sought to assess the effectiveness of urban agriculture as a nature-based solution for enhancing urban climate resilience in Mutare. The study adopted a sequential exploratory design where data was collected through Focus Group Discussions, Key Informant Interviews and a structured household survey. Qualitative findings revealed that urban agriculture is widely practiced across all residential zones with crops such as leafy greens, fruits, and small livestock like poultry being most common. Quantitative data showed strong agreement among participants on the benefits of urban agriculture, particularly in enhancing food security, reducing household costs, and contributing to environmental sustainability. Key challenges faced by urban agriculture farmers include limited access to land, water shortages, pest and disease outbreaks. In response, farmers have adopted self-initiated coping strategies such as land rental, crop diversification, and value-added activities. The study also found strong support for technology-driven interventions like vertical farming and water harvesting. The findings underscore the need to strengthen policy implementation, enhance institutional support, and integrate urban agriculture into climate resilience frameworks. Urban agriculture in Mutare demonstrates significant potential as a nature-based solution for sustainable urban development and local resilience.

Keywords: Urban agriculture, Nature-based solutions, Climate change, Climate resilience, Mutare Zimbabwe, Food security

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1. Introduction

1.1 Background

Urban areas are expected to survive, adapt and thrive in the face of climate related shocks and stressors such as drought, heatwaves, floods and storms, (Wardekker, 2021). However, the world's urban areas are grappling with poverty, growing population, food insecurity, pollution and inequalities in the face of climate change, making climate resilience an important attribute for urban areas today, (ADB, 2014; Kiribou et al., 2024; Orsetti et al., 2022). Some scholars, policy makers and decision makers have developed and implemented several climate resilient pathways to assist urban areas address climate related challenges in a sustainable manner, (Allan et al., 2024; Calheiros & Stefanakis, 2021; Kiribou et al., 2024). These efforts are in line with the Sustainable Development Goals (SDG), especially Goal 11, which seeks to make cities inclusive, safe, resilient and sustainable. These efforts include strengthening and modifying urban infrastructure, building social capacities, use of integrated approaches as well as exploring nature-based solutions (NbS), (Allan et al., 2024; Canet-Martí et al., 2021; Orsetti et al., 2022; Wardekker, 2021). The concept of NbS involves working with nature to address urban challenges. This includes practices that use natural processes to mitigate environmental and social risks. Castaldo et al., 2025 and Okello et al., 2024 highlighted that NbS include urban agriculture, green roofs, water regulation, agroforestry and green built environment.

As one of the NbS for urban climate resilience, urban agriculture is gaining attention as a strategy to address multiple challenges in urban contexts worldwide. Urban agriculture is the practice of farming (both plants and animals) within the boundaries of urban areas (Kiribou et al., 2024; Langemeyer et al., 2021). Urban agriculture also refers to the practice of cultivating, processing, and distributing food within urban areas. It therefore includes backyard farming, use of balconies, bee keeping, community gardens, as well as farming in open urban spaces. According to Corbould, 2013, Gerster-Bentaya, 2013 and Singh et al., 2018, about 20% of the world's food is produced in cities worldwide and much of this percentage is attributed to the increase in the number of people practicing urban agriculture. Urban agriculture improves urban resilience through diversification of food sources, reducing dependency on external food supplies, reducing the food miles as well as connecting people with nature (Corbould, 2013; Kiribou et al., 2024; Langemeyer et al., 2021).

The beneficial and promising role of urban agriculture as a NbS for urban resilience is widely acknowledged by scholars, policy makers and decision makers, (ADB, 2014; Corbould, 2013; Djan, 2023; Kiribou et al., 2024; Langemeyer et al., 2021). However, with climate change and variability, there is a dearth of information on the effectiveness of urban agriculture as a nature-based solution for building urban climate resilience especially in low- and middle-income countries like Zimbabwe

(Corbould, 2013; Hampwaye, 2013; Korth et al., 2014; Langemeyer et al., 2021; Nogeire-McRae et al., 2018; Stone et al., 2024). As urbanization is increasing at a rate of 4.3% per year in Zimbabwe, urban vulnerability to the impacts of climate change is also on the rise, (UNDP, 2019). There is an increase in the number of food insecure households in Zimbabwe due to the impacts of the climate induced droughts experienced in recent years. In addition, Zimbabwe faced an El Nino induced drought in 2024 affecting both rural and urban households. According to the Zimbabwe Vulnerability Assessment Committee (ZIMVAC) 2023 report, there was an increase from 19% in 2022 to 22% in 2023 in the number of households practicing urban agriculture in Zimbabwe.

Urban agriculture has the potential to act as a NbS in addressing climate-related challenges in Mutare. This can be achieved when urban agriculture contributes to enhancing climate resilience by improving food security, reducing urban heat islands, and managing water resources effectively. Hence there is a need to explore urban agriculture as a potential pathway to building urban climate resilience in Zimbabwe. Therefore, the purpose of this research was to assess the effectiveness of urban agriculture as a NbS for enhancing urban climate resilience in Mutare, Zimbabwe.

1.2 Problem statement

In Mutare, urban communities are increasingly vulnerable to climate change and the impacts of climate change, including extreme weather events, food insecurity, and declining environmental quality, (Mugiyo et al., 2023; Samu & Akıntuğ, 2020). These challenges are compounded by rapid urbanization, economic downturns, and limited access to adaptive infrastructure, (Gutu Sakketa, 2023; Kamuzhanje, 2019). Urban agriculture has emerged as a potential NbS that can contribute to climate resilience. However, despite its growing prevalence in Mutare, there is limited empirical evidence on the effectiveness of urban agriculture in enhancing urban climate resilience. Furthermore, the nature and extent of urban agricultural practices, as well as their socio-economic and environmental impacts to households in Mutare remain poorly understood. Without a clear understanding of these dynamics, it becomes difficult to integrate urban agriculture into urban planning and climate adaptation strategies effectively. Therefore, this study sought to assess the effectiveness of urban agriculture as a NbS for enhancing urban climate resilience in Mutare.

1.3 Justification

The research was envisaged as resulting in improved understanding of urban agriculture as a NbS for urban climate resilience in Mutare, because an improved understanding potentially helps policymakers, urban planners, and practitioners integrate urban agriculture into urban development frameworks more effectively. It also supports evidence-based decision-making for sustainable urban transformation, especially in Mutare where there is rapid urbanization. The research identifies urban

agricultural practices in Mutare with potential to be scaled up and improve urban climate resilience. Identifying scalable urban agriculture practices such as vertical farming, aquaponics, and community gardens enables strategic deployment of resources in the areas most vulnerable to climate risks. These practices offer environmental co-benefits to the city like carbon sequestration and biodiversity enhancement as well as social benefits like job creation and community engagement. Scaling up proven models ensures resource efficiency and broader impact while aligning with climate action plans and urban sustainability goals.

Networks for urban climate resilience research and collaborations in Mutare will be created through the research. Building interdisciplinary and cross-sectoral networks fosters innovation, knowledge exchange, and the co-creation of solutions that are effective in addressing the city's urban agricultural challenges. Collaboration among academia, local governments, civil society, and private stakeholders enhances the scope and applicability of urban agriculture interventions. Such networks are critical for resource mobilization, influencing policy, and maintaining momentum in research and implementation. They also contribute to building capacity and institutional frameworks necessary for long-term resilience strategies.

This research offers mentorship to early-career researchers in the fields of urban sustainability and climate resilience. Through this support, the initiative facilitates effective knowledge transfer, fosters academic excellence, and strengthens the overall quality and impact of the research.

1.4 Objectives

Main objective

The main objective of the research was to assess the effectiveness of urban agriculture as a nature-based solution for enhancing urban climate resilience in Mutare, Zimbabwe, studied over a four-month period.

Specific objectives

The specific objectives for the study were to:

a. Establish the nature and extent of urban agricultural practices in Mutare

b. Determine the benefits of urban agriculture in Mutare

c. Establish the challenges facing urban agriculture farmers in Mutare

d. Establish the coping strategies being adopted by urban agriculture farmers in Mutare

e. Establish the stakeholders' perceptions of urban agriculture as a nature-based pathway for urban climate resilience in Mutare

1.5 Research questions

The study sought to answer the following questions:

a. What is the nature and extent of urban agricultural practices in Mutare? How can these practices be scaled up for urban climate resilience?

b. What are the benefits of urban agriculture in Mutare?

c. What are the challenges facing urban agriculture stakeholders in Mutare and how can they be mitigated?

d. What are the coping strategies being adopted by urban agriculture farmers in Mutare?

e. What are the perceptions of stakeholders in Mutare on urban agriculture as a nature-based pathway for urban climate resilience?

2. Literature Review

2.1 Climate-Related Shocks and Stressors in Zimbabwe's Urban Areas

Zimbabwe's urban areas are increasingly vulnerable to climate-related shocks and stressors, with direct impacts on infrastructure, livelihoods, public health, and food security, (Kadungure et al., 2023; Spiegel et al., 2023; Tirivangasi et al., 2023). In recent years, rapid urbanization, combined with erratic weather patterns, has exposed cities such as Harare, Bulawayo, Gweru and Mutare to unprecedented environmental risks. Key among these are extreme heat, urban flooding, water scarcity, and more frequent droughts linked to climate variability, particularly the El Niño-Southern Oscillation. During the 2023/24 El Niño event, Zimbabwe experienced one of the worst droughts in history, leading to widespread crop failures, depleting water sources, and increasing food insecurity, (Mugiyo et al., 2023). The El Niño had national consequences, and its effects were also pronounced in urban settings where reliance on market-based food systems is high, and infrastructure is already under strain. Reports indicate that urban households faced food price spikes and increased water rationing as a result of economic insecurity, (FAO, 2023; Mugiyo et al., 2023; OCHA, 2023).

Urban infrastructure is not adequately equipped to manage climate extremes, (Tirivangasi et al., 2023). Drainage systems in most cities in Zimbabwe are outdated or blocked due to poor waste management, often resulting in flash floods during heavy rains, (Ndlovu, 2019). Conversely, prolonged dry spells lead to water shortages,

with most cities, like Gweru and Bulawayo, routinely implementing water rationing schedules, sometimes for weeks at a time, (Mugiyo et al., 2023). These challenges are exacerbated by limited investment in climate-resilient infrastructure. Urban residents, especially those in low-income and informal settlements, are disproportionately affected because many live in poorly constructed housing without access to reliable water sources, sanitation, or food production spaces, (Orsetti et al., 2022; Roy et al., 2023). Consequently, these populations face heightened food insecurity and health risks with few formal safety nets in place.

2.2 Climate Resilient Pathways in Zimbabwe

According to the World Bank, 2024, addressing urban climate vulnerability requires proactive and inclusive climate-resilient development pathways. Recent studies emphasize that anticipatory adaptation measures are critical for long-term resilience, (Government of Zimbabwe, 2024; Robinson et al., 2024; Thompson et al., 2010). This means that such pathways will involve investing in adaptive infrastructure, promoting sustainable livelihoods, and integrating climate considerations into urban planning for them to be successful. In urban areas, this translates into urgent needs for upgraded drainage systems, expanded access to clean water, climate-resilient housing, and the greening of urban spaces. The Government of Zimbabwe, in collaboration with development partners, has launched several initiatives aimed at enhancing urban climate resilience, (World Bank, 2024). These include exploring NbS, the development of climate-smart urban policies, integration of climate risk assessments into city planning processes, and support for local-level adaptation projects.

2.3 Nature-Based Solutions as a pathway for building climate resilience in Zimbabwe

NbS offer promising strategies for building climate resilience in Zimbabwe's urban areas. These approaches involve working with natural ecosystems such as wetlands, urban forests, and green spaces to address climate challenges while supporting biodiversity, public health, and community well-being, (Asamoah et al., 2025; Kiribou et al., 2024; Panda et al., 2024). In Zimbabwe, urban greening initiatives, including tree planting, green belts, and community gardens, are gaining traction, (Kembo et al., 2024; Maphosa & Moyo, 2024; Moyo, 2023). These interventions help mitigate the urban heat island effect, improve air quality, manage stormwater, and provide recreational spaces, (Nyikahadzoi & Mhlanga, 2021). However, such efforts remain limited in scale and often lack coordination or integration into formal urban planning frameworks. Despite their benefits, the implementation of NbS in Zimbabwe's cities is challenged by deficient policy support, limited funding, and competing land-use demands, (Maphosa et al., 2025; Nyathi & Ndlovu, 2025). Moving forward, a more strategic, evidence-based approach is needed to embed NbS into local plans and national urban development strategies.

2.4 Urban Agriculture Practices in Zimbabwe

Urban agriculture is an increasingly vital NbS in Zimbabwe, providing a critical buffer against food insecurity and economic stress. In the face of recurrent climate shocks and rising urban poverty, households across Harare, Bulawayo, Mutare, and other urban centers engage in small-scale farming to supplement their food needs and in some cases earn additional income, (Kanonhuwa et al., 2021; Malapela et al., 2016; Maphosa & Moyo, 2024). In these cities, urban agriculture takes various forms, including backyard gardens, community allotments and peri-urban plots. According to Burgin (2018), a backyard garden or home garden is a small-scale garden on a private residential property used for the production of crops and small livestock. Community allotments, also known as community gardens, are public or shared spaces in urban, peri-urban, or rural areas where community members collaboratively cultivate a variety of crops on individually managed plots, (Chari & Ngcamu, 2025). Peri-urban agriculture is the cultivation of crops and rearing of livestock in the transitional areas surrounding cities. Common crops include vegetables such as tomatoes, onions, spinach, and maize, with some households also raising chickens or small livestock, (Korth et al., 2014; Langemeyer et al., 2021; Nogeire-McRae et al., 2018). The practice is often informal and driven by necessity, especially among low-income residents who cannot afford to rely solely on the market for food.

In high-density suburbs of Harare, studies have shown that urban farming is a key strategy for coping with food poverty, (Bandauko & Arku, 2024; Malapela et al., 2016; Matamanda, 2020). Households use whatever space is available for instance backyards, road verges or open plots to grow food. In Bulawayo, backyard poultry keeping is also widespread, offering protein sources and occasional income, (Maphosa et al., 2025). These practices are often women-led and community-oriented, fostering local cooperation and resilience. However, urban agriculture in Zimbabwe faces numerous constraints like limited land availability, particularly in high-density areas. Access to water is a significant barrier, with many cities experiencing regular supply disruptions. Additionally, urban farming is often excluded from formal zoning regulations, and municipal policies can be inconsistent, (Bandauko & Arku, 2024; Maphosa & Moyo, 2024). When urban agriculture is excluded from zoning rules and policies are inconsistent, residents experience uncertainty about the future of their gardens making it difficult for them to plan, invest or rely on urban agriculture as a stable source of livelihoods, (Davies et al., 2021). Despite these challenges, the persistence of urban agriculture indicates its importance in the urban social fabric.

