

**THE ROLE OF URBAN AGRICULTURE IN BUILDING RESILIENCE TOWARDS
CLIMATE CHANGE IN THE CITY OF TSHWANE**

BY

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ABSTRACT

This thesis seeks to explore the role of urban agriculture in building climate resilience in the city of Tshwane, South Africa. It looks at how urban agricultural practices in the city can be used to influence climate change policy designs and implementation leading to enhanced resilience. This is premised on the need to ensure that major metro cities like Tshwane take the necessary steps to contribute to effective water management and the building of climate resilient societies. Based on a qualitative research method, this thesis provides a deeper understanding of the status and benefits of urban agricultural practices in Tshwane. Qualitative techniques in a form of semi-structured interviews and observations were administered on key informants to better understand the key factors influencing the implementation of urban agricultural practices.

The study established that urban agriculture exists within the city of Tshwane, particularly within specific communities around the city. Vegetable gardening emerged as the most prominent practice throughout the city in spaces such as schools, community gardens and open spaces to contain soil erosion. The thesis illustrates that there are number of urban greening programmes implemented through the various structures of the municipality which relates to urban agriculture, yet there is no overarching policy outline within which these can be tied together. Clearly, duplications among policy instruments exists and there seem no way of reducing and filling up gaps and exploiting synergies. Although South Africa and by virtue the City of Tshwane is one of the signatories to the United Nations' Sustainable Development Goals and has committed to working towards achieving food security, clean water and affordable clean energy, it is clear that the implementation of climate change mitigation and adaptation strategies in the city remains challenging. Despite the successful establishment of green initiatives, there are some hindrances within the city that inhibit transition of urban agriculture into a resilient city. As such, it is recommended that relevant authorities put in more funding into research and learnership programmes to ensure the successful establishment of urban agriculture in the city. In particular, the government should fund the development of new urban agriculture production because it needs financial resources to enhance the capacity of most farmer.

Keywords: Vegetable gardening, Resilience, Climate Change, Urban Agriculture

DECLARATION

I, Mulalo Mphaphuli declare that this thesis, submitted for the degree of Master of Philosophy in Integrated Water Management at Monash South Africa, contains no material accepted for an award of any other degree or diploma in any university or other institution. To the best of my knowledge, it contains no material previously published or written by another person except where due reference is made in the text of this thesis.

Student signature

Date 30 November 2022

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DEDICATION

The following study is dedicated to my two beautiful children.

Khodani Ramulondi and

Wanga Ramulondi

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ACRONYMS

ARC	: Agricultural Research Council
CRVA	: Climate Risk and Vulnerability Assessment
CoT	: City of Tshwane
CSU	: City Sustainability Unit
DEA	: Department of Environment and Agriculture
FAO	: Food and Agriculture Organisation
GHGEI	: Greenhouse Gas Emissions Inventory
MDGs	: Millennium Development Goals
NMT	: Non-Motorised Transport
SA	: South Africa
SDGs	: Sustainable Development Goals
STATS SA	: Statistics South Africa
TIEP	: Tshwane Integrated Environmental Policy
UA	: Urban Agriculture
UPA	: Urban Peri Agriculture
UN	: United Nations
WMO	: World Meteorological Organisation

CHAPTER 1

BACKGROUND AND INTRODUCTION

1.1 INTRODUCTION

This thesis seeks to explore various approaches to address complex matters around urban agriculture and climate resilience policies and programs in the Tshwane Municipality. It proposes that the core elements of urban agriculture programmes that influence proper management of these new approaches already exist, but are fragmented because, apart from researchers working in the environmental management, the investigators who have developed them are marginalized (Bammer, 2003). The main aim of the thesis is to explore how urban agricultural practices in Tshwane can impact climate change policy designs, implementation, monitoring and evaluation. The purpose is to take the necessary steps in making sure that major metro cities like Tshwane can add to water resource management in the country. The study sought to engage what people understand about how urban agriculture can be used in combating climate change and if there were gaps in that understanding, where and how they could be addressed.

1.2 BACKGROUND

As Tshwane develops, it will continue to rely on nature as a core component of building a sustainable and resilient city for all (Senosha, 2017). This is in line with the African Union's Agenda 2063, which aims for environmentally sustainable and climate-resilient economies and communities. Though South Africa has rich information on climate at national level, cascading that information down to municipal level to be incorporated into the operational needs of various portfolios becomes a challenge due to limited skills in the subject of climate change. The South African Constitution (Chapter 2, Section 27.1b) asserts that every citizen has the right to have access to sufficient food and water that the state must take reasonable legislative and other measures, within its available resources, to progressively achieve this right (Pieterse, 2007). The National Integrated Food Security Strategy (IFSS, 2002) was adopted by cabinet in response to this imperative, hence in accordance with the Millennium Development Goals.

Agriculture, which includes all economic activities from provision of farming inputs, farming and value adding, remains an important sector in the South African economy despite its small direct share (less than 5%) of the total gross domestic product (GDP). Currently, the primary sector contributes 1.3% of City of Tshwane (CoT)'s broad economic structure and agriculture holds the key to unlock the full potential of the city's economy. According to a STATS SA,

2010 report, increased migration from rural to urban areas put tremendous stress in the city's ability to feed its dwellers. It is estimated that the world population will grow by 50%, from 6, 1 billion in mid-2001 to 9, 3 billion by 2050 (Priyadarshi, 2019). The 49 least developed countries will nearly triple in size, from 668 million to 1, 86 billion people (Chamie, 2001). These latest estimates and projections are now growing by 1.3% or 77 million people per year. Six countries account for half of this growth: India (with 21% of the total increase), China, Pakistan, Nigeria, Bangladesh, and Indonesia (Nagdeve, 2007). All the projected growth will take place in today's developing countries, which by 2050 will account for over 85 per cent of world population (Hussain & Bhat, 2018). According to Hussain & Bhat (2018), total population in developed countries will remain at around 1.2 billion. For a period of hundred years withdrawals of water to meet the demands and satisfy the needs of people across the world have intensified (Haarstrick & Bahadir, 2022). It is noted that, between the year 1900 and 1995, withdrawals of water from the source increased by six times which is twice more than the rate of population growth (Hiscock et al., 2002). Water is a necessity and play many roles in satisfying multifaceted human requirements and the surrounding environment. South Africa (SA) has an average rainfall of 497mm/a, compared to international average of 860mm/a. (Shippey et al., 2004). Uneven distribution of water resources, i.e., 60% of river flow arising from only 20% of land area (Shippey et al., 2004). SA has no major rivers of global comparative scale. The Orange River is SA's biggest river, but carries markedly less water than the Zambezi River, which is closest big river. Total surface runoff (50 bill. M3/a) of all SA's rivers combined, is still less than half of that of the Zambezi (Kapangaziwiri et al., 2021).

Water is scarce resource and an essential ingredient to economic growth (Falkenmark, 2013). According to this author, arid regions across the world occurring naturally is an indication that there are restrictions patterning to the progress that may be based on availability of water resources allocated for agriculture. The availability of water sources is not equally distributed, and can be found in deserts, where little or no rain falls, to the tropical regions, which receives most of its rainfall a year (Roebroek et al., 2020). Few rivers are found to have most of the water flowing, for example, the Amazon River transmits 16% of the world 's runoff, while one third of the world's river flow transmission occurs in the Congo –Zaire River basin across the African continent. This leaves the dry region and half dry regions of the world with 40% of the land mass coverage and only 2% of the world's runoff.