2.5 Urban Agriculture Benefits in Zimbabwe

The benefits of urban agriculture in Zimbabwe are multifaceted. Dube et al., 2021 and Kanonhuwa et al., 2021 highlighted that urban agriculture enhances food security through local food production, thereby reducing households' reliance on volatile markets. This also creates more stable food access, especially during times of

economic or climate stress. Although not all households sell their produce, many are able to reduce their household food expenditure, freeing up income for other essential needs thereby contributing to poverty alleviation, (Maphosa & Moyo, 2024). In some cases, urban farmers can generate modest earnings from selling surplus produce, improving their economic resilience. Households gain access to fresh vegetables and protein sources, leading to more diversified diets hence contributing to improved health and nutritional outcomes, (Malapela et al., 2016). This is particularly important in low-income urban communities where malnutrition and micronutrient deficiencies are common.

Urban agriculture in Zimbabwe contributes to climate adaptation and ecosystem services through the gardens and green spaces that help cool urban areas, improve air quality, and reduce surface runoff during rains, (Government of Zimbabwe, 2024; Nyikahadzoi & Mhlanga, 2021). In addition, urban agriculture in Zimbabwe fosters community cohesion and self-reliance with community gardens providing shared spaces for interaction, knowledge exchange, and collective action, (Kanosvamhira & Tevera, 2024; Maseko, 2024). Women, in particular, benefit from the social capital and empowerment that come from managing gardens and contributing to household welfare. Women benefit from urban agriculture through building supportive networks with neighbors where they can share seeds, knowledge and resources. By taking responsibility for planning, coordinating, and sustaining their day-to-day garden activities, women build strong leadership and organizational skills. According to a study of urban farmers in Dar es Salaam and Lomé, urban agriculture contributes to women's empowerment by strengthening their economic autonomy and enhancing their social status, which in turn positively influences their psychological well-being, (Konou et al., 2024).

2.6 Challenges Facing Urban Agricultural Farmers

Urban farmers in Zimbabwe face a host of challenges that limit the effectiveness and scalability of their efforts with access to land for agricultural activities being often highlighted as the main challenge for urban agriculture farmers, (Gunhidzirai, 2023). With increasing urban density and competition for space, few formal mechanisms exist to allocate land for agriculture. Informal settlements, commercial developments, and infrastructure projects often encroach on areas used for farming. Some scholars have highlighted water scarcity as another significant hurdle for urban agriculture farmers like in Bulawayo and Harare, municipal water systems are frequently overwhelmed, resulting in long periods of water rationing, (Dube et al., 2021; Kamana et al., 2024; Nyikahadzoi & Mhlanga, 2021). Farmers are forced to rely on shallow wells, greywater, non-revenue municipal water or inconsistent borehole access compromising both the productivity and safety of crops.

Legal and institutional frameworks also present barriers as urban agriculture is not widely recognized in city bylaws, and in some cases, it is actively discouraged,

(Bandauko & Arku, 2024; Jonga, 2014; Marumahoko et al., 2025). Plots may be cleared without notice, or farmers may face fines for cultivating in undesignated areas. This uncertainty discourages long-term investment in soil improvement, irrigation systems, or infrastructure like fencing. Additionally, extension services are limited in cities, and access to inputs like seeds, compost, or pest control is inconsistent, (Mwenye & Kutywayo, 2021). While some farmers grow primarily for household use, those who wish to sell produce face transportation issues, competition with formal retailers, and lack of cold storage. These barriers reduce the economic viability of urban agriculture and limit its contribution to the wider food systems.

2.7 Coping Mechanisms

In response to these challenges, urban communities in Zimbabwe have developed a range of coping strategies like diversification of livelihood activities. Many urban households combine agriculture with other income-generating activities, such as vending, tailoring, or small-scale services, to reduce reliance on any single source of income, (Djan, 2023; Kiribou et al., 2024; Maphosa & Moyo, 2024). Community gardening has emerged as a key adaptation strategy in response to climate change, food insecurity, and social challenges, especially in areas with municipal or NGO support, (Nyathi & Ndlovu, 2025). Shared gardens allow residents to pool resources, reduce individual land constraints, and learn from one another. These spaces often become hubs for information exchange and resilience-building.

Water-saving techniques are increasingly adopted by urban farmers, including the use of greywater, mulching, and water-harvesting systems. While not always safe or efficient, these practices demonstrate ingenuity and a willingness to adapt to scarcity. In some neighborhoods, organizations have invested in shared boreholes to support agricultural activities, (Maphosa & Moyo, 2024). Training programs led by NGOs, universities, and faith-based organizations have helped build local capacity to manage urban agricultural activities successfully. For example, in Bulawayo, training in organic farming and composting has enhanced both productivity and sustainability in several communities, (Maphosa et al., 2025; Nyathi & Ndlovu, 2025). In addition to local capacity building, local authorities, NGOs, and communities engage in dialogue to develop a shared understanding and coordinated approach to urban agriculture, (Bandauko & Arku, 2024; Maphosa & Moyo, 2024; Marumahoko et al., 2025).

2.8 Conclusion

Zimbabwean urban areas face growing climate-related shocks and stressors ranging from drought and flooding to water shortages and food insecurity. These shocks and stressors disproportionately affect the urban poor, compounding existing vulnerabilities and threatening basic livelihoods. However, numerous pathways for resilience are emerging, for instance climate-resilient urban development, informed

by participatory planning and supported by targeted investments in infrastructure and services, offers a clear opportunity. In addition, NbS, though underutilized, show promise in managing urban climate risks while enhancing biodiversity and social cohesion. Urban agriculture stands out as a practical, community-driven response to food insecurity, climate adaptation, and social empowerment; despite facing significant challenges, it continues to offer nutritional, economic, and environmental benefits. Scaling up this practice through formal recognition, better access to resources, and policy integration can play a crucial role in building resilient and inclusive urban food systems. Climate action in Zimbabwe's cities must prioritize the needs and capacities of vulnerable communities. Investing in localized, nature-based, and community-driven approaches is an adaptation and development opportunity.

3. Methodology

3.1 Description of study area

The research was carried out in Mutare, Zimbabwe, the fourth largest city in Zimbabwe, Figure 1. Between 2012 and 2022, the urban population of Mutare increased by 20% from 187621 to 224802. Mutare is in Manicaland province, which has the second highest proportion of households (36%) practicing urban agriculture in Zimbabwe, (ZIMVAC, 2023).

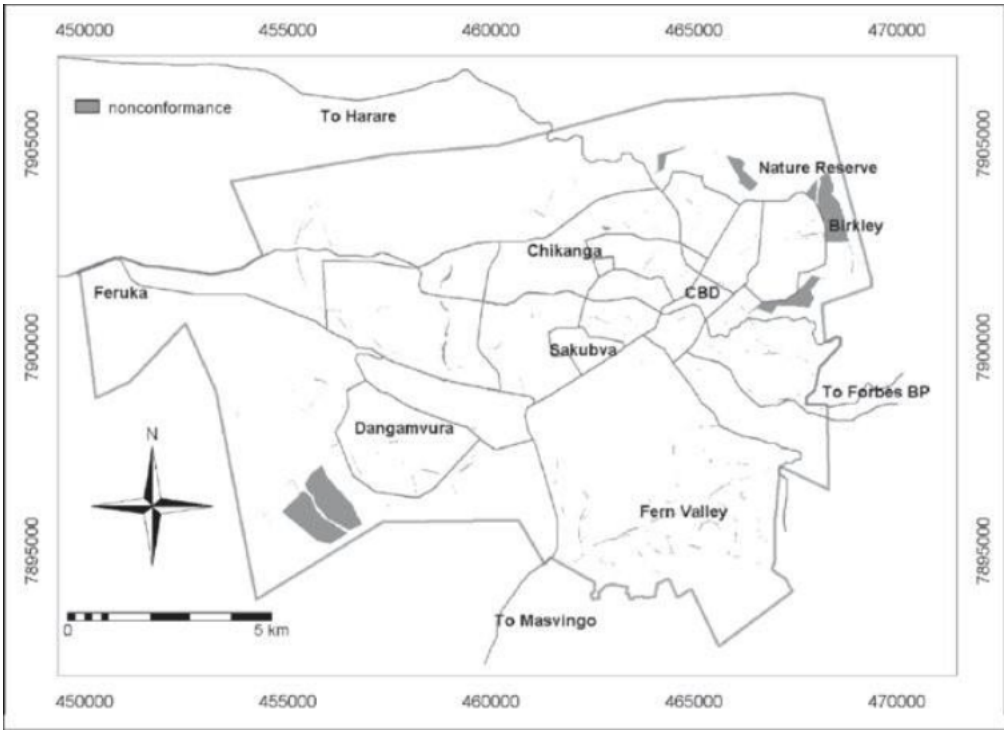

Figure 1: Map of Mutare (Mabaso et al., 2015)

The city of Mutare is popularly referred to as a gap town because it lies in a valley surrounded by mountain ranges and hills. The areas surrounding Mutare are in agro-ecological regions I and II, while Mutare is in agro-ecological region III as indicated in Figure 2. Agroecological regions in Zimbabwe are also known as Natural Regions, are classifications used to divide the country based on climate, soil type, rainfall patterns, and agricultural potential. According to this classification, agroecological region III is characterized by a moderate climate, with about 650–800 mm annually and a high susceptibility to flash flooding and droughts.

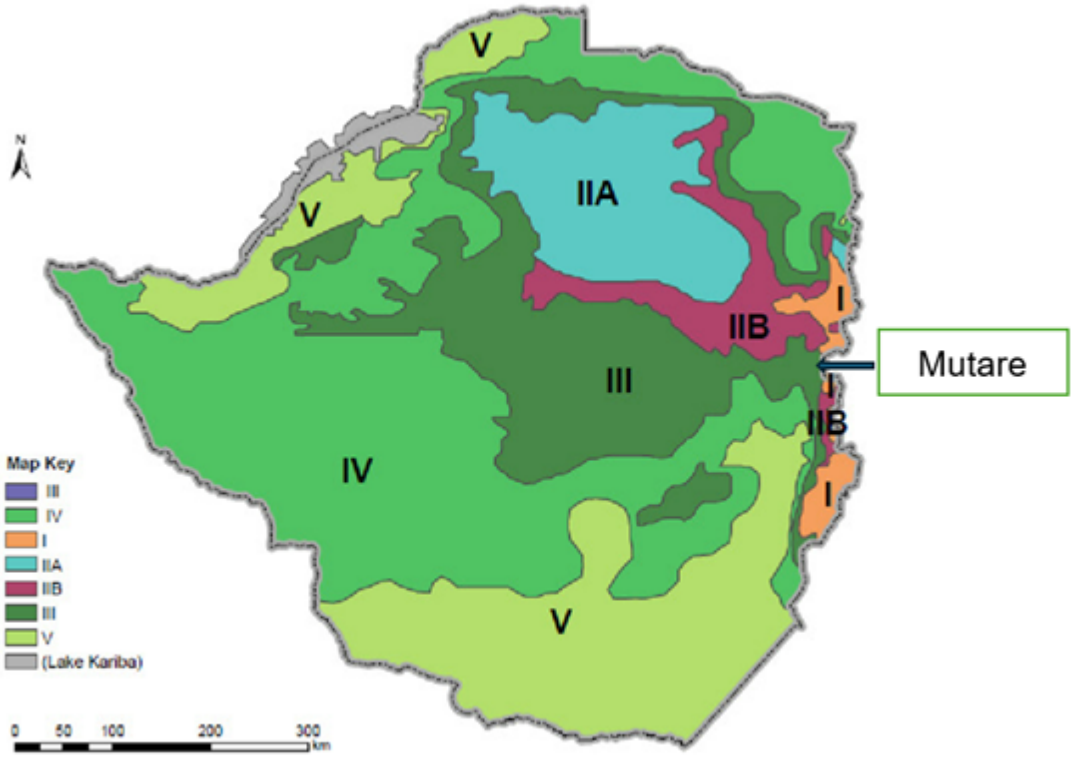

Figure 2: Agro-ecological regions of Zimbabwe (adapted from Mtisi, 2008)

3.2 Research design

The research followed sequential mixed methods of case study design, as illustrated in Figure 2. This approach enabled the collection of both qualitative and quantitative data within a single study. Data was collected in two distinct phases. In the first phase, qualitative data was gathered to gain an in-depth understanding of the current nature and extent of urban agriculture in Mutare, as well as to explore its role as a nature-based solution for enhancing urban climate resilience. The insights obtained from this phase informed the development of the research instrument used in the second phase. In the second phase, quantitative data was collected. This phase allowed for the responses to be quantified, generalized, and statistically analyzed. The

data generated helped to assess the effectiveness of urban agriculture as a NbS for urban climate resilience.