The swift growth in demanding for water is caused by ongoing dependence of water required for irrigation to meet food security, increase in number of waters for industrial use and household purposes. Many experts, governments, and international organisations around the world are predicting that water availability will be one of the major challenges facing human society in the 21st century and that the lack of water will be one of the key factors limiting development. The impact of Climate Change through the water courses will be gradual, with subtle shifts in average temperatures, rainfall, and sea levels (Sathre et al., 2022). But modifications in averages cause dramatic variations in the risks of extreme climatic events, and climate change will be manifested in a catalogue of disasters such as storms, droughts and flooding unparalleled in modern times (Eckstein & Wings, 2018). The main uncertainty is where and when they will occur. According to Eckstein & Wings (2018), other places where river flows could increase with equally disastrous consequences.

Warming will melt mountain glaciers and snow, changing the seasonal flow of rivers, disrupting agriculture, and risking the catastrophic failure of large dams (Ali et al., 2009). As some nations succumb to rising waters, others will become parched and increasingly at risk from catastrophic drought and famine (Higgins, 2023). While making coastal regions wetter, global warming will cause the hot deserts of continental interiors to expand as evaporation rates increases. On the fringes of the deserts, rivers will dry up and crops will fail as droughts intensify. Between 1985 and 1999, nearly 561, 000 people died in natural disasters (Ali et al., 2009). Only 4% of the fatalities were in industrial countries and 77% of the deaths were in Asia (Gaffga & Mintz, 2007). Between 1985 and 1999, 49% of the recorded death by disasters were floods and 15% windstorms (Abramovitz, 2001). Salem et al., (2020) found that the average number of flood victims for the five-year period from 1973 through to 1977 was 19 million and has escalated sharply to 111 million for the 1988 through 1992 and still further to 131 million for the 1993 to 1997 five-year period. According to Abramovitz (2001), between 1990 and 2025, many people residing in urban areas are expected to double to more than 5 billion people. Almost all this growth – a staggering 90%- will occur in the countries of the developing world. In the developing world, South America and the West Indies constitute the most inner part of the city- with more than 70% of its population living in urban areas in 1995. Rapid urban growth is continuing especially in small-and intermediate size cities. Loss of agricultural land has been linked to high rates of urban sprawl worldwide (Güneralp et al., 2020). By contrast, Africa and Asia are now only about 30 to 35% urban (Simkin et al., 2022). It is in these regions that the most explosive growth is under way, at roughly 4% per year. This trend is projected to continue for several decades. Both Asia and Africa are expected to be about 54% urban by 2025.

1.3 RESEARCH PROBLEM

Climate variability and change have a significant impact on the food security and livelihoods of smallholder farmers, requiring farmers to prioritize investments in adaptation and mitigation approaches to build resiliency (Chitakira & Ngcobo, 2021). South Africa is one of the signatories to the UN to have devoted to working towards achieving the Sustainable Development Goals (SDGs) to ensure food security, fresh water and reasonable clean energy, PROGRESS ON climate change mitigation and adaptation strategies, as well as development of sustainable communities, actions to be taken seem challenging (Sivakumar, 2021). The City of Tshwane has excelled in introducing green initiatives which affects how climate change challenges can be overcome. There are number of urban greening programmes implemented through the various structures of the municipality which relates to urban agriculture, yet there is no overarching policy outline within which these can be tied together, duplications reduced, gaps filled, and synergies maximised. For example, the institution of a sustainability office that motivates the conversion to a climate resilient city. Among these are also organisations formed by members of society and non-governmental organisations that were established to strengthen adaptation to climate change from the basics. Despite the successful establishment of these green initiatives, there are some hindrances within the city that inhibit their transition to a resilient city. The current urban agriculture infrastructure was designed to cater for certain number of people with more people coming into Gauteng, it puts enormous pressure on the urban systems and on the other hand the money budgeted for urban agriculture infrastructure is allocated for maintenance not for the upgrade. The situation is exacerbated by uncertainty on the extent of climate change.

In South Africa, it is only the National Treasury that is constitutionally allowed to raise funds through the taxation system, however, the funding required for urban agriculture practices and the administration of urban agriculture programmes become a local responsibility (Thornhill, 2014). Hence, it should be apparent that the success of the policy's implementation process is dependent on the economic, political, and technical capacities of local institutions and individuals (Capano, 2020). The impacts of climate change are starting to show and being felt in the city. One common symptom is an increase in temperature. In the Tshwane municipality, there has been a significant increase in temperature in recent years - almost twice the world rate. Climate change is not prioritised when budget allocations are due, though all spheres of

government are required through national policy to act against climate change, allocations of these funds seem invalid and do not reflect this imperative (Spires, 2015). There is growing recognition of urban and peri-urban agriculture (UPA) as an important strategy for climate change adaptation and mitigation, to a lesser extent. Cities, which now host most of the global population, are vulnerable to environmental and socio-economic disturbances, which are likely to increase in number and severity soon (Spires 2015). The study conducted by the World Bank (using annual high-resolution data) discovered that, people who lives in settlement areas across the globe have increased from 85% to over 1.28 million square kilometers (Rentschler et. al, 2022). While agriculture is widely practiced throughout the city of Tshwane, especially in regions 4, 5, 6 and 7; these are areas also prone to extreme events such as flooding and intense thunderstorms, which can have a detrimental impact on agricultural infrastructure. Rentschler et al., (2022) further explained that countries around the world are increasingly facing the threat of flooding, providing systemic evidence that they are not adapting to increasingly frequent climate shocks. The city of Tshwane Climate Action Plan shows that there is a need to focus on implementing actions to build the general resilience of the city and its people by increasing awareness, providing training, improving health and food security, business management and ensuring environmental protection.