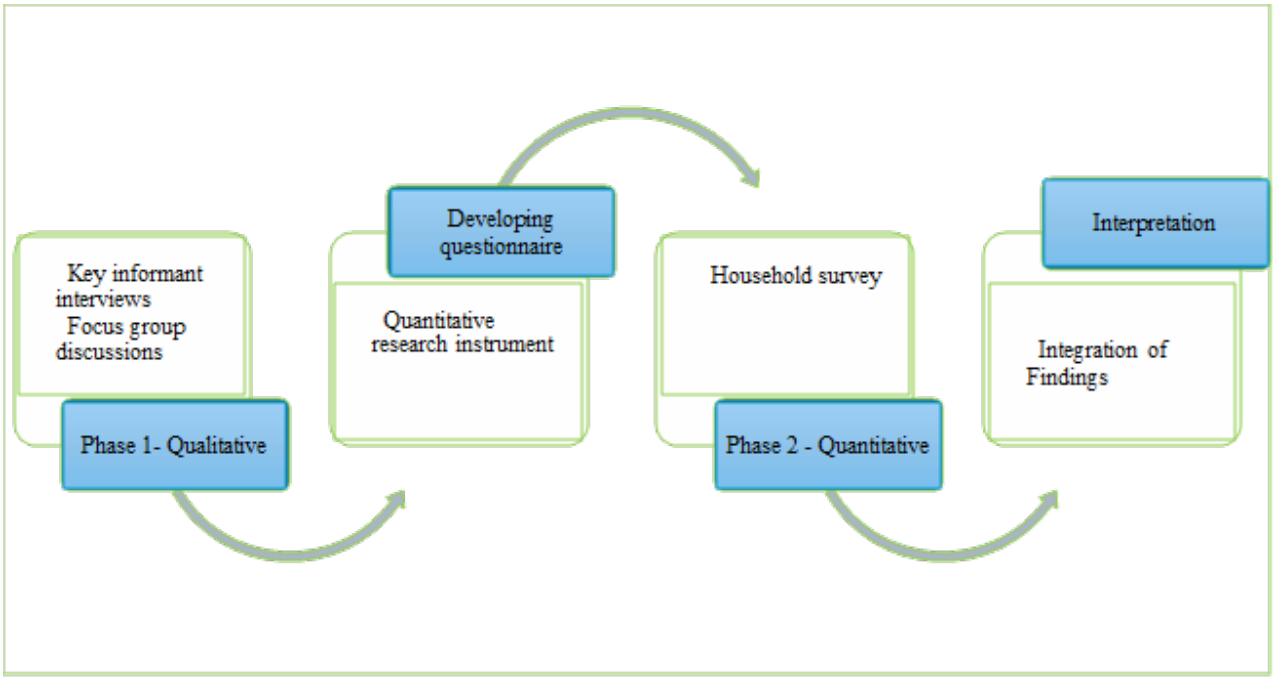

Figure 3 Research design for the Study

3.3 Study Population and Sampling

Study Population

The study population for phase one of the study was key urban agriculture stakeholders in Mutare. These included local extension workers, local leaders, representatives from local non-governmental organizations, and household representatives. The study population for the second phase of the research was the households in Mutare, that is 60353 households (ZIMSTATS, 2022).

Sampling

Purposive sampling was used to select key informants and focus group discussion participants for the first phase of the research. This approach allowed the researcher to intentionally select individuals with relevant knowledge and experience in urban agriculture. Purposive sampling was used within a stratified sampling framework to select household participants for the second phase of the study. Stratification was based on settlement type specifically, low-, medium-, and high-density suburbs to ensure representation across different socio-economic contexts. Within each stratum, participants were purposively selected based on their involvement or potential exposure to urban agriculture activities. The number of participants allocated to each stratum was determined using the probability

proportional to size approach, as outlined by Skinner, 2016, to reflect the actual distribution of households across the city.

Community Entry

Community entry approval was obtained from the local authorities. The purpose of the study was clearly explained, and any potential concerns were addressed. All relevant documentation, including data collection tools, was presented to the appropriate stakeholders. The meetings with the relevant authorities facilitated the research team's introduction to the community and helped establish trust. Once permission was granted by the local authorities, the research proposal, along with all supporting documents, was submitted to the Africa University Research and Ethics Committee (AUREC) for review. Ethical approval to conduct the study was subsequently granted.

Once approval was obtained from both the local authorities and AUREC, interview meetings were scheduled with key informants as part of the first phase of data collection. The location, date, and time of each interview were agreed upon in consultation with the participants. Interview venues were selected to ensure privacy and minimize noise and interruptions. Prior to each interview, the purpose of the study was explained to the key informants, and written informed consent was obtained using the form provided in Appendix 1.

The schedule for the FGDs was developed and finalized in consultation with local leaders. It was noted that low- and medium-density housing areas account for approximately 11% of all households in Mutare, while high-density areas comprise about 89%. To ensure balanced representation, the high-density areas were further divided into four distinct zones based on location. The date, time, and venue for each FGD were agreed upon with participants. Prior to the commencement of each session, the purpose of the research was explained, and written informed consent was obtained using the form provided in Appendix 1. Throughout the research process, the research team and assistants adhered strictly to ethical guidelines and respected all relevant community protocols.

3.4 Data collection

Key informant interviews (KII) were used during the first phase of data collection. Eight KIIs were conducted, and the key informants included community leaders, representatives from local authorities, and staff from non-governmental organizations. The interviews were guided by the KII guide provided in Appendix 2. The sample size was informed by guidelines from (Marshall et al., 2013) and (Sharma et al., 2024), who recommend a range of 4 to 30 participants as a rule of thumb for qualitative data collection. They also emphasize the importance of data saturation, that is, the point at which no new information or themes emerge as the appropriate

stage to conclude data collection and analysis. This research also followed the principle of data saturation, with interviews continuing until no new insights were observed.

Focus Group Discussions (FGDs) were used to collect data during the first phase of the research. Participants were drawn from household representatives in the three different settlement types according to the local council's database. FGD guide (Appendix 3) guided the discussions. There were between 4 to 9 participants in each focus group as guided by Morgan (2012) and a total of six FGDs.

Household Surveys were conducted during the second phase of the research to collect quantitative data. Both self-administered and researcher-administered questionnaires were utilized to accommodate participants without access to digital connectivity. The household questionnaire (Appendix 4) served as the main data collection instrument.

Mutare Urban has a total of 60,353 households (ZIMSTAT, 2022). Using a 95% confidence level and a 5% margin of error, the minimum required sample size for the survey was calculated to be 382 households. The actual number of responses collected was 413, which exceeds the required sample size of 382, increasing the reliability of the findings.

Pre-testing

The data collection tools were submitted to the project mentors for expert guidance on their structure, clarity, and overall ease of use. In addition, the research team reviewed the instruments to assess the completeness and relevance of the questions. The tools were also pre-tested to evaluate their effectiveness, reliability, suitability, and the logical flow of the questions. Responses obtained during the pre-testing phase were not included in the final data analysis. However, feedback from this process was carefully reviewed, and necessary adjustments were made to improve the research instruments. The time taken by respondents to complete the questionnaires during pre-testing was recorded to provide future participants with an accurate estimate of the expected duration for data collection.

3.5 Data analysis

Qualitative data from interviews and focus group discussions were analyzed manually using thematic content analysis to identify key themes related to the nature and extent of urban agriculture, its benefits and challenges, and emerging opportunities. This approach provided valuable insights into the perceptions and challenges associated with urban agriculture in Mutare.

Quantitative data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS). Descriptive statistics were employed to summarize key variables,

while multiple linear regression and correlation analysis were used to examine the benefits, challenges, and stakeholders' perceptions of urban agriculture as a NbS for enhancing urban climate resilience.

3.6 Ethical considerations

The research received approval from both the Africa University Research and Ethics Committee and the relevant local authorities. The study strictly adhered to all established research protocols, including community entry procedures. Written informed consent was obtained from all participants prior to data collection, using the consent form provided in Appendix 1.

Before participating, the purpose of the study was clearly explained to each participant. Consent was sought before data collection and prior to recording any interviews or discussions. Participants were informed that their involvement was voluntary and that they could withdraw from the study at any time without any negative consequences.

To ensure privacy and confidentiality, data collection was conducted in private locations mutually agreed upon by the researcher and the participants. All collected data was securely stored: digital data on password-protected devices, and physical copies of consent forms and questionnaires in a locked cabinet, in accordance with Africa University's data management guidelines.

4. Results

4.1 Demographic information

4.1.1 Qualitative Findings

The qualitative phase included 8 Key Informant Interviews (KIIs) and 5 Focus Group Discussions (FGDs) with between 4 and 9 participants, to capture both institutional and community-level perspectives on urban agriculture in Mutare. The KIIs were conducted with representatives from local authorities, government departments, and regulatory authorities. Data saturation was reached after the fifth KII. However, interviews continued up to the eighth participant to ensure that all individuals identified through snowball sampling were included and that no potentially valuable insights were missed. These informants provided critical insights into policy frameworks, regulatory challenges, and institutional support structures influencing urban agriculture in Mutare. The FGDs were composed of mixed-gender participants and were stratified by residential location, ensuring balanced representation across different urban contexts. Specifically, three FGDs were conducted to represent high-density areas (Sakubva, Dangamvura, Chikanga), one medium-density area, and one low-density area FGD. This stratified and inclusive approach allowed the collection of

diverse perspectives, ensuring that both policy-level considerations and community experiences from across the city were meaningfully represented in the findings.

4.1.2 Quantitative findings

Figure 4 highlights the participants for the qualitative phase of the research by location with Dangamvura, Sakubva and Chikanga representing the high-density areas.

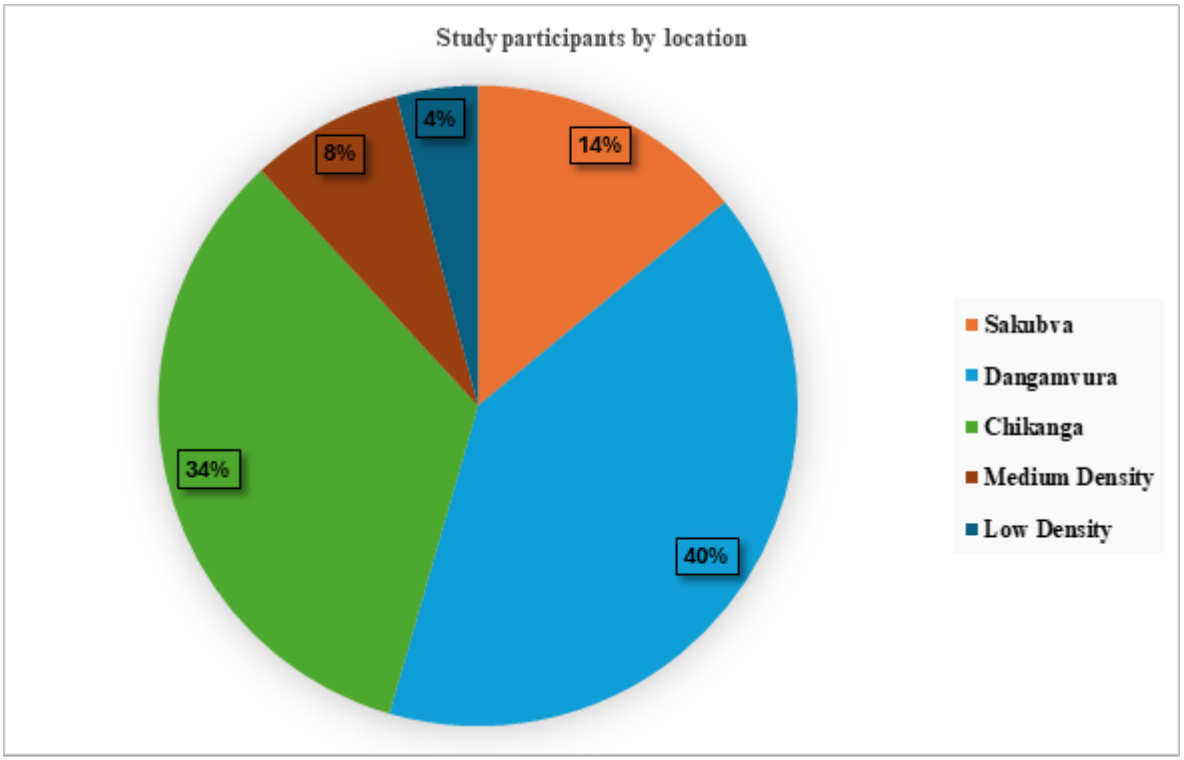

Figure 4: Quantitative study participants by location

More than 60% of the participants fall within the 25-to-54 years age range as indicated in Table 1. The same table also highlights that there were more female participants compared to male participants, and both employed and unemployed participants engage in urban agriculture. About 90% of the participants have attained secondary and tertiary education. In addition, the majority (61%) of the participants have been involved in urban agriculture for more than 5 years.

Table 1 Demographic Characteristics

Suburb	Sakubva	Dangamvura	Chikanga	Medium-Density	Low-Density	Mutare Urban
Age Group						
18-24	9	19	17	3	0	**48**
25-34	9	29	31	10	13	**92**
35-44	7	45	22	9	2	**85**
45-54	6	43	31	7	1	**88**

55-64	15	18	27	3	0	**63**
65 and above	12	13	11	0	1	**37**
Total	**58**	**167**	**139**	**32**	**17**	**413**
Gender						
Male	31	60	55	9	8	**163**
Female	27	107	84	23	9	**250**
Total	**58**	**167**	**139**	**32**	**17**	**413**
Employment status						
Employed full time	20	53	50	21	7	**151**
Employed part time	9	5	4	0	7	**25**
Student	9	17	8	3	0	**37**
Business owner	3	16	16	0	3	**38**
Unemployed	7	31	12	3	0	**53**
Self-employed	3	41	40	5	0	**89**
Other (please specify)	7	4	9	0	0	**20**
Total	**58**	**167**	**139**	**32**	**17**	**413**
Highest level of education completed						
Primary	11	17	15	0	0	**43**
Secondary	30	82	57	15	4	**188**
Tertiary	17	68	67	17	13	**182**
Total	**58**	**167**	**139**	**32**	**17**	**413**
Duration						
Less than 1 year	1	11	14	3	0	**29**
1-3 years	12	31	28	16	3	**90**
4-5 years	1	23	14	0	3	**41**
More than 5 years	44	102	83	13	11	**253**
Total	**58**	**167**	**139**	**32**	**17**	**413**

4.2 Urban Agricultural Practices in Mutare

4.2.1 Qualitative Findings

The qualitative phase provided valuable insights into the nature and extent of urban agriculture practices across different residential areas in Mutare. The findings helped shape the design of the quantitative survey and offer contextual understanding of the trends observed in the quantitative data. Participants across all high-, medium-, and low-density areas reported engaging in urban agriculture activities that included field crops, horticultural, fruit and animal production, as indicated by the statement below,

"In most areas, especially high-density suburbs, people are using whatever space they can find to grow vegetables. Urban farming here is really about both feeding the family and making a little income on the side." KII participant.

Poultry and rabbits were the most reported form of livestock keeping, especially in all the areas of the city. Piggery was also mentioned by participants who indicated they had bigger spaces. Fruit cultivation particularly of guavas, mangoes, and lemons was more prominent in all areas. Participants from all residential zones acknowledged the dual role of urban agriculture, that is for both household consumption and income generation. Participants in all residential zones indicated value-added activities in addition to the production practices.

The FGDs and KIIs highlighted various spaces used for urban agriculture, including backyards, which were identified as the most used spaces across all zones. In addition, open spaces and rented plots, particularly in high-density areas were also identified as spaces that were being used. The use of containers such as buckets and sacks was mentioned as an alternative approach, especially in areas with limited access to land like high-density areas.

4.2.2 Quantitative findings

Dangamvura led in urban agriculture activities in Mutare, particularly the production of leafy green vegetables, fruits, and field crops as indicated in Figure 5. Chikanga shows a significant involvement in fruit trees, leafy greens, and poultry while Sakubva focuses mainly on leafy greens and field crops with minimal animal production. The medium and low-density areas show involvement in all the urban agriculture activities. Animal production is generally lower than crop production, especially in high-density areas.

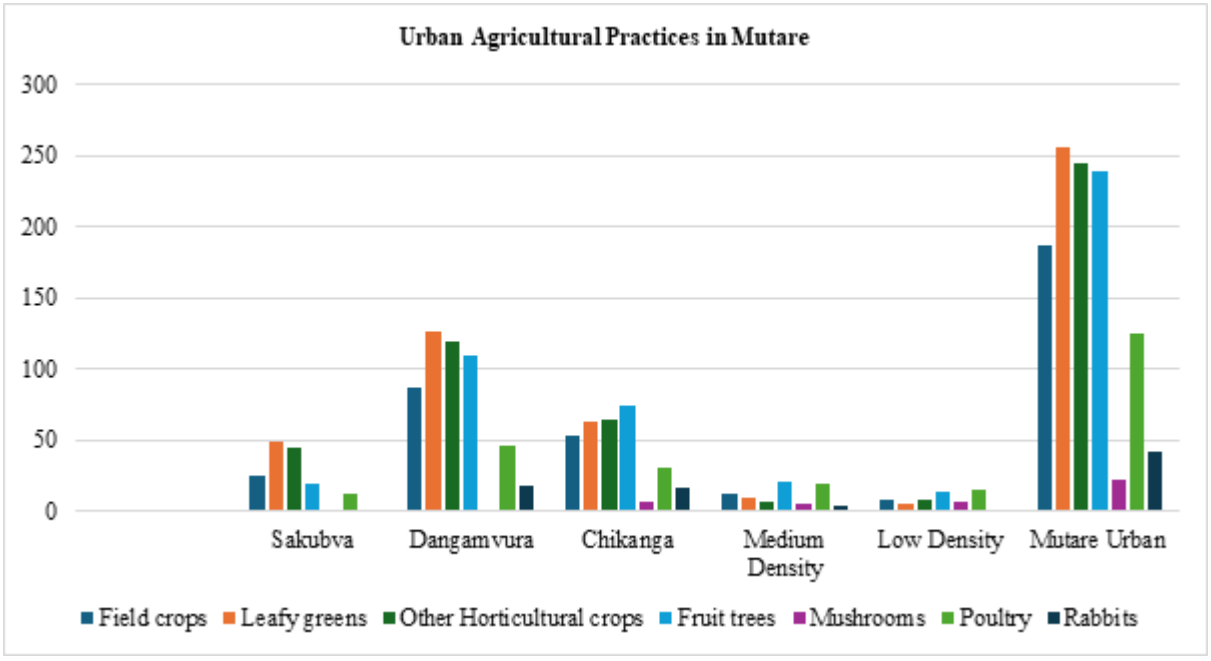

Figure 5: Urban Agriculture Practices in Mutare

More than 50% of the urban agriculture participants in Mutare both consume and sell their produce. The dual activity was more prominent in the high-density areas. Backyards are the most common spaces used for urban agriculture across all areas as shown in Figure 6. Open spaces are the most used spaces for the high-density areas while renting shows a small but visible presence in Chikanga while the use of buckets or sacks has a small presence in Sakubva and the medium-density areas.

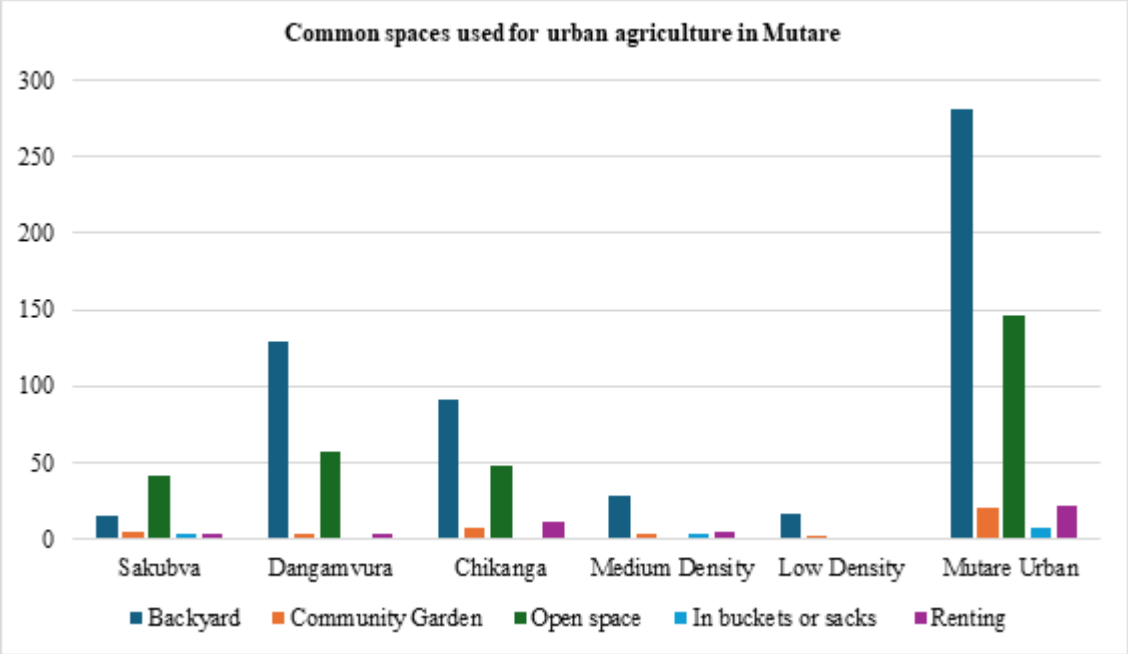

Figure 6: Common spaces for urban agriculture

4.3 Benefits of Urban Agriculture in Mutare

4.3.1 Qualitative Findings

The FGDs and KIIs provided rich insights into how residents of Mutare perceive the benefits of urban agriculture across different residential settings. Participants from all areas expressed generally positive attitudes toward urban agriculture, emphasizing the multi-dimensional value to households and the broader community. Participants emphasized the role of urban agriculture in enhancing food security, improving access to fresh and healthy food, and promoting positive dietary habits, as highlighted by following statement from a KII:

"Food access at household level improves as farmers have bumper harvest in good years. This means that nutrition also improves. Farmers are also able to earn income when they sell excess produce." KII

Findings from the FGDs also supported this notion of urban agriculture improving access to fresh and healthy food, with participants consistently highlighting that

urban agriculture played a vital role in sustaining their households. Economic benefits were also highlighted, including reduced household food costs and opportunities to generate supplemental income, particularly in high-density areas. Environmental advantages such as waste management, greening of urban spaces, and community environmental awareness were noted as indicated by the following statement in one of the FGDs:

"We practice urban agriculture in open spaces in our area, therefore, if there are burst sewage pipes, they are fixed fast. Also, people are not dumping waste in the open spaces anymore because our crops will be in those open spaces." FGD participant

The qualitative data supports the view that urban agriculture contributes significantly to household resilience, community well-being, and environmental sustainability, aligning closely with the positive perceptions captured in the quantitative findings. Key informants emphasized that the COVID-19 lockdown demonstrated the critical role of urban agriculture in sustaining households. One informant noted that:

"Lockdown showed that urban farmers fed their families from their produce and sold some of their produce to earn income." KII

4.3.2 Quantitative findings

Figure 7 presents participants' perceptions of the benefits of urban agriculture in Mutare. Participants related to their agreement with 14 statements on a 5-point Likert scale, Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree. Across all statements, there is widespread positive perceptions of urban agriculture with more than 70% of the participants highlighted that they either agree or strongly agree. Neutral responses are present, but relatively minimum and negative responses are also minimal for most benefits. The top perceived benefits include improved food security, contribution to the availability of fresh food, reduced cost of living, positive healthy eating habits, and reduction in the food miles. Environmental benefits are also recognized by participants as contributing to environmental conservation and waste management. Employment creation had the highest shared disagreement between the high-density and the low and medium-density

areas.

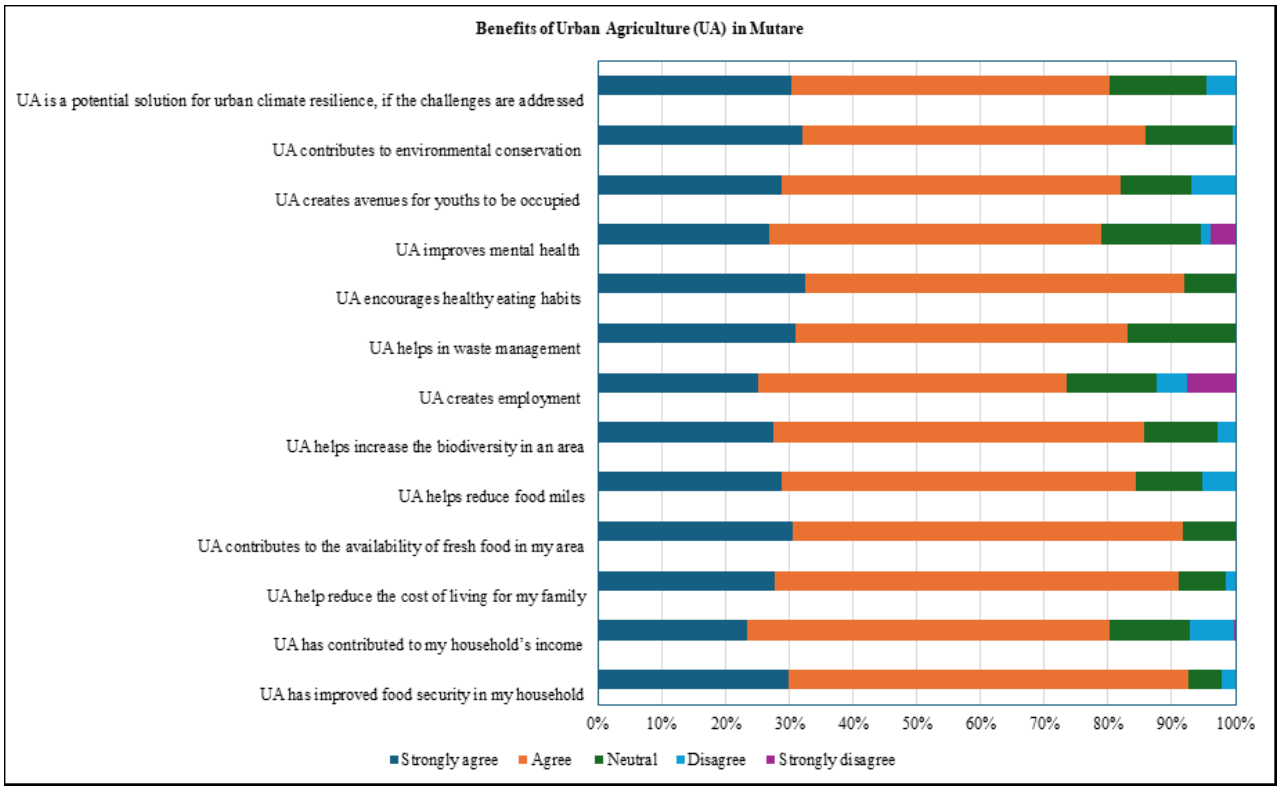

Figure 7: Benefits of Urban Agriculture in Mutare

4.4 Challenges facing urban agriculture farmers in Mutare

4.4.1 Qualitative Findings

The qualitative findings revealed that urban agriculture in Mutare is constrained by a complex interplay of spatial, environmental, economic, social, and regulatory challenges. Participants across high- and medium-density areas expressed concern over the limited availability of land, especially where space competition between housing and farming is most intense. Several respondents reported that access to secure, long-term land for cultivation is often uncertain and subject to municipal restrictions. KII also echoed the same sentiments of limited space for practicing urban agriculture, creating multiple compounding challenges, as expressed below:

"Urban agriculture farmers end up cultivating on mountain slopes and stream banks contributing to environmental degradation and increase in flash floods in the city." KII

Environmental challenges were also discussed extensively, particularly the increased frequency of dry spells, water shortages, heat stress, and the spread of pests and diseases and participants acknowledged that these factors have become more unpredictable due to climate variability. These factors were said to reduce crop yields and discourage investment in long-term production. Participants particularly in high-density areas emphasized the unclear or inconsistent municipal policies, with reports

of conflict between farmers and authorities over land use, by-laws, and licensing requirements. Many respondents noted the lack of institutional support, with extension services rarely reaching informal or small-scale urban farmers.

4.4.2 Quantitative findings

Urban agriculture in Mutare is challenged by a combination of spatial, environmental, economic, social, and regulatory factors. Figure 8 shows the participants' responses regarding the challenges facing urban agriculture farmers in Mutare. The participants were asked to rate their level of agreement with a range of challenges related to urban agriculture. The data reveals that urban farmers face multiple, overlapping challenges with particular emphasis on land access, climate variability, pests and disease management as well as policy ambiguity.