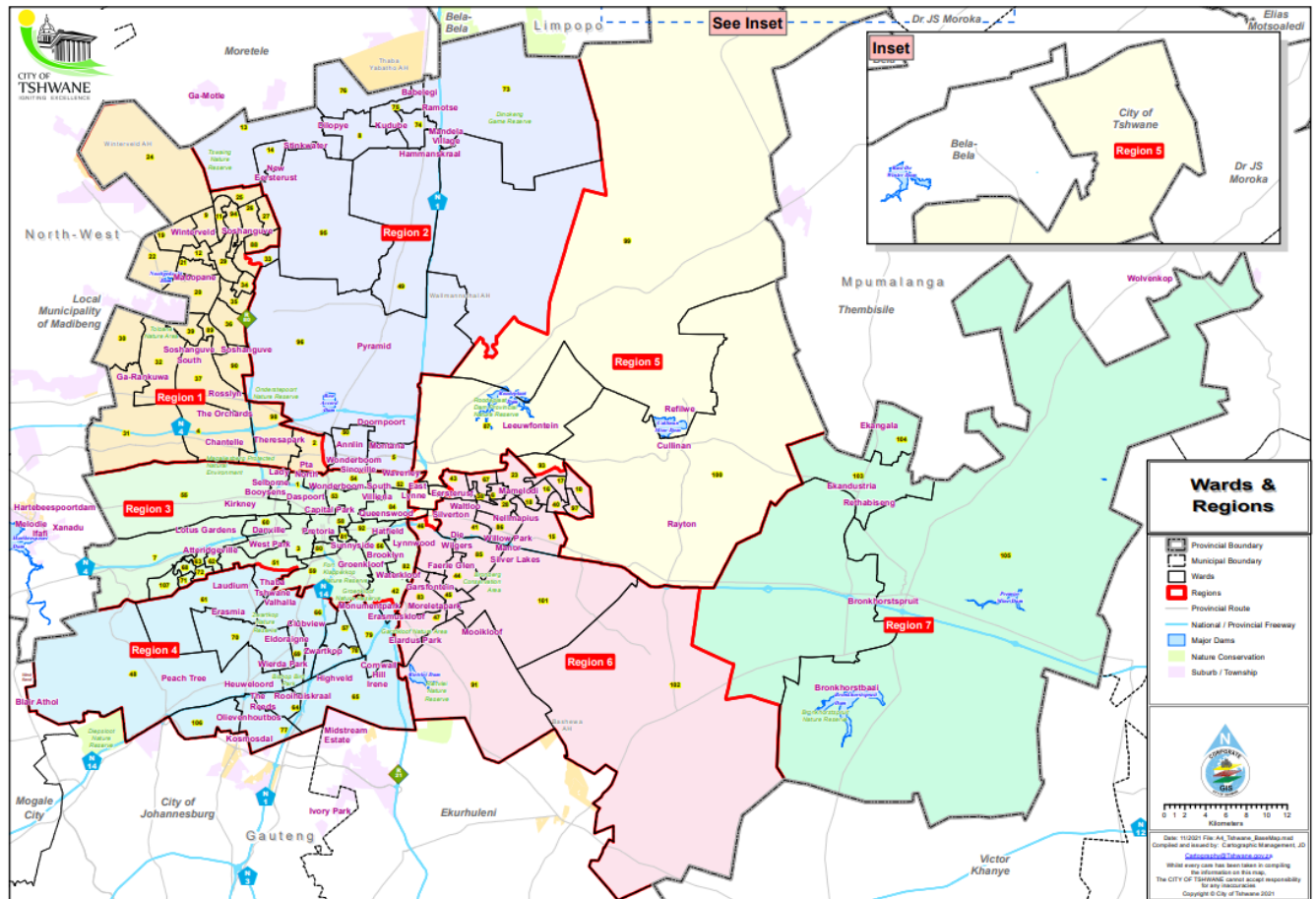


Figure 1.3.1. Map of regions within the City of Tshwane municipality. Source: https://www.tshwane.gov.za/sites/about_tshwane/MapsAndGIS/Pages/General-Maps.aspx

In Vietnam, a flood risk assessment for Ho Chi Minh City finds that informal poor settlements are systematically at higher flood risk than the rest of the city, while evidence from the United States documents how new construction site on the Atlantic coast avoided building in exposed areas to flooding areas by building in less flood zone situated in compacted areas (Rentschler et. al, 2022). Despite the increasing relationship between rapid urbanization trends and flood disasters, risks are mostly documented in circumstantial evidence and case studies (Sakijege & Dakyaga, 2022). Though climate change forms part of strategies within the national policy such as the National Development Plan, which also guide the 2030 vision, it recognises climate change as an enabler that affects the context in which South Africa does business but does not directly address the impact of climate change in urban areas (National Planning Commission, 2013). The study focused on the current challenges faced by the Tshwane municipality regarding the roles of urban agriculture in building resilience to climate change.

1.4 SIGNIFICANCE OF THE SUDY

1.4.1 Significance to Management of City of Tshwane

The findings of this study will be of significance value to the city of Tshwane, policy makers within the government department and Agricultural Research Council (ARC). Reason being that this study seeks to explore various approaches to address complex matters around urban agriculture and climate resilience policies and programs in the Municipality. It proposes that the core elements of urban agriculture practices already exist, but are fragmented because, apart from researchers working in the environmental management, the investigators who have developed them are marginalized (Bammer, 2003). The research findings could act as useful references to document UA and inform the municipality of more effective ways of practicing urban agriculture for building resiliency through multi-stakeholder processes, where research alternates with policy formulation for practical interventions (Dahlberg 1999; Hamm & Baron 1999). There are few urban agriculture policies to establish synergies between urban agriculture production systems and climate change to guide urban-agricultural integrated programs (Allen 1999; MacRae 1999). This will ensure integration and implementation of sciences are critical for integrating policy relevance, evidence-based practice, and innovation, which are key concepts now driving research (Bammer, 2003).

1.4.2 Significance to research

There are many options for incorporation of Urban Agriculture into the urban environment, as well as resources available to help choose among these options for general urban areas (Mougeot, 2000). In addition, there have been many studies that have defined the effectiveness of such practices in field applications (Mougeot, 2000). For this research, the study will focus on the evaluation of Urban Agriculture policies and programs in the city of Tshwane Municipality to determine the linkages between policy failures and their implementation thereof. Drescher et al., (2021) found that many studies had been established that looked at the various stages and level of development in the Urban Peri Agriculture (UPA) in Asia. The work of Razak and Roff (2007) looked at the status and potentials of urban and peri-urban agriculture in Malaysia against the backdrop of challenges of food security, while on the other hand, Islam and Siwar (2012) worked on the analysis of urban agriculture development in Malaysia relating it to advances in environmental biology and how the agricultural produce will be safe for human consumption.

The purpose of this study was to build on these studies by exploring the necessary steps required in making sure that major metro cities like Tshwane can add to water resource management in

the country. In particular, the study sought to address key questions related to the nature of urban agricultural practices are, who champions these initiatives and how they unravel. The study engaged what people understand about how urban agriculture can be used in combating climate change and if there are gaps in that understanding, where and how we can fill them. The study contributes to research through advancing understanding about how we can start moving to create policies to improve and widen the scope of agricultural practices and climate resilience because of their prevalence in the study.

1.5 RESEARCH AIM

The main aim of the research was to explore how urban agricultural practices in Tshwane impacted policy designs, implementation, monitoring and evaluation.

1.6 RESEARCH OBJECTIVES

The overall purpose of this thesis is to gain a deeper understanding of the role of urban agriculture in building climate resilience for the City of Tshwane.

Specific objectives

The above aim will be advanced through the following objectives.

1. To establish the status of Urban Agriculture practices in the city of Tshwane
2. To determine the benefits of Urban Agriculture practices in the development of Climate Change strategies
3. To determine factors influencing the implementation of Urban Agriculture policies in the city of Tshwane
4. To understand the impact of Urban Agriculture policies on building resilience in the city of Tshwane
5. To recommend ways of improving urban agriculture practices that can assist policy makers in making informed decisions to respond to climate change.