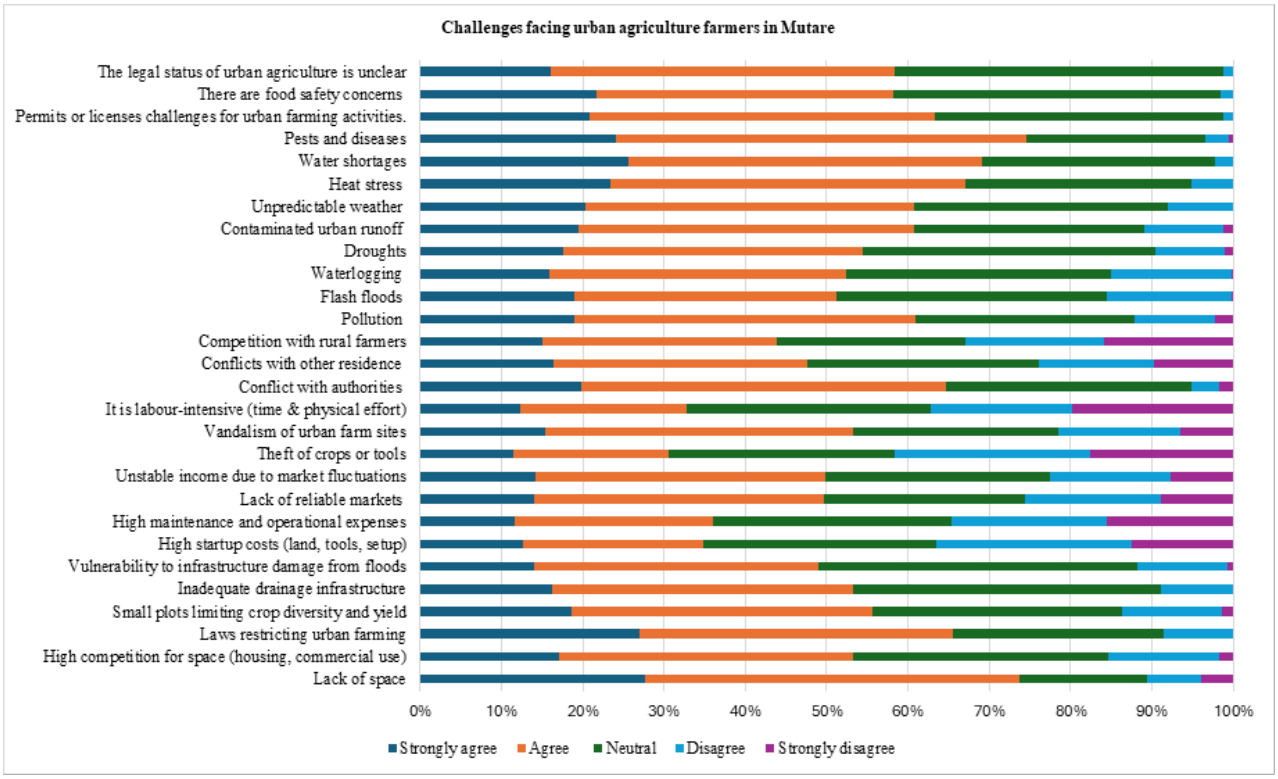

Figure 8: Challenges facing urban agriculture farmers in Mutare

More than 60% of the participants indicated lack of space (72%), pests and diseases (74%), water shortages (69%), heat stress (67%), conflict with the authorities (64%), and licensing and permits (63) as top challenges. In contrast, few challenges showed higher disagreement including labor intensive (32%), theft (30%), higher start up and operational costs (34%). Kendall's Tau-b correlation analysis indicated that the challenges with lower levels of agreement were more strongly associated with participants from high-density areas in Mutare.

4.5 Coping strategies being adopted by Urban agriculture farmers in Mutare

4.5.1 Qualitative Findings

The qualitative findings reveal that urban agriculture farmers in Mutare employ a number of coping strategies to address challenges such as limited space, pests, and water shortages. A common approach that was highlighted in response to limited space is renting land from neighbors, especially in high-density areas where personal space is scarce. This informal land-sharing allows farmers to expand their production beyond their immediate plots. Participants also highlighted diversification of production practices, combining different production types to spread risk. Many farmers mentioned that they engage in alternative business ventures, such as informal trading or food processing, to supplement their income alongside farming. One FGD participant summarized these coping mechanisms, stating:

"*We rent small plots from neighbors when we need more space, and we grow different crops so if one fails, others can still feed us. We also have other "hustles" like small retail businesses to keep money coming in because farming alone is not enough.*" KII participant.

4.5.2 Quantitative findings

To understand how urban agriculture farmers in Mutare are responding to the challenges they face, participants were asked to rate a range of coping strategies using a 5-point Likert scale, ranging from Strongly Disagree to Strongly Agree. Figure 9 presents the commonly adopted strategies, highlighting the level of agreement among participants and providing insight into the adaptive measures being implemented across different urban settings.

More than 60% of the participants indicated that they rent land from neighbors, diversify production to spread risk, practice crop rotation and engage in alternative business ventures as their top coping strategies. In contrast, formal support services like extension services and collaborations are less utilized.

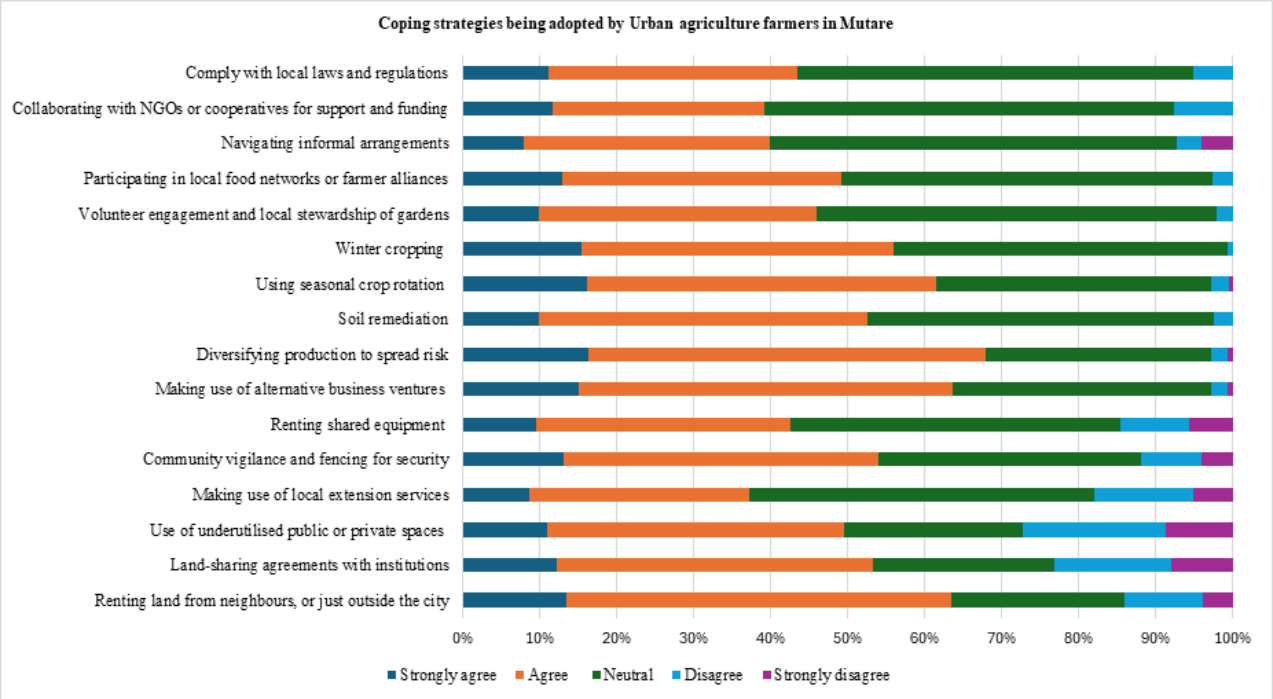

Figure 9: Coping strategies adopted by urban agriculture farmers in Mutare

4.6 Potential Strategies for Scaling up Urban Agriculture

4.6.1 Qualitative Findings

The qualitative phase provided critical insights into participants' views on how urban agriculture in Mutare can be scaled up to enhance its impact and sustainability. Participants expressed strong support for practical, low-cost, and technology-driven interventions that are adaptable to the constraints of urban environments. Water harvesting emerged as a widely supported strategy with participants highlighting climate change and the unreliability of municipal water supply as the major drivers to the growing need to harness rainwater for irrigation. Similarly, regular soil and water testing were viewed as essential for improving productivity and ensuring the safe use of urban spaces for cultivation. The use of innovative technologies, such as hydroponics, vertical farming, and sack gardening, was also mentioned by all participants. This is highlighted below by one FGD participant and one KII respondent focused on technology-driven interventions for scaling up urban agriculture in Mutare:

"In these small spaces, we can't plant the usual way. But with things like vertical gardens or using sacks, you can still grow enough vegetables for your family. It's practical and fits our situation." FGD participant.

"Technological innovations can make a big difference, especially here in Mutare where we are out of land for urban agriculture. But there is a need for policies, training and support to help farmers adopt these methods effectively." KII

However, all of the participants highlighted that to upscale urban agriculture successfully in Mutare, there is need to address the trade-offs, as highlighted by the statement below from one KII:

"People know the right way of farming, but they don't have enough resources, therefore they end up practicing unsustainable practices because they don't have an option." KII

4.6.2 Quantitative findings

To identify effective pathways for expanding and enhancing urban agriculture in Mutare, participants assessed a range of proposed strategies using a 5-point Likert scale. The results indicate strong support for practical and technology-driven interventions as shown in Figure 10. The highest levels of agreement were recorded for water harvesting techniques (90%), regular soil and water testing (89%), and the adoption of innovative technologies such as vertical farming (91%). Notably, decongesting urban areas had the lowest support with only 16% in agreement and the majority being neutral or disagreeing with the strategy.

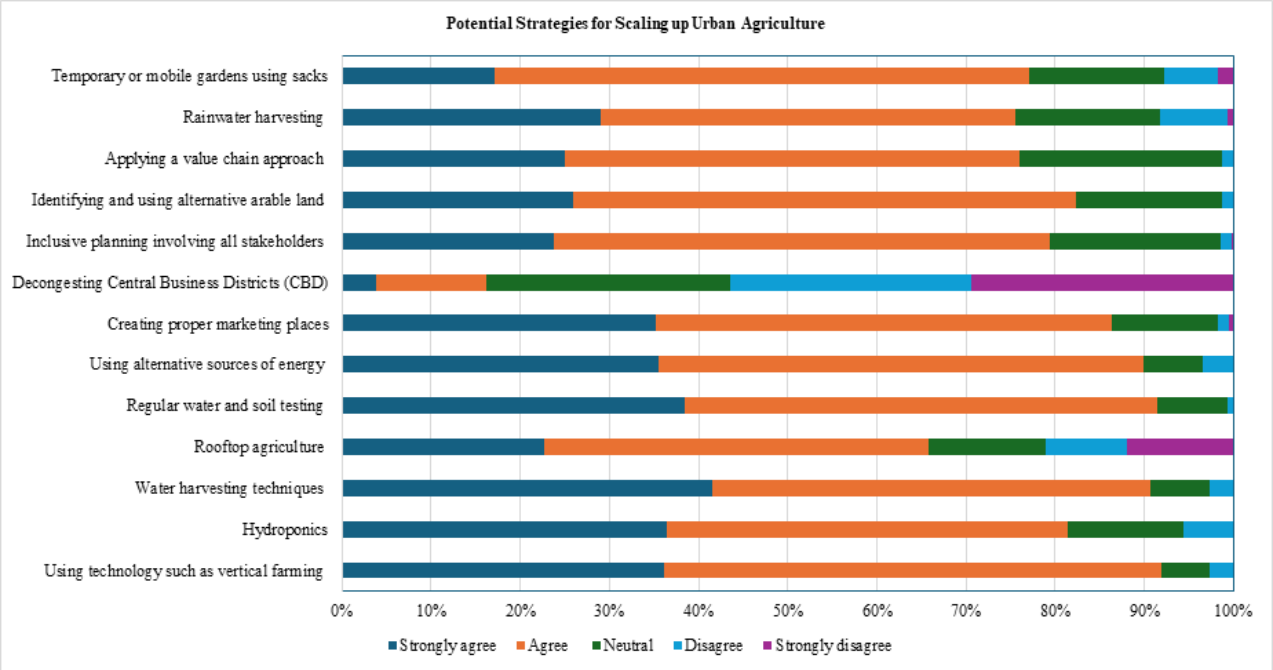

Figure 10: Potential strategies for scaling up urban agriculture

5. Discussion and Implications

5.1 Urban Agricultural Practices in Mutare, Zimbabwe

The quantitative and qualitative findings of this study reveal that urban agriculture in Mutare is widespread with varying degrees of intensity and diversity depending on the residential context. Crop production, particularly of leafy green vegetables and field crops like maize, is the dominant activity across all areas. High-density suburbs such as Dangamvura, Sakubva, and Chikanga demonstrate higher levels of engagement, largely due to economic necessity and limited access to formal employment. The use of backyards as the primary production space reflects the spatial constraints in these areas, while open spaces and rented plots serve as supplementary land sources. Innovative practices like container gardening using buckets and sacks also reflect the adaptive nature of urban farmers operating under space limitations. Animal production, though present in all zones, is limited in scale and largely focused on poultry and rabbits, with piggery only noted in areas where space allows. The dual purpose of urban agriculture for household consumption and income generation was strongly emphasized by participants. This aligns with existing literature that highlights urban agriculture's role in addressing food insecurity and supplementing household income in rapidly urbanizing African cities, (Kanosvamhira & Shade, 2025; Korth et al., 2014).

Participants reported engaging in value-added activities, such as small-scale food processing and local sales, particularly in high-density areas. These activities enhance the economic viability of urban agriculture and point to its potential as a contributor to local food systems and informal economies. The findings reflect a locally driven, adaptive, and multifunctional urban agriculture system in Mutare. However, its full potential remains constrained by limited land access, policy ambiguity, and environmental stressors issues discussed further in the subsequent sections on challenges and coping strategies. As far as policy is concerned, it is important to note that Zimbabwe does not have an Urban Agriculture Policy. This makes it difficult for local authorities to give directions to residents on how they can carry out the practice in an economically and environmentally friendly manner. Another factor is that, in the past, urban agriculture was even considered as an illegal activity as it was carried out on land planned for other purposes. Whilst the local authority could actually make by-laws in support of the practice, this is rarely the case.

The widespread engagement in urban agriculture across all residential zones in Mutare demonstrates its critical role in urban livelihoods. Nevertheless, this practice sometimes operates informally on insecure land. There is therefore a need to create awareness around urban agriculture and the existing legal framework to enhance community participation and address misconceptions. By improving access to information and clarifying the rights and responsibilities of urban farmers, local

governments can foster a more inclusive, transparent, and enabling environment for urban agriculture to thrive. Awareness initiatives, such as community workshops, local media campaigns, and collaboration with ward councilors can play a crucial role in bridging this knowledge gap and promoting sustainable, legally compliant urban farming practices. Furthermore, the dual function of urban agriculture, for both household consumption and income, signals an opportunity to integrate it into broader local economic development and urban food system strategies. Regulated production in backyards, open spaces, and communal plots could enhance food security while promoting environmentally sustainable practices within the city.

5.2 Benefits of Urban Agriculture in Mutare

The study findings demonstrate that urban agriculture delivers a wide range of benefits to households across Mutare's high-, medium-, and low-density areas. Both qualitative and quantitative data show strong agreement that urban agriculture significantly contributes to household food security, the availability of fresh produce, and the reduction of food-related costs. These benefits are particularly pronounced in high-density areas, where economic vulnerability is greater, and urban farming serves as a buffer against rising food prices. Participants also identified improved dietary habits as a key benefit, as access to home-grown vegetables and fruits supports healthier eating patterns. This aligns with global evidence linking urban agriculture to improved nutrition outcomes in low-income settings, (Gunhidzirai, 2023; Tatsvarei et al., 2018). In addition to food-related advantages, urban agriculture was seen to offer environmental benefits, including waste reduction contributing to local environmental management.

While most participants recognized the role of urban agriculture in income generation, particularly through small-scale sales, there was less consensus on its potential for formal employment creation. These findings highlight urban agriculture's role not only as a subsistence strategy but also as a contributor to economic resilience, environmental sustainability, and community well-being in Mutare.

The study confirms that urban agriculture delivers multiple co-benefits beyond food production, including improved household nutrition, reduced food expenditure, and enhanced environmental outcomes. Improved nutrition results from the broader variety of foods grown and from the consistent access to fresh vegetables and the reduced cost of acquiring nutritious foods. These results have important policy implications. Planning authorities need to maintain zoning provisions that support urban agriculture and actively promote awareness and clarity around these policies. Although urban agriculture is formally recognized within the city's planning framework, many residents and stakeholders remain unaware of the provisions or lack clarity on how to engage with them. While the local council indicated that a policy does exist, FGD participants reported not knowing about it and expressed a desire for a clear, accessible framework. This highlights a significant gap in policy

communication and accessibility, leaving farmers uncertain about legal procedures and available support. This disconnect limits uptake and contributes to ongoing conflicts over land use, particularly in high-density areas where demand for food production space is highest. Strengthening communication, community outreach, and institutional coordination is therefore essential to ensure that urban farmers can fully benefit from existing policies and operate within a supportive, well-understood regulatory environment. Additionally, its contributions to health (through access to fresh food), local economies (through small-scale sales), and the environment (through waste reuse and green cover) align closely with sustainable development objectives. Public health practitioners, environmental agencies, and urban planners should collaborate to incorporate urban agriculture into sustainability and public health policies. Awareness campaigns and educational programs can further promote these benefits and reduce negative perceptions, thereby strengthening community and institutional support.

5.3 Challenges Facing Urban Agriculture Farmers in Mutare

Urban agriculture in Mutare provides crucial food and income security, is however constrained by a range of spatial, environmental, economic, and regulatory challenges. The study findings indicate that limited access to land is one of the most pressing issues, particularly in high-density areas where demand for housing and infrastructure competes with space for cultivation. Participants reported relying heavily on backyards and informal open spaces, often without tenure security, which increases the risk of displacement or conflict with authorities.

Environmental factors, especially pests and diseases, water shortages, and heat stress, were also widely reported. These issues are exacerbated by climate variability, making food production less predictable and more resource intensive. This aligns with broader research in Sub-Saharan Africa, which shows urban farmers are disproportionately vulnerable to climate-related risks due to limited adaptive capacity, (Nyberg et al., 2021; Tatsvarei et al., 2018). Mutare urban farmers also highlighted challenges with licensing, unclear policies, and municipal restrictions. Conflict with local authorities over land use, coupled with the absence of targeted urban agriculture policies, undermines the sustainability and expansion of farming activities.

Many of the challenges mentioned are overlapping, interdependent, and interrelated. For instance, lack of space and legal ambiguity fuel conflict with authorities and within the farmers; flash floods, water shortages, pollution and pests are worsened by unpredictable weather. Interestingly, challenges such as labor demands, start-up costs, and theft received lower levels of agreement, particularly in medium- and low-density areas, suggesting that these are less critical or more context-dependent.

The challenges faced by urban farmers in Mutare, particularly related to land access, pest and disease control, water shortages, and limited understanding of regulatory frameworks, require urgent institutional and operational attention. Although urban agriculture is formally recognized in policy, gaps in awareness, clarity, and enforcement have led to ongoing conflicts with authorities and uncertainty among farmers. This limits the farmers' ability to plan, invest, and adopt sustainable practices. There is a need to strengthen the implementation of existing policies through clearer communication of land use rights, environmental standards, and institutional roles and responsibilities. Addressing barriers, such as inconsistent water supply and exposure to climate-related risks, also requires a coordinated, multi-sector approach involving urban planning, agriculture, water, and environmental stakeholders. Moreover, introducing simplified licensing processes and community-level conflict resolution mechanisms could reduce tensions and build trust between farmers and authorities, paving the way for more harmonious and productive urban agriculture systems.

5.4 Coping Strategies adopted by Urban Agriculture Farmers in Mutare

Urban agriculture farmers in Mutare are adopting a range of informal and adaptive coping strategies in response to spatial, environmental, and institutional challenges. Key among these is crop diversification and crop rotation reflecting an understanding of the need to mitigate risks such as pest outbreaks, soil depletion, and climate-related stresses. The widespread use of renting land from neighbors, particularly in high-density areas where land scarcity is most acute. This informal land access strategy highlights both the innovation and vulnerability of urban farmers operating without formal tenure. These practices are cost-effective and also sustainable, contributing to improved resilience at the household level. Many participants also engage in alternative income-generating activities, such as food vending or informal trading, to supplement farming income pointing to the multi-dimensional nature of urban livelihoods as alluded to by, (Castaldo et al., 2025; Kanosvamhira & Shade, 2025). Despite these grassroots efforts, the limited utilization of formal support systems such as extension services and agricultural training suggests a gap in institutional engagement. This disconnect may stem from accessibility issues or a lack of targeted urban agriculture programs. The coping strategies in Mutare are largely self-reliant and context-specific, underscoring the need for supportive policy frameworks and technical assistance that align with the realities of the urban farmers.

Urban farmers in Mutare have developed a range of adaptive strategies in response to the challenges they face, including land rental, crop diversification, crop rotation, and engagement in alternative income-generating activities. These self-driven strategies demonstrate local resilience and innovation. However, despite the

existence of an urban agriculture policy framework, many of these practices occur with minimal institutional recognition, support, or technical guidance. This highlights a critical gap between policy and implementation. There is a clear need to strengthen the operationalization of existing policies by aligning them with the realities on the ground. Grassroots coping strategies should be formally acknowledged, supported, and scaled through targeted programs. Extension services and agricultural support systems must be restructured to better reach urban farmers with practical, context-specific advice. In addition, investments in technical training, input provision, and value addition can enhance the sustainability and profitability of urban agriculture. These strategies also present opportunities for collaboration between local authorities, non-governmental organizations, and community groups to co-create inclusive and sustainable urban food systems.

5.5 Potential Strategies for Scaling up Urban Agriculture

The study identifies a range of practical, evidence-backed strategies with strong potential to enhance and scale up urban agriculture in Mutare. Findings from both FGDs and KIIs, supported by quantitative data, highlight technology-driven and resource-efficient interventions as the most widely supported approaches among participants. Top-rated strategies include water harvesting techniques, regular soil and water testing, and the adoption of innovative production systems such as vertical farming. These were particularly appealing to participants from high-density areas, where space and water limitations are most severe. Participants viewed these methods as adaptable, cost-effective, and well-suited to the urban context, especially when supported by training and technical resources.

However, more institutional and long-term strategies such as decongesting urban areas or formal land allocation received limited support, reflecting skepticism about their feasibility within the current urban planning framework. This highlights a need for locally grounded, context-specific solutions. Furthermore, scaling efforts must include strategies to ensure inclusivity, sustainability, and integration into broader urban policy frameworks. Strengthening technical support, ensuring equitable access to resources, and embedding urban agriculture in climate resilience and food security planning are critical for moving from fragmented efforts to a coordinated urban agriculture system that can scale effectively.

The strong support expressed by urban farmers for technology-driven and resource-efficient strategies, such as vertical farming, water harvesting, and regular soil testing, demonstrates a clear readiness to adopt innovative approaches that respond to the spatial and resource limitations of urban environments. These findings point to the need for increased investment in capacity building through farmer training, demonstration sites, and improved access to affordable technologies. While Mutare already has an urban agriculture policy framework, greater effort is needed to align scaling strategies with local realities and to ensure their implementation is both

practical and inclusive. Notably, proposals such as urban decongestion received minimal community support, highlighting the importance of designing strategies that are feasible within existing urban dynamics. Long-term success in scaling urban agriculture will depend on strengthening stakeholder engagement, improving evidence-based planning through continuous data collection, and embedding urban agriculture within broader urban development, food security, and climate resilience strategies. By bridging the gap between policy and practice, urban agriculture in Mutare can evolve from a survival strategy into a strategic pillar of sustainable urban development.

5.6 Urban Agriculture as a Nature-Based Solution for Climate Resilience

Urban agriculture in Mutare demonstrates strong alignment with several core principles of NbS as defined by the International Union for Conservation of Nature (IUCN) and other international frameworks, (Cohen-Shacham et al., 2024). The findings clearly support climate adaptation, enabling households to respond to food insecurity, water stress, and heat through localized food production. It also delivers multiple co-benefits, including improved food security, household nutrition, income generation, and enhanced community resilience. The practice contributes to biodiversity and ecosystem health, reduced food miles, greening of urban spaces, and diversified crop production. It is also locally appropriate and context-specific, shaped by land availability, socio-economic realities, and the adaptive capacity of residents.

However, to function fully as a sustainable NbS, urban agriculture in Mutare requires strategies to ensure long-term sustainability, such as secure land access, reliable water sources, and formalized support mechanisms. There is also a need to enhance inclusivity and equity, ensuring women, youth, and marginalized groups have equal access to resources and decision-making. Moreover, for greater impact, urban agriculture must be integrated into broader urban planning, food systems, and climate strategies. Finally, investments in monitoring and data collection are essential to make the benefits measurable and evidence-based, strengthening the case for policy support and scaling up.

5.7 Potential study limitations

This study offers important insights into the nature, benefits, challenges, and future potential of urban agriculture in Mutare. However, several limitations must be acknowledged. Firstly, the study's findings are context-specific and may not be fully generalizable to other urban areas in Zimbabwe or elsewhere. Mutare’s unique socio-economic, geographic, and institutional context means that practices observed here may differ significantly from those in other cities with different governance structures or resource availability. Secondly, the use of snowball sampling for KIIs and FGDs, may have introduced sampling bias because it can potentially exclude individuals or

groups who are not connected to established networks or institutions, thereby limiting the diversity of perspectives captured. Thirdly, both qualitative and quantitative data relied on self-reported responses, which can be affected by recall bias or social desirability bias. Lastly, the study offers a cross-sectional perspective, capturing practices and perceptions at a single point in time. A longitudinal approach could provide a deeper understanding of how urban agriculture evolves in response to ongoing urbanization and climate pressures. Despite these limitations, the study provides a strong foundation for informing urban agriculture policy and practice in Mutare and similar urban settings.

6. Conclusions

This study has provided a comprehensive examination of urban agriculture practices, benefits, challenges, coping strategies, and potential pathways for scaling in Mutare. The findings reveal that urban agriculture is deeply embedded across all residential zones, serving as a vital livelihood activity that supports both household consumption and income generation. Farmers engage in diverse practices including crop production, horticulture, fruit cultivation, and animal husbandry. Urban agriculture offers multiple tangible benefits, ranging from enhanced food security, improved income, and improved nutrition to environmental conservation and waste management. Despite these advantages, urban agriculture farmers in Mutare face significant challenges, notably limited land access, climate variability, pests and diseases, water shortages, and regulatory ambiguities. In response, farmers have developed adaptive coping strategies such as land rental, production diversification, and alternative income generation, though formal support services remain underutilized. Importantly, the study highlights strong community support for scaling up urban agriculture through technology-driven and resource-efficient interventions, such as water harvesting, soil testing, and vertical farming. However, effective expansion will require integrated policy frameworks that address spatial barriers, inclusivity, sustainability, and integration into broader urban planning and climate resilience strategies.

Urban agriculture in Mutare exemplifies a locally grounded NbS with significant potential to contribute to urban food systems, livelihoods, and climate adaptation, provided that its development is supported by evidence-based, context-specific policies and collaborative stakeholder engagement.

7. Practical application for humanitarian work and recommendations

7.1 Practical application for humanitarian work

The findings from this study offer valuable guidance for humanitarian agencies working to enhance food security, livelihoods, and resilience in urban settings facing socio-economic and environmental pressures. Urban agriculture in Mutare clearly functions as a critical safety net, providing both food and income for vulnerable populations across diverse residential zones.

- Humanitarian actors can leverage these insights by integrating urban agriculture into emergency response and recovery programs, especially in contexts of food shortages, displacement, or economic shocks.
- Supporting locally appropriate coping strategies, such as land rental, crop diversification, and container farming, can empower urban communities to strengthen their self-reliance and reduce dependence on external aid.
- Moreover, the demonstrated benefits of urban agriculture, including improved nutrition, environmental conservation, and waste management, align well with sustainable development and climate adaptation objectives. Humanitarian initiatives can promote technology-driven interventions like water harvesting and vertical farming to optimize limited urban space and resources.
- By collaborating with local authorities and communities to clarify land use policies, reduce regulatory barriers, and enhance access to extension services, humanitarian programs can create enabling environments for urban agriculture to flourish. This approach not only improves immediate food security but also builds long-term urban resilience against climate variability and socio-economic instability.

This research highlights urban agriculture as a practical, scalable nature-based solution that humanitarian organizations can incorporate into holistic urban resilience and livelihood strategies.