1.7 STRUCTURE OF THESIS

Chapter 1 sets the scene of the study, giving the background and the importance of water as a natural resource. The challenges facing urban agriculture against building a purposeful climate change resilience in the City of Tshwane are outlined, furthermore the research question and the objectives are listed. Chapter 2 reviews current knowledge from available literature that is related to the study. Chapter 3 presents the research methodology through which the research will be conducted. Chapter 4 shows data analysis for the study with findings, and Chapter 5 presents conclusions and recommendations for the study.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Snyder (2019) postulated that all research studies must be designed around known literature as shared by previous researchers. According to Machi and McEvoy (2021), literature review is a consolidated knowledge tapped from the previous workings of other researchers adopted by the researcher to support their study. This chapter, therefore, presents work by authors that resemble the themes of urban agriculture and climate change. The chapter examines theories and concepts that are key to this thesis.

2.2 EXPLORING URBAN AGRICULTURE

Urban agriculture is not an entirely new industry, although it has been expanding since the 1970s due to rapid urbanization, ineffective agricultural policies (Anaifo & Akolgo, (2018), crippled food distribution systems, withdrawal of subsidies, reduction of wages, inflation, unemployment, lax urban regulations, civil strife, and droughts, and more recently climate change. Urban agricultural practices are traced to the early Incaic, Aztec and Mayan cities, early Javanese and Indus settlements, and towns of the Tigris and Euphrates (Lebedeva, 2008). Although contemporary urban agriculture is said to be widely practiced in Asian countries it is gradually penetrating places as disparate as Dar es Salaam, Montreal, Belo Horizonte, Rosario, Moscow, Cagayan d 'Oro and Cape Town among others. While there is a dearth of data on the successes or otherwise of urban agriculture, it is pointed out that several cities, including Kathmandu, Karachi, Singapore, Hong Kong, and Shanghai produce between 25 – 85 percent of their fruit and vegetable requirements from urban farms while Hong Kong, Kampala and Singapore raise between 70 and 100 percent of the poultry they consumed (Anaifo & Akolgo, (2018). It is further argued that some cities even manage to export produce from urban farms to other countries. Studies carried out in the 1990s in East Africa also showed that 17–36 percent of the urban population grow crops and/or keep livestock. There are several useful definitions of urban agriculture (UA) or urban and peri-urban agriculture (UPA/UA), (Lee-Smith & Memon, 1994; Mbiba, 1995, 2000; Binns & Lynch, 1998; Mougeot, 2000; Hovorka, 2005). Arosemena (2012) states that ‘the evolution of cities and industrial agriculture more than 100 years ago compelled the need for a process of separation in areas between food production and urban settlements, therefore the term urban agriculture brings together two

parallel activities which include living in urban areas and farming'. Since there was no real definition, it has left some questions in attempt to find out what urban agriculture is? (Arosemena, 2012). In a broader term Urban Agriculture can be referred to any agriculturally related activities, which include production, processing, and marketing, occurring in built up intra-urban areas and in peri-urban fringes of cities and towns, (Lee-Smith & Memon, 1994; Mbiba, 1995, 2000; Binns & Lynch, 1998; Mougeot, 2000; Hovorka, 2005, Thornton, 2008). The Food and Agriculture Organisations of the United Nations recognised urban agriculture as “agricultural practices which were introduced to cities to meet the needs of urban dwellers” Activities that FAO considers urban agriculture include horticulture (ornamental plants, livestock, fodder and milk production, aquaculture (aquatic plants and animals) and afforestation (planting of trees). Arosemena further established that “activities related to the cultivation of food near cities where the destination of those products is part of the city’s agro-food processing such as (production, distribution, consumption, and management of generated organic waste, (Arosemena, 2012, p. 20). Activities related to the cultivation of food near cities where the destination of this product is part of the city’s agro-food processing such as (production, distribution, consumption, and management of generated organic waste). For this study urban agriculture can therefore be associated with the production of crops or plants for consumption.

2.3 IMPACTS OF CLIMATE CHANGE

Climate change is one of the world's most persistent problems and raises a lot of important questions that remain unanswered (Bulkeley, (2013). According to Bulkeley, more than half of the world’s population lives in urban areas, which is a great significance source of greenhouse emission brought by climate change. The response to climate change is a major challenge. Different players involved in urban climate, and municipal management, international organisations and funding agencies point to cities as major arenas for the answer (Bulkeley, (2013). Freshwater management is no longer an issue of local concerns but rather a global phenomenon involving multiple role players to make informed decisions pertaining to water resources (Cosgrove & Loucks, 2015). The accessibility of good quality water is becoming less with projections that demand will increase by 55% in 2050 (Boretti & Rosa,2019). To date, South Africa’s water security has mainly relied on surface (fresh) water for its development. Like any other developing country, South Africa is facing water challenges (DWAf, 2006).

The sustainability of the country's freshwater resources has reached a critical point and its associated management is now at a crossroads (Franzke et al., 2022). The government acknowledges that everyone has the right to access to clean drinkable water as guaranteed by the constitution. However, increase in demand exacerbated by population growth makes it impossible for equal distribution and continual supply (Zapana-Churata et al., 2022). South Africa is a water-stressed country and is facing several water challenges and concerns, including aging infrastructure, environmental degradation and resource pollution pose a major threat to the security of water supply (Shippey et al., 2004). As water continues to become scarce and the pressure on our limited water resources continues to increase, it is important to secure the entire water supply as an integral part of the water system. During continued water scarcity and increased stress on our limited water resources, it is critical that the whole catchment is an integral component of the water supply infrastructure (DWAf, 2006). South Africa is extremely susceptible to the effects of climate change (Falkenmark, 2013). Varying weather patterns intensify normal temperatures by increasing their occurrence and thus intensifying dry conditions and droughts, creating major problems for water security, improved grassland conditions and intensifying wildfires, while posing risks to agricultural livelihoods (Espinosa et al., 2022). Rainfall distribution varies across the country and gives rise to the uneven distribution of surface runoff water with more than 60% of the river flow arising from 20% of the land area. In many developed and developing countries, governments, corporations, and communities are under constant pressure to rehabilitate and expand water management infrastructures to serve growing demands for water, energy, and food (Falkenmark, 2013). This work is challenged by the negative impacts of floods and droughts, which may be further exacerbated by climate change (Ahmad et al., 2022). Climate forecasts for the city of Tshwane based on the A2 emissions scenario which show that less rain and more hot days are expected. The occurrence of extreme weather-related events such as droughts, floods, hailstorms, and heat waves are also expected to increase in frequency and intensity, impacting particularly vulnerable populations, critical infrastructure and economic development. According to social, health and environmental vulnerability rankings, region 1 is classified as high-risk population density and located within the flood line influenced by set up of its informal settlements. Regions 2, 3, 4, 5 and 6 have moderate to high vulnerabilities and region 7 has low to moderate vulnerabilities. Vulnerable sectors identified in the city include human health, human settlements at risk of flooding, agricultural ecosystems that provide food security, water security, both supply and quality, high energy demand for domestic and industrial use, and ecosystem goods and services.

As time progresses demand for natural resources is becoming a leading factor with a little bit in heart for proper planning. Improper planning and mismanagement of infrastructure at all spheres of government has been reported as the main cause or failure in the provision of

portable water in rural and urban areas. Recently more focus has been on the green infrastructure policies and governance which serves as a guideline towards the implementation but lacks the how, what, and when.