7.2 Recommendations

Based on the findings from this study, the following recommendations are proposed to increase the effectiveness of urban agriculture as a NbS in building climate resilience of urban farmers in Mutare:

Policy and Institutional Strengthening

Although urban agriculture is already recognized within Mutare's policy framework, more needs to be done to strengthen its implementation. Clear communication of land use rights, licensing procedures, and institutional responsibilities is essential to reduce regulatory ambiguity and build trust among stakeholders. Existing policies should be reviewed and operationalized through zoning guidelines, secure tenure arrangements, and conflict resolution mechanisms tailored to the urban agriculture context.

Support Services and Capacity Building

Extension services need to be expanded and restructured to provide technical support specifically adapted to urban farming systems. This includes guidance on pest and disease management, climate-smart agricultural techniques, and post-harvest handling. Investment in demonstration plots, training programs, and farmer field schools can promote adoption of innovative, resource-efficient technologies such as vertical farming, water harvesting, and regular soil testing.

Access to Resources and Markets

Access to land remains a central constraint, especially in high-density areas. Authorities should support formalized land rental systems, community garden initiatives, and policies that protect the use of open and underutilized spaces for urban farming. Enhancing market access and developing local value chains will further increase the economic viability of urban agriculture, providing meaningful income-generating opportunities for households.

Community Engagement and Inclusion

Strengthening participatory processes is vital to ensure that urban agriculture initiatives reflect local needs and priorities. Farmers should be actively engaged in planning and decision-making, and specific efforts should be made to support the inclusion of women, youth, and other marginalized groups. Creating feedback platforms and farmer forums can improve accountability and encourage local ownership of urban agriculture initiatives.

Research, Monitoring and Learning

To inform adaptive management and scale-up efforts, longitudinal research is needed to track the evolution of urban agriculture in response to climate change, urban growth, and policy shifts. Evaluations of the effectiveness of technology adoption, support services, and community-based interventions will help refine strategies and allocate resources more efficiently. Additionally, research into the socio-economic and health benefits of urban agriculture can reinforce its value as a multi-dimensional development tool.

References

ADB. (2014). Urban Climate Change Resilience: A Synopsis. *ADB: Asian Development Bank*, 13. http://www.adb.org/sites/default/files/publication/149164/urban-climate-change-resilience-synopsis.pdf

Allan, M., Rajabifard, A., & Foliente, G. (2024). Climate resilient urban regeneration and SDG 11–stakeholders' view on pathways and digital infrastructures. *International Journal of Digital Earth*, *17*(1), 1–23. https://doi.org/10.1080/17538947.2024.2385076

Asamoah, S., Mensah, H., Simpeh, E. K., Oduro-Ofori, E., Boateng, S. S., Boateng, S., Frimpong, L. K., & Okyere, P. (2025). A review of the role of nature-based solutions in mitigating food insecurity in Africa. *Green Technologies and Sustainability*, 100173. https://doi.org/10.1016/J.GRETS.2025.100173

Bandauko, E., & Arku, G. (2024). 'They want to get rid of us by all means': A critical analysis of policy and governance responses and their implications for street traders' access to urban space in Harare, Zimbabwe. *Environment and Planning C: Politics and Space*. https://doi.org/10.1177/23996544241298414

Bank, W. (2024). *Zimbabwe Country Climate and Development Report. CCDR Series*. https://hdl.handle.net/10986/41137

Calheiros, C. S. C., & Stefanakis, A. I. (2021). Green Roofs Towards Circular and Resilient Cities. *Circular Economy and Sustainability*, *1*(1), 395–411. https://doi.org/10.1007/s43615-021-00033-0

Canet-Martí, A., Pineda-Martos, R., Junge, R., Bohn, K., Paço, T. A., Delgado, C., Alenčikienė, G., Skar, S. L. G., & Baganz, G. F. M. (2021). Nature-based solutions for agriculture in circular cities: Challenges, gaps, and opportunities. *Water (Switzerland)*, *13*(18). https://doi.org/10.3390/w13182565

Castaldo, A. G., Nocentini, M. G., Lemes de Oliveira, F., & Mahmoud, I. H. (2025). Nature-based solutions and urban planning in the Global South: Challenge orientations, typologies, and viability for cities. *Land Use Policy*, *150*(March 2022), 107439. https://doi.org/10.1016/j.landusepol.2024.107439

Cohen-Shacham, E., Andrade, A., Karangwa, C., & Maginnis, S. (2024). *Proposing the IUCN Global Standard for NbS as the main operational framework to implement UNEA Resolutions 5/5 on NbS for supporting Sustainable Development IUCN Information Paper*. 1–20. https://www.researchgate.net/publication/386875495

Corbould, C. (2013). Feeding the Cities: Is Urban Agriculture the Future of Food Security? *Future Directions International*.

Djan, M. A. (2023). Urban Food Security: Examining the Unique Challenges and Opportunities Associated with Ensuring Food Security in Urban Areas. *European Journal of Nutrition & Food Safety*, *15*(9). https://doi.org/10.9734/ejnfs/2023/v15i91335

Dube, T., Sibanda, S., & Chiwara, P. (2021). Adapting peri-urban agriculture to climate change in Bulawayo, Zimbabwe: A qualitative assessment. *Cogent Social Sciences*, *7*(1), 1–16. https://doi.org/10.1080/23311886.2021.1944486

FAO. (2023). *Anticipating El Niño: Mitigation, preparedness and response plan for Southern Africa, 2023–2025*. 2023–2025. https://doi.org/10.4060/cc9079en

Gerster-Bentaya, M. (2013). Nutrition-sensitive urban agriculture. *Food Security*, *5*(5). https://doi.org/10.1007/s12571-013-0295-3

Government of Zimbabwe. (2024). *Zimbabwe's National Climate Change Response Strategy*. https://faolex.fao.org/docs/pdf/zim169511.pdf

Gunhidzirai Constance. (2023). Urban Agriculture and the attainment ofSustainable Development Goal 2 (ZeroHunger) in Zimbabwe. *International Journal of Development and Sustainability*, *12*(7), 286–302. https://www.researchgate.net/publication/373999279_Urban_Agriculture_and_the_attainment_ofSustainable_Development_Goal_2_ZeroHunger_in_Zimbabwe

Gutu Sakketa, T. (2023). Urbanisation and rural development in sub-Saharan Africa: A review of pathways and impacts. *Research in Globalization*, *6*, 100133. https://doi.org/10.1016/J.RESGLO.2023.100133

Hampwaye, G. (2013). Benefits of urban agriculture: Reality or illusion? In *Geoforum* (Vol. 49). https://doi.org/10.1016/j.geoforum.2013.03.008

Jonga, W. (2014). Local Government System in Zimbabwe and Associated Challenges: Synthesis and Antithesis. *Archives of Business Research*, *2*(1), 75–98. https://doi.org/10.14738/abr.21.89

Kadungure, A., Machemedze, R., Malaya, W., Banda, N., Loewenson, R., & Sverdlik, A. (2023). Towards climate change resilience and informal workers' health in Zimbabwe: an action-research case study. *Cities and Health*, *7*(6). https://doi.org/10.1080/23748834.2023.2261755

Kamana, A. A., Radoine, H., & Nyasulu, C. (2024). Urban challenges and strategies in African cities – A systematic literature review. *City and Environment Interactions*, *21*, 100132. https://doi.org/10.1016/J.CACINT.2023.100132

Kamuzhanje, J. (2019). Community Resilience and the Sustainable Development Goals in Zimbabwe. In *Community Resilience under the Impact of Urbanisation and Climate Change*. https://doi.org/10.2307/j.ctvgc61mv.8

Kanonhuwa, T., Toriro, P., & Chirisa, I. (2021). The Future of Food, the City and Environment: Case for Resilience in Zimbabwe. In *Advances in 21st Century Human Settlements*. https://doi.org/10.1007/978-981-16-0305-1_13

Kanosvamhira, T. P., & Shade, M. D. (2025). Urban agriculture for environmentally just cities: the case of urban community gardens in Cape Town, South Africa. *Local Environment*, *30*(1), 133–149. https://doi.org/10.1080/13549839.2024.2434757

Kanosvamhira, T. P., & Tevera, D. (2024). Unveiling quiet activism: Urban community gardens as agents of food sovereignty. *Geographical Research*, *62*(3), 402–415. https://doi.org/10.1111/1745-5871.12661

Kembo, G. D., Macheka, L., Dembedza, M., Nyadenga, P., Mavhunga, Y., & Kairiza, T. (2024). *Food and Nutrition Council, Zimbabwe Livelihoods Assessment Committee - Urban Livelihoods Assessment Technical Report 2024* (Issue March).

Kiribou, R., Djene, S., Bedadi, B., Ntirenganya, E., Ndemere, J., & Dimobe, K. (2024). Urban climate resilience in Africa: a review of nature-based solution in African cities' adaptation plans. *Discover Sustainability*, *5*(1). https://doi.org/10.1007/s43621-024-00275-6

Korth, M., Stewart, R., Langer, L., Madinga, N., Rebelo Da Silva, N., Zaranyika, H., Van Rooyen, C., & De Wet, T. (2014). What are the impacts of urban agriculture programs on food security in low and middle-income countries: A systematic review. *Environmental Evidence*, *3*(1), 1–13. https://doi.org/10.1186/2047-2382-3-21

Konou, A. A., Zinsou-klassou, K., Mwakalinga, V. M., Munyaka, B. J., Firmin, A., & Mbianda, K. (2024). Exploring the Association of Urban Agricultural Practices with Farmers' Psychosocial Well-Being in Dar es Salaam and Greater Lom é : A Perceptual Study. Sustainability, 16(16), 6747.

Langemeyer, J., Madrid-Lopez, C., Mendoza Beltran, A., & Villalba Mendez, G. (2021). Urban agriculture — A necessary pathway towards urban resilience and global sustainability? In *Landscape and Urban Planning* (Vol. 210). https://doi.org/10.1016/j.landurbplan.2021.104055

Malapela, T., Chisita, C., & Chinyemba, F. (2016). Challenges and Opportunities in providing for Animal Agricultural information services in Zimbabwe: The case of poultry farmers in Harare. *Columbus IFLA*.

Maphosa, M., & Moyo, P. (2024). Assessing climate vulnerabilities of urban food systems and institutional responses: the case of Bulawayo, Zimbabwe. *Frontiers in Sustainable Cities*, *6*, 1–13. https://doi.org/10.3389/frsc.2024.1488144

Maphosa, S. N., Nkosi, S. E., & Chabalala, Y. (2025). Impact of Urban Green Spaces on the Livelihoods of Residents in Bulawayo and Johannesburg Cities. *Urban Science*, *9*(6), 194. https://doi.org/10.3390/urbansci9060194

Marshall, B., Cardon, P., Poddar, A., & Fontenot, R. (2013). Does sample size matter in qualitative research?: A review of qualitative interviews in is research. *Journal of Computer Information Systems*, *54*(1), 11–22. https://doi.org/10.1080/08874417.2013.11645667

Marumahoko, S., Nhede, T. N., & Mapuva, J. (2025). Interrogating multi-level government power dynamics and cooperation in Zimbabwe: Evidence from Harare City Council. *Cities*, *164*, 106038. https://doi.org/10.1016/J.CITIES.2025.106038

Maseko, Z. T. M. (2024). Urban Open Space Utilization for Subsistence Agriculture: A Study of Esikhaleni Township. *Journal of Asian and African Studies*. https://doi.org/10.1177/00219096241287716

Matamanda, A. R. (2020). Battling the informal settlement challenge through sustainable city framework: experiences and lessons from Harare, Zimbabwe. *Development Southern Africa*, *37*(2). https://doi.org/10.1080/0376835X.2019.1572495

Moyo, T. (2023). The 2030 Agenda, Climate Urbanism and Urban Planning in Zimbabwe. In *Reimagining Urban Planning in Africa*. https://doi.org/10.1017/9781009389457.021

Mugiyo, H., Magadzire, T., Choruma, D. J., Chimonyo, V. G. P., Manzou, R., Jiri, O., & Mabhaudhi, T. (2023). El Niño's Effects on Southern African Agriculture in 2023/24 and Anticipatory Action Strategies to Reduce the Impacts in Zimbabwe. *Atmosphere*, *14*(11). https://doi.org/10.3390/atmos14111692

Mwenye, D., & Kutywayo, D. (2021). Institutional Arrangements in Changing Climate: Case of Zimbabwe. In *Handbook of Climate Change Management: Research, Leadership, Transformation* (Vol. 6). https://doi.org/10.1007/978-3-030-57281-5_266

Ndlovu, D. (2019). THE ROLE OF THE MEDIA IN ENVIRONMENTAL DISCOURSES IN ZIMBABWE. In *Sustainability (Switzerland)* (Vol. 11, Issue 1). http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI

Nogeire-McRae, T., Ryan, E. P., Jablonski, B. B. R., Carolan, M., Arathi, H. S., Brown, C. S., Saki, H. H., McKeen, S., Lapansky, E., & Schipanski, M. E. (2018). The role of urban agriculture in a secure, healthy, and sustainable food system. In *BioScience* (Vol. 68, Issue 10). https://doi.org/10.1093/biosci/biy071

Nyathi, D., & Ndlovu, J. (2025). *Urban Climate Change and Zimbabwe*. *August*. https://doi.org/10.1177/00219096251352491

Nyberg, Y., Wetterlind, J., Jonsson, M., & Öborn, I. (2021). Factors affecting smallholder adoption of adaptation and coping measures to deal with rainfall variability. *International Journal of Agricultural Sustainability*, *19*(2). https://doi.org/10.1080/14735903.2021.1895574

Nyikahadzoi, K., & Mhlanga, L. (2021). *Case Studies from Zimbabwe's Urban and Rural Areas Climate Change Impact, Adaptation and Mitigation in Zimbabwe*. www.kas.de/simbabwe

OCHA. (2023). *El Niño, ANTICIPATORY ACTION PLAN ZIMBABWE*. *November 2023*.