Table 2.3.1. South African climatic condition projections. Source: DEA 2013a and DEA 2011b.

Climate Parameter	Observed changes since the 1960s	Projected changes in climate by 2050
Temperature 	• Increase in average annual temperatures by at least 1.5 times the global average. • Increase in maximum and minimum daily temperatures in almost all seasons.	• The coast is likely to warm by around 1–2°C and the interior by around 2–3°C. • Increase in temperature extremes and heat waves.
Rainfall 	• High interannual variability. • Annual rainfall trends are weak overall, but the tendency is toward a significant decrease in the number of rain days in almost all hydrological zones. • This implies a tendency toward an increase in the intensity of rainfall events and increased dry spell duration.	• A risk of drier conditions to the west and south of the country and a risk of wetter conditions over the east of the country. • Many of the projected changes are within the range of historical natural variability, and uncertainty in the projections is high. • Greater frequency of extreme rainfall events.
Sea Level Rise 	Sea levels are rising by: • 1.87 mm per year on the west coast • 1.47 mm per year on the south coast • 2.74 mm per year on the east coast	• Continued rise in sea levels. • Modelling has shown that some areas along the coastline will be more susceptible than others, but the understanding is incomplete.

2.4 IMPLEMENTATION OF URBAN AGRICULTURE POLICIES

South African National Government has made progress in bringing up to date old policies as demonstrated in NDP, IUDF and SPLUMA. However, the problem persists. For example, current decision-making structures and guidelines on existing policies, Pasquini et al., (2013:229) have stated that “despite certain claims that certain departments in all levels of the municipality are initiating strategies and mitigation plans to minimise the aftereffects of climate change, local municipalities are not required to carry out climate change mitigation and adaptation activities” (Ziervogel et al., 2014:606). Legislation such as the National Climate Change Response White Paper was designed to encourage return in investment related to ecosystem services (Cumming et al., 2014:11), but due to fragmented in internal structures, the implementation at local level seems dire (Pasquini et al., 2013:229). Pasquini et al. (2013), concluded that climate change is not a priority in strategic planning at the municipality level, but more broadly, there is still a lack of green planning towards the development and protection of ecosystem services as was found in the United Kingdom. Problems related to helping the urban poor require urgent and appropriate responses from cities, national and national

authorities, and international organisations. Urban policies should filter down to include food security and more attention be given towards building sustainable cities. To a lesser extent, urban and peri-urban agriculture (UPA) is increasingly recognised as an important strategy for climate change adaptation and mitigation. Metropolitan, municipality like city of Tshwane can play a proactive and synchronizing role in enhancing urban food security and cities resilience by:

1. Integrating urban food security/UPA into climate change adaptation and disaster management strategies
2. Maintaining and managing agriculture projects as part of the urban and peri-urban green infrastructure
3. Identifying open urban spaces prone to floods and landslides and protecting or developing these as permanent UPA/multi-functional areas
4. Integrating UPA into all-inclusive integrated water (shed) management plans.
5. Including UPA in social, housing, land and urban upgrading programmes
6. Developing a municipal urban agriculture and food security monitoring programme

Local climate change planning and policy documents are often prepared by consultants, resulting in general conclusions and recommendations that are difficult to implement and limiting the ability of municipal staff to update plans and other administrative documents. The Government often lack the training and access to information, enticements, or funding to put plans and strategies into use (Spires, 2015). There are number of initiatives as developed by the City of Tshwane, for example, Vision 2055 roadmap for a low carbon, resource-efficient and climate-resilient city, and a Green Economy Strategic Framework (2013) identifying adaptation and mitigation actions and ultimately plans to create an integrated climate change response strategy. In 2014, the city drafted a Vulnerability Assessment to Climate Change. The city established a Sustainability Unit to guide the city's sustainable development and climate change-related efforts. The Sustainability Unit drafted a Sustainable Financing Mechanism strategy to support green economy efforts and launched an Outreach Program, called Tshwane Green, to raise public awareness. Like national strategies, there is no dedicated analysis of urban adaptation.

2.5 CLIMATE CHANGE STRATEGIES AND BUILDING RESILIENCE

Climate change measures related to environmental security are of great concern in South Africa as they threaten food security, water resources, and infrastructure, health, biodiversity, and ecosystem services (Ziervogel et al., 2014, Claes et al., 2012). In South Africa it is expected that drought will continue for a long time and damage will increase due to flooding of rivers and sea areas. (Killian et al., 2005; Ogundeji et al., 2013). This is especially important given the country's vast coastline (Retief et al., 2014). South Africa is scarce in natural resources and water resources are running dry (Cumming et al., 2014:11). Climate change adaptation is increasingly emphasised in relation to address social needs and threats to ecosystem services (Ziervogel et al., 2014) and has become the most important issue for planners. Globally, the response to climate change takes two main forms. The first as mitigation is aimed at reducing or avoiding the impacts of climate change. The other as adaptation aimed at managing and controlling the inevitable climate change (Laukkonen et al., 2009). Ecosystem based adaptation and mitigation will become increasingly important in South Africa's response to climate change (Cumming et al., 2014:11) to receive benefits as reported in Durban South Africa (Roberts, 2010; Roberts et al., 2011; Roberts & O'Donoghue 2013). Climate change is not an imprecise idea of the future that may emerge in the future, the impacts of climate change are real and are already happening in the city of Tshwane. The most notable indicator is rising temperatures. In the Tshwane region these have been increasing significantly over recent decades – at about twice the global rate (Lakhraj-Govender & Grab, 2019). The amount of rainfall has not changed significantly, but the maximum number of consecutive rainy days per year is decreasing.

2.6 BENEFITS OF URBAN AGRICULTURE

Cities, which now host most of the global population, are vulnerable to environmental and socio-economic disturbances, which are likely to increase in number and severity soon. Urban agriculture (UA) can help make cities more resilient to a range of stresses and severe shocks by improving food security and public health, building social, capital and promoting a circular economy. Environmental, social, and economic factors are emerging as the main drivers of urban agriculture (Arosemena, 2012). Their connectedness will differ according to the role that they play in the environment. Urban agriculture drivers differ due to the actual function of the connection rather than the practical considerations introduced by these factors.

In particular, the ecological link refers to urban waste being used in urban agriculture such as composting or water recycling, social networking requires the integration of farmers living and

farming in the same city, and the economic ties that bring about the self-sufficiency of urban farms can support urban residents to any reasonable degree. (Arosemena, 2012). The key idea is that everything is stored within the city, reducing transport costs and recycling waste so that each city is dependent in terms of how it affects the global environment. Food systems are key component in the health and well-being of societies, and undernourishment is one of the leading causes of non-communicable diseases and related deaths worldwide. Thus, securing access to enough nutritious food for urban populations in the face of disturbance is a fundamental part of resilience.



Figure 2.6.1 vegetable gardening covered in mulch to conserve moisture.

Source: (own picture)

2.7 BARRIERS TO URBAN AGRICULTURE

The change in the concept of urban agriculture has been driven by social, political and economic factors, changing the role of agriculture in the urban environment. Urban agriculture might be important in reducing poverty within various communities, its limitation cannot be ignored (Lwasa; et al 2014). Such limitations can be associated with the production of crops and distribution systems where spaces are confined, risks, lack of staff involvement, and damage to infrastructure, including water shortages, are the key limiting factors identified in literature. Space, in the form of land, is an important factor in production (Smit, Ratta, & Nasr 1996). Urban agriculture is in direct competition with other urban land users for natural resources, the development of urban industries and the consideration of land in towns and cities. Therefore, there is a need for Urban Agriculture systems to acquire land for species for agricultural production. Urban markets are said to have expanded in sub-Saharan African cities due to increased remittances from settlements and used as places for foreign investment (Lwasa; et al 2014). In urban areas, especially informal settlements without proper housing, land boundaries, as well as lack of inclusion to city planning, have resulted in the creation of roads, roads islands, public open spaces, flood plains, around landfill sites and near railways (Lwasa; et al 2014). However, farmers use the technique of enclosing the area to cover the area by carving the available area around the buildings, especially for niche products. Therefore, high value vegetables, poultry and high productive livestock tend to be the enterprises in which urban farmers are investing (Smit, Ratta, & Nasr 1996). There are also other obstacles within the city that prevent them from becoming a sustainable city, and these include uncertainty about climate change, limited funding for rehabilitation programs and the attitude of the authorities who do not accept new ways of doing things (Smit, Ratta, & Nasr 1996). Studies conducted in the country of Ghana found that the urban agriculture sector faces several challenges such as difficult access to land for urban farming; inadequate access to water resources; lack of services and credit support; health and environmental issues resulting from using harmful pesticides and untreated organic waste and sewage among others; as well poor institutional frameworks supporting urban agriculture; despite its benefits portrayed in the environment (Drechsel, & Dongus, 2010). Finance is the major challenge preventing municipalities from taking actions against climate change and successful implementation of urban agriculture (Spires 2015). A study conducted in 2018 found that the biggest impediment to local municipalities in allocating funds for climate change action is because many municipalities across the country are working on zero budget which does not even cater for service delivery. Spires, (2015) found that half of the community population within South African metros, live below the poverty line or in

informal settlements without land titles (and therefore does not pay taxes). As a result, Tshwane is unable to cover the cost of basic services such as water and electricity. This leaves Tshwane unable to recover costs for basic services such as water and electricity. Vacant positions remaining opened for a period creating competency gaps for skills needed (Spires 2015).

2.8 CONCLUSIONS

South Africa is vulnerable to the consequences of climate change due to the number of variability (Spires, 2015). Climate Change is projected to cause drier conditions in Gauteng with an increase in mean annual temperature of $>0,2$ degree Celsius. So far South Africa has excelled in developing policies and laws that sought to ensure the use of, protection and conservation of natural resources in an equal substantial manner. As geared towards the 4th industrial revolution is no longer business as usual but rather be seen as a platform to adapt and transformational changes through innovation and technological advancement. The National Water Policy stated that Sustainable Water Management is an integral part of sustainable development meaning that it must provide for both present and future needs without compromising the ability of the next generation to meet their needs. To achieve sustainable water management, mixed approaches should be integrated into planning and development to address environmental, economic and social issues. The accessibility of good quality water is becoming less with projections that demand will increase by 55% in 2050. Water is crucial for upliftment of urban growth, mining industry, agricultural farming, and tourism. As such it is the driving force towards economic growth, reducing poverty and inequality. Freshwater management is no longer a local issue but rather a global phenomenon involving multiple role players to make informed decisions.

The next chapter describes the research steps, procedures and processes followed to collect data underpinning this study.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

The overall purpose of this study was to gain a deeper understanding of the role of urban agriculture in building climate resilience for the City of Tshwane. Qualitative methods in a form of semi-structured interviews and observation were administered to technical and management teams in the agriculture department. Kivunja and Kuyini (2017), define methodology as the approaches, procedures and flow of the systematic processes followed in conducting research to gain insights into a research problem. This chapter presents the research methodology, design, the study site, data collection tools/instruments, data analysis and interpretation, the ethical considerations and trustworthiness of the study.

3.2 RESEARCH METHDODOLOGY

3.2.1 INTERPRETIVE RESEARCH PARADIGM

Interpretive approach was established in response to the shortcomings and limitations of positivism in social sciences. Interpretive theory was applied based on Qualitative model (Kuzel and Like, 1991, Altheide and Johnson, 1994; Secker et al., 1995). From an ontological point of view, there are multiple realities or multiple truths based on the construction of reality. Reality is socially constructed (Berger and Luckmann, 1966) and so it changes continually. The central theme on which this paradigm is positioned is that people are fundamentally different from objects. On an epistemological level, there is no access to reality independent of our minds, no external referent by which to compare claims of truth (Smith, 1983). The researcher and participants are interactively linked so they can draw conclusions from each other in the context of the circumstances that shape the investigation (Guba and Lincoln, 1994; Denzin and Lincoln, 1994). The recognisable world is the world of meanings attributed by individuals.

Table 3.2.1.1: Characteristics of the basis of Interpretivism paradigm of social research

Ontology	Constructivism: the recognisable world is the world of meanings attributed by individuals
Epistemology	The goal is to understand individual knowledge
Methodology	Sympathetic collaboration between researcher and item being studied

Adapted from Gog, (2015). Source: partially adapted from Corbetta 2003, p. 14 and Della Porta/Keating 2008, p. 23.

This study chose to follow the interpretive paradigm to get an in-depth understanding of the importance of urban agriculture in building resilience and adaptation towards climate change in the city of Tshwane. Because the aim of interpretivist research is to gain in-depth understanding, it often requires the researcher to spend many hours in direct contact with those being studied, to be able to appreciate how they experience daily life and to get an understanding of what is meaningful and relevant to them.

3.2.2 QUALITATIVE APPROACH

Qualitative research is known as the approach used to determine how people view or experience the world, using qualitative research methods such as one on one interviews and observations. The choice of research method influences the way in which the researcher collects data as specific research methods also imply different skills, assumptions, and research practices. In this research. Kaplan and Maxwell (1994) argue that the goal of understanding a phenomenon from the point of view of the participants and its particular social and institutional context is largely lost when textual data are quantified. The motivation to do qualitative research for this study comes from the observation that, if there is one thing that distinguishes people from the natural world, it is our own views and experiences. Face to face semi structured interviews with agricultural development specialists, deputy directors and policy makers, were used to conduct this research to investigate a contemporary phenomenon on urban agriculture in building resilience towards climate change in the city of Tshwane.

3.3 EXPLORATORY CASE STUDY RESEARCH DESIGN

A case study is a qualitative research method which involves a detailed examination of the actual experiences of a real-life subject, which may be an organisation, community, entity, programme, or person (Yin, 2009). In most cases, a case study method selects a small geographical area or a very limited number of individuals as the subjects of study. Case studies, in their true essence, explore contemporary real-life phenomenon through detailed contextual analysis of a limited number of events or conditions, and their relationships (Fidel, 1984).

According to Fidel, case studies seem appropriate for investigating phenomena under the following conditions:

- (i) When a large variety of factors and relationships are included
- (ii) No basic laws exist to determine which factors and relationships are important.
- (iii) Factors and relationships can be directly observed.