Okello, C., Githiora, Y. W., Sithole, S., & Owuor, M. A. (2024). Nature-based solutions for water resource management in Africa's arid and sem-arid lands (ASALs): A systematic review of existing interventions. *Nature-Based Solutions*, *6*, 100172. https://doi.org/10.1016/J.NBSJ.2024.100172

Orsetti, E., Tollin, N., Lehmann, M., Valderrama, V. A., & Morató, J. (2022). Building Resilient Cities: Climate Change and Health Interlinkages in the Planning of Public Spaces. *International Journal of Environmental Research and Public Health*, *19*(3), 1–22. https://doi.org/10.3390/ijerph19031355

Panda, S., Parida, C., Azharunnisa, A., & Thakur, R. R. (2024). Integrating nature-based solutions in the urbanization process by urban agriculture: a case of Bhubaneswar city, India. *Discover Sustainability*, *5*(1). https://doi.org/10.1007/s43621-024-00503-z

Robinson, S., Hoetker, G., & Bowen, K. (2024). Governance to enable climate resilient development of healthcare systems – A conceptual overview. *The Journal of Climate Change and Health*, *19*, 100334. https://doi.org/10.1016/J.JOCLIM.2024.100334

Roy, A. S., Mazaniello-Chézol, M., Rueda-Martinez, M., Shafique, S., & Adams, A. M. (2023). Food systems determinants of nutritional health and wellbeing in urban informal settlements: A scoping review in LMICs. *Social Science & Medicine*, *322*, 115804. https://doi.org/10.1016/J.SOCSCIMED.2023.115804

Samu, R., & Akıntuğ, B. (2020). Pre-disaster planning and preparedness: Drought and flood forecasting and analysis in Zimbabwe. *Water SA*, *46*(3), 448–457. https://doi.org/10.17159/wsa/2020.v46.i3.8655

Sharma, S. K., Mudgal, S. K., Gaur, R., Chaturvedi, J., Rulaniya, S., & Sharma, P. (2024). Navigating Sample Size Estimation for Qualitative Research. *Journal of Medical Evidence*, *5*(2), 133–139.

Singh, S., Singh, D. R., Velmurugan, A., Jaisankar, I., & Swarnam, T. P. (2018). Coping with climatic uncertainties through improved production technologies in tropical island conditions. In *Biodiversity and Climate Change Adaptation in Tropical Islands*. https://doi.org/10.1016/B978-0-12-813064-3.00023-5

Skinner, C. J. (2016). Probability Proportional to Size (PPS) Sampling. In *Wiley StatsRef: Statistics Reference Online*. https://doi.org/10.1002/9781118445112.stat03346.pub2

Spiegel, S. J., Kachena, L., & Gudhlanga, J. (2023). Climate disasters, altered migration and pandemic shocks: (im)mobilities and interrelated struggles in a border region. *Mobilities*, *18*(2). https://doi.org/10.1080/17450101.2022.2099756

Stone, T. F., Huckins, E. L., Hornbuckle, E. C., Thompson, J. R., & Dentzman, K. (2024). Equity and resilience in local urban food systems: a case study. *Agriculture and Human Values*, *41*(3). https://doi.org/10.1007/s10460-024-10551-w

Tatsvarei, T., Mwakiwa, S., & Mukarumbwa, E. (2018). Ameliorating food and income insecurity for vulnerable urban households: A case of community gardens in Gweru, Zimbabwe. *International Journal of Development and Sustainability*, *7*(8), 2204–2215. www.isdsnet.com/ijds

Thompson, H. E., Berrang-Ford, L., & Ford, J. D. (2010). Climate change and food security in Sub-Saharan Africa: A systematic literature review. *Sustainability*, *2*(8), 2719–2733. https://doi.org/10.3390/su2082719

Tirivangasi, H. M., Dzvimbo, M. A., Chaminuka, N., & Mawonde, A. (2023). Assessing climate change and urban poverty in the context of the COVID 19 lockdowns: Rethinking personality and societal challenges in Zimbabwe. *Scientific African*, *20*, e01710. https://doi.org/10.1016/J.SCIAF.2023.E01710

UNDP. (2019). *Urban Resilience Systems Analysis Zimbabwe*. 365.

Wardekker, A. (2021). Contrasting the framing of urban climate resilience. In *Sustainable Cities and Society* (Vol. 75). https://doi.org/10.1016/j.scs.2021.103258

ZIMSTATS. (2022). *2022 Population and Housing Census: Preliminary Report*. *16(07):2022*. https://doi.org/10.21475/ajcs.22.16.07

ZIMVAC. (2023). *Zimbabwe Vulnerability Assessment Committee (ZimVAC) 2022 Rural Livelihoods Assessment Report*. www.fnc.org.zw.

Appendices

Appendix 1: Consent Form

You are being asked to participate in a research study. Researchers are required to provide a consent form to inform you about the research study, to convey that participation is voluntary, to explain risks and benefits of participation, and to empower you to make an informed decision. You should feel free to ask the researchers any questions you may have.

Study Title: Effectiveness of urban agriculture as a nature-based solution for enhancing urban climate resilience in Mutare, Zimbabwe

Researchers: (*NAMES*)

1. Purpose of Research

- You are being asked to participate in research to study the effectiveness of urban agriculture as a nature-based solution for urban climate resilience in Mutare, Zimbabwe
- You have been selected as a possible participant in this study because of your direct involvement with, or significant knowledge of, urban agriculture and climate resilience.
- From this study, the researchers hope to gain a comprehensive understanding of the role of urban agriculture in enhancing climate resilience in Mutare, that is, the environmental, social, and economic benefits, understanding challenges to its implementation and exploring the potential for scaling these practices for broader urban climate adaptation
- Your participation in this study will take about 30 - 45minutes
- The research findings will be shared with participants through printed summary.

2. What You Will Do

You will be asked questions regarding your perceptions, impacts, challenges and opportunities of urban agriculture in building urban climate resilience

3. Potential Benefits

- You will not directly benefit from your participation in this study. However, your participation in this study may provide insights into how urban agriculture can serve as an effective, sustainable, and adaptable solution to urban climate resilience in Mutare.

4. Potential Risks

- There are no foreseeable risks associated with participation in this study.
- Your participation in this study will not affect your relationship with the local authority nor lead.

5. Privacy and Confidentiality

- The data for this project are being collected anonymously. Neither the researchers nor anyone else will be able to link data to you. Data will be coded and a key maintained separately. The data will be stored on a password protected computer and locked office. The Researcher and Research Assistants will have access to the data.
- The results of this study may be published or presented at professional meetings, but the identities of all research participants will remain anonymous.

6. Your Rights to Participate, Say No, Or Withdraw

- Participation is voluntary. Refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled.
- You have the right to say no.
- You may change your mind at any time and withdraw.
- You may choose not to answer specific questions or to stop participating at any time.
- Choosing not to participate or withdraw from this study will not make any difference in the quality of any services you may receive.

7. Costs and Compensation for Being in The Study

- You will not incur any costs for participating in this study.
- You will compensation for your time spent participating in this study.
- Where applicable, participants will be reimbursed for their transportation and lunch.

8. Contact Information

If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the researchers (*NAMES, ADDRESS AND CONTACT NUMBERS*)

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the AUREC at (*ADDRESS, CONTACT NUMBERS*)

9. Documentation of Informed consent.

Your signature below means that you voluntarily agree to participate in this research study.

_____

Signature Date

You will be given a copy of this form to keep.

10.

- Interviews will be recorded with a voice recorder. Recordings will be stored on password protected computer and will be used to analyze information on effectiveness of urban agriculture as a nature-based solution for enhancing urban climate resilience in Mutare
- I agree to allow audio recording of the interview.

☐ Yes ☐ No Initials_____

Appendix 2: Interview guide for KII

- Can you describe your experience with urban agriculture in Mutare, Zimbabwe?
- How would you describe the current urban agriculture challenges in Mutare?
- What specific benefits do you think urban agriculture offers households?
- What opportunities do you see for scaling up urban agriculture to contribute to broader climate resilience goals in Mutare?
- How do you see urban agriculture's future in Mutare?
- Is there anything else you would like to add regarding urban agriculture in Mutare or its potential?
- Are there any other organizations, besides yours, that you think researchers should include in this study to make it more comprehensive?

Appendix 3: Focus Group Discussion Guide

- May you describe your experience with urban agriculture?
- What kind of impact do you think these urban agricultural practices have on your household, community, or the environment?
- How would you describe the current urban agriculture challenges in Mutare?
- Can you share any success stories or best practices in urban agriculture that you believe could be replicated in other areas of Mutare or beyond?
- What support would be needed to improve urban agriculture?
- In your opinion, how could the community, government, or other stakeholders collaborate to enhance the growth and sustainability of urban agriculture in Mutare?
- What opportunities do you see for scaling up urban agriculture to contribute to broader climate resilience goals in Mutare?
- How do you see urban agriculture's future in Mutare?
- What other aspects of urban agriculture in Mutare do you think are important to consider for this research?
- Is there anything else you would like to add regarding urban agriculture in Mutare or its potential?

Appendix 4: Household Questionnaire

HOUSEHOLD QUESTIONNAIRE
Date **Questionnaire number** **Suburb**

SECTION A: Demographic Information:

1.Age Group

18-24	
25-34	
35-44	
45-54	
55-64	
65 and above	

2. Gender:

Male	
Female	

3. Employment status:

Employed full time	
Employed part time	
Student	
Business owner	
Unemployed	
Self-employed	
Other (please specify)	

4. Highest level of education completed:

Primary	
Secondary	
Tertiary	
Other (please specify)	

SECTION B

Nature and Extent of Urban Agricultural Practices in Mutare

B1. Do you currently engage in urban agriculture (e.g., crop production, gardening, livestock farming)?

Yes	
No	

B2. If yes, how long have you been practicing urban agriculture?

Crop production	
Maize	
Onions	
Cabbage	
Covo	
Rape	
Spinach	
Lettuce	
Tomatoes	
Sweet potatoes	
Fruit production	
Mangoes	
Guavas	
Oranges	
Avocados	
Lemons	
Grapes	
Paw paws	
Peaches	
Animal production	
Broilers	
Layers	
Rabbits	
Guinea fowls	
Pigeons	

Other	
Mushrooms	
Honey	
Fisheries	

B4. Do you currently engage in any form of food processing or value addition with agricultural produce?

Yes	
No	

If yes, which of the following value addition activities do you engage in? *(Select all that apply)*

Drying (e.g., sun-dried vegetables, fruits)	
Canning or bottling	
Pickling or fermenting	
Making juices, jams, or sauces	
Roasting or milling (e.g., spices, flours)	
Branding or marketing of processed goods	
Cooking or baking for direct sale (e.g., street food, snacks)	

B6. Where do you practice urban agriculture?

Backyard	
Community Garden	
Vacant land or open space	
Balcony	
In buckets or sacks	
rent or lease	

B7. What is your source of water for your agricultural activities

Municipal water – burst pipes	
Municipal water - tap	
Borehole water	
From the river	

SECTION C: Benefits of Urban Agriculture in Mutare

C1. The following statements relate to the benefits of urban agriculture.
Please indicate the extent to which you agree or disagree with each statement by selecting the response that best reflects your opinion.

Urban agriculture…	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
has improved food security in my household					
has contributed to my household's income					
help reduce the cost of living for my family					
contributes to the availability of fresh food in my area					
helps reduce the distance food travels from production to consumption.					
helps increase the variety of plants and animals in an area.					
creates employment					
helps in waste management					
encourages healthy eating habits					
improves mental health					
creates avenues for youths to be occupied					
contributes to environmental conservation					

is a potential solution for urban climate resilience in Mutare if the challenges are addressed					

C2. Which of the following best describes your position regarding what you produce through urban agriculture?

I consume what I grow and raise through urban agriculture	
I sell what I grow and raise through urban agriculture	
I consume and sell what I grow and raise through urban agriculture	

SECTION D: Challenges Facing Urban Agriculture farmers in Mutare

The following statements describe possible challenges faced by urban agriculture farmers.
Please indicate the extent to which you agree or disagree with each statement based on your own experience.

The challenges we face with regards to urban agriculture include	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Spatial & Infrastructural challenges					
Lack of space					
High competition for space (housing, commercial use)					
Laws restricting urban farming					
Small plots limiting crop diversity and yield					
Inadequate drainage infrastructure					
Vulnerability to infrastructure damage from floods					
Economic & Social challenges					
High startup costs (land, tools, setup)					
High maintenance and operational expenses					
Lack of reliable markets					
Unstable income due to market fluctuations					
Theft of crops or tools					
Vandalism of urban farm sites					
It is labor-intensive (time & physical effort)					
Conflict with authorities					
Conflicts with other residence					
Competition with rural farmers					
Environmental degradation & Climate					
Pollution					
Flash floods					

Waterlogging					
Droughts					
Contaminated urban runoff					
Unpredictable weather					
Heat stress					
Water shortages					
Pests and diseases					
Policy					
It is difficult to get permits or licenses for urban farming activities.					
There are food safety concerns					
The legal status of urban agriculture is unclear					

SECTION E. The following statements describe various coping strategies that urban agriculture farmers may use when facing challenges.
Please indicate the extent to which you agree or disagree with each statement based on your own experience.

The coping strategies we use to address the challenges of urban agriculture include	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Spatial & Infrastructure					
Temporary or mobile gardens using sacks					
Renting land from neighbors, or just outside the city					
Land-sharing agreements with institutions (e.g., schools, churches)					
Use of underutilized public or private spaces					
Economic & Social					
Making use of local extension services					
Community vigilance and fencing for security					
Renting shared equipment					
Making use of alternative business ventures like Value addition: making products like jams, dried fruits and herbs to increase income					
Diversifying production (vegetables, herbs, poultry, mushrooms, etc.) to spread risk					
Environmental degradation & Climate					

Soil remediation					
Using seasonal crop rotation					
Winter cropping					
Policy					
Volunteer engagement and local stewardship of gardens					
Participating in local food networks or farmer alliances					
Navigating informal arrangements in the absence of formal land rights					
Collaborating with NGOs or cooperatives for support and funding					
We have adapted our farming practices to comply with local laws and regulations					

SECTION F: SCALING UP STRATEGIES

Please select the option that best reflects your opinion.

The following are potential strategies for scaling up urban agriculture	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Using technology such as vertical farming can help scale up urban agriculture.					
Hydroponics is an effective method to increase urban farming productivity					
Water harvesting techniques improve the sustainability of urban agriculture.					
Rooftop agriculture offers valuable space for expanding urban farming					
Regular water and soil testing enhances urban farming success					
Using alternative sources of energy supports the growth of urban agriculture					
Creating proper marketing places helps urban farmers reach more customers					
Decongesting Urban areas can free up space for urban agriculture.					
Inclusive planning involving all stakeholders is essential for urban agriculture development.					

Identifying and using alternative arable land boosts urban farming opportunities.					
Applying a value chain approach strengthens urban agriculture systems					
Rainwater harvesting is a vital strategy to support urban farming.					

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