Morgan and Smircich (1980) argue that the actual suitability of a research method, derives from the nature of social phenomena to be explored. Case study is not intended as a study of the entire organisation, rather its focus is on a particular issue, feature, or unit of analysis (Noor, 2008). A case study research design usually involves qualitative methods, but quantitative methods are sometimes also used. Case studies are good for describing, comparing, evaluating and understanding different aspects of a research problem. (McCombes & van den Eertwegh, 2019). To understand the roles of urban agriculture plays in building resilience towards climate change, exploratory case study approach was chosen. To explore the roles of urban agriculture in building resilience within the city of Tshwane, the following steps were used as introduced by Yin (2014, p.1)

1. The first step I followed was to plan and interpret the research question. According to Yin (2014, pp. 10-11), planning is the most important step in the research process. Every process within the research relies on planning to be successful, hence I choose a single case study to focus on. In 2012 Ilrion city, Nigeria discovered that climate change is the unspoken cause for low urban agriculture. Now this became an important case study for understanding the root cause of climate change and its effects on agriculture.

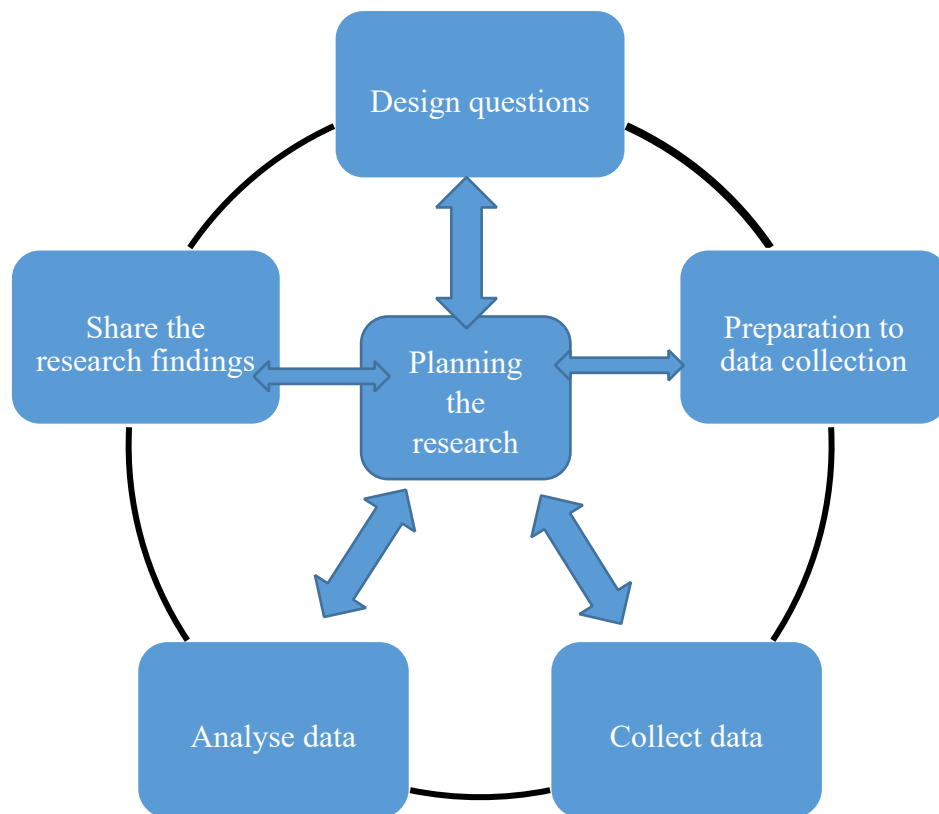


Figure 3.3.1.1: Single case study research design. Gog, (2015). Source: Illustration based on Yin (2014, p. 1).

2. Following the planning process was the designing of questionnaires for interviews relating to the case study design. According to Yin (2014, p. 29), the design stage comprises of the following components besides the research question:

(i) Propositions, (ii) elements of analysis, (iii) linking objectives to the research question, (iv) steps to interpret the findings. In this step the cases to be examined are specified resulting in a single case study design. (Yin 2014, p. 50).

3. After the designing of questions, I prepared to collect data for the case study. At this stage researcher must possess certain skills that are crucial to ensure that the researched data is valid and reliable and not unfairly prejudiced (Yin 2014, p. 76).

4. The fourth step was the collection of data. According to Yin (2014), there are six sources to collect data for a case study and these are the steps I applied for this study: documents, archival records, interviews and participant-observation. For this study semi-structured interviews were used (Yin 2014, p. 102).

5. The fifth step was to analyse the case study data. The importance of analysing case study data resulted in developing more analytical techniques such as codes and align those codes with objectives to come up with different themes (Yin 2014, p. 142-168).

6. Finally, the last step was to prepare a report and share case study findings to the relevant authorities. Textual and visual preparations must be done in order that the target group can develop their own conclusions. (Yin 2014, p. 176).

The method enabled me to understand the complex nature of urban agriculture policies into practice. Humans are engaged in a continuous process of interacting with their environment by acquiring, interpreting, and processing the information they receive, and in doing so, a new type of knowledge that will bring about changes in the field is generated (Morgan and Smircich, 1980). The study followed an interpretive paradigm to get an in-depth understanding of the importance of urban agriculture in building resilience and adaptation towards climate change in the city of Tshwane through a single case study.

3.3.1 SNOWBALLING SAMPLING TECHNIQUE

I began this process by attending a meeting with the Department of Agriculture personnel and during that process, I was able to identify three participants who were technical specialist in the field of agriculture. After that participant one walked with me and recruited three more participants, the same applied to participant number three. At that stage the researcher had just been appointed and was not familiar with different portfolios within the municipality, and it was going to be a challenge to come up with reliable participants, hence the snowball technique was chosen. Snowballing is not a new concept in research but has been informally used by Coleman (1958) and Trow (1957). Columbia Bureau of Applied Social Research has been using this method dated back to early 1940s under the leadership of Paul Lazarsfeld. The method involved primary data sources from nominating other potential primary data sources with interest in urban agriculture practices, policies and programmes within the Department of Agriculture and Rural Development. This included members of the technical team with specialty in Urban Agriculture, policy makers, Directors, and Deputy Directors.

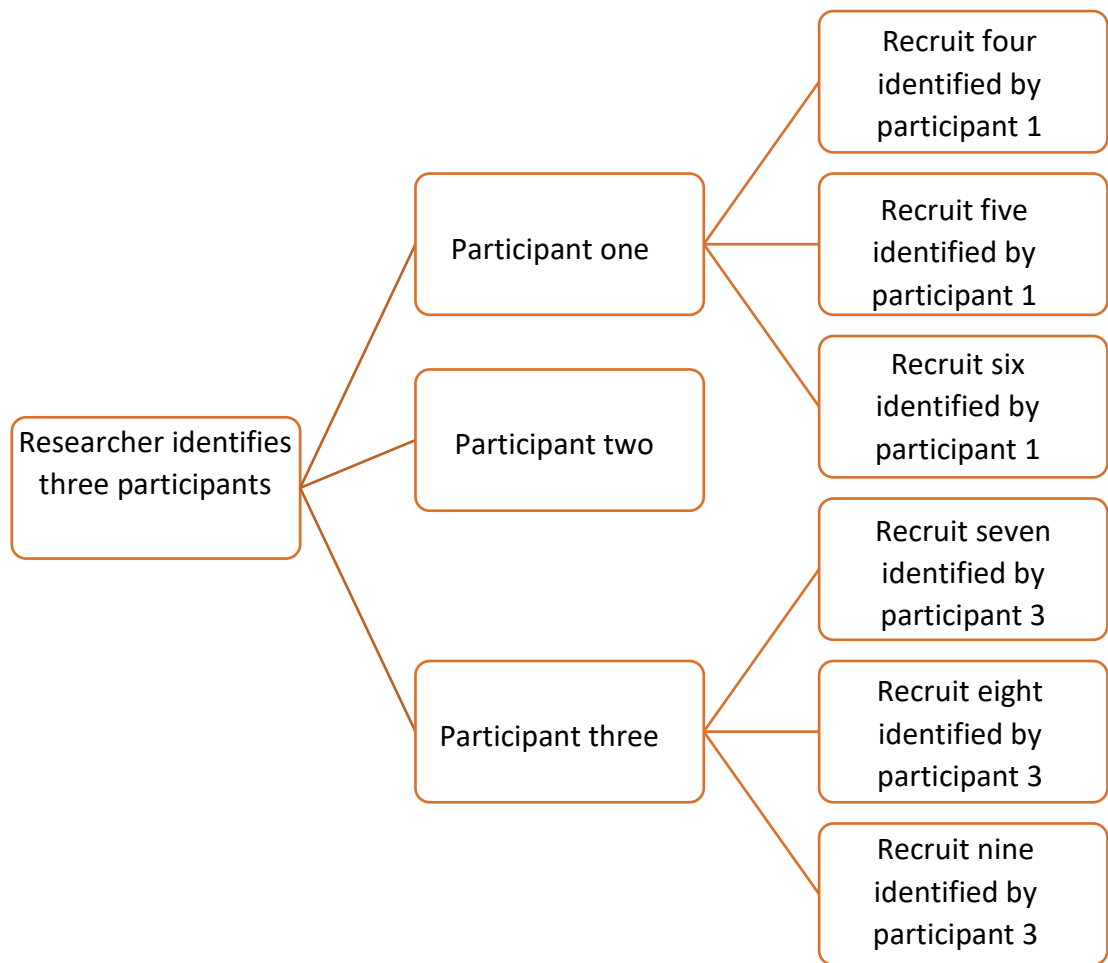


Figure 3.3.1.2: Snowball sampling diagram. Source: (Hendricks et al., 1992)

Snowball sampling also known as a “chain-referral”, or “networking” sampling occurs when the researcher begins gathering information from a small number of people and then requests, they put the researcher in touch with others who may be friends, relatives, colleagues, or other significant contacts (Etikan and Abubakar, 2016). According to Etikan and Abubakar, the initial subject serves as “seeds,” through which wave one subject is recruited; wave one subject in turn recruits’ wave two subjects; and the sample consequently expands wave by wave like a snowball growing as it rolls down a hill. Since the subject is used to locate the hidden population, the researcher does not have to invest money or time in the sampling process. Snowball sampling can be used informally to reach the target population. For this research, I interviewed nine different people with different jobs. The first five being agriculture development specialists, two deputy directors and two policy makers. Since the purpose of the study was qualitative in nature and aimed to gain in-depth understanding on the role of urban agriculture in the city of Tshwane, snowball sampling was the selected approach. (Hendricks

et al., 1992). Furthermore, snowball sampling is most often used to conduct qualitative research, primarily through interviews.

3.4 QUALITATIVE DATA COLLECTION

According to Higson-Smith and Bless (1995), there are three clear advantages of using individual interviews as a strategy for data collecting. First off, it is possible to conduct interviews with illiterate participants using this approach of data collecting. The responder does not need to be able to read or write because the researcher reads the question and records the answers. Second, if the researcher believes that the responder does not completely comprehend the question, the researcher could further explain the question or its terms. Thirdly, the researcher may ensure that all questions were addressed and that difficult ones were not omitted by using this data gathering technique. Semi-structured audio-taped interviews were conducted as part of this study throughout the months of June and July 2021. Semi-structured interviews were used as the primary technique for gathering qualitative data to provide participants the freedom to tell their stories in their own terms and to unearth topics and hypotheses that had not been foreseen at the outset of the study (Pope and Mays, 2000).

3.4.1 SEMI-STRUCTURED INTERVIEWS

Denzin and Lincoln (2003) states that, an interview took place when the researcher and the participants meet face-to-face to create a conversation. In qualitative research there are various types of interviews:

1. Structured: This is where the researcher uses a similar list of interview questions for all participants and does not turn away from the set questions (Research guide, 2017).
2. Semi- structured: A semi-structured interview is flexible, permitting new questions to be posed throughout the interview as an outcome of what the respondent said (Lindlof & Taylor, 2002:195). The researcher, in a semi-structured interview, usually has a framework of themes to be discovered. Lindlof and Taylor (2002:195) enhance that during the interview, a researcher asks a respondent question(s), based on a written list of questions and topics.
3. Unstructured interviews: This is where the researcher may use several ordinary main questions but is mostly free to change the discussion in any way, according to issues that may come up.

Semi-structured interviews are described as interviews in which the interviewer asks important questions and probes for further information in (Arthur and Nazroo, 2003). Semi-structured interviews, as contrast to unstructured interviews, offered a more organised method of interviewing to guarantee subject coverage while letting participants use their own words to explore and find new areas (French, 1993). The semi-structured interviews gave me the chance to investigate and explain replies while encouraging each participant to take the initiative and craft their own story because they included numerous broad questions about certain subject areas (Rubin & Rubin, 1995). Most participants were office bearers and technical experts who spend most of their time in meetings and site visits conducting field work, so it was imperative to conduct one-to-one interviews instead of focus group. Semi-structured interviews were conducted at an interval of three days after another. The interview schedule consisted of 32 questions which were administered to 9 participants from relevant Department within the Tshwane Metro were interviewed during the period of July - August 2021. Since we were in the middle of Covid 19 pandemic only 9 participants agreed to be interviewed. Before the commencement of the fieldwork, a brief explanatory statement was emailed to the departmental head to seek permission and explaining the reason for the invite and why it is important for that section to participate in the research. This was followed by site visit to the Tshwane house to introduce myself and the intended purpose for the visit. This was crucial for me as I was able to meet with possible participants in person. Permission was granted upon producing an explanatory statement, low risk ethical clearance forms and permission to conduct research study letter (see annexure i-iv) obtained from Human Resources Department city of Tshwane.

All interviews were conducted in English and audio recorded to capture what was said during the interview. This was also to assist the researcher to stay focused and maintain eye contact during the interview and can act as a follow up monitoring tool at a later stage where further clarity is needed. The following approach was followed as adopted by Dahlgren and Fallsberg (1991) and Sandberg (2000),

1. Audiotaped personal interviews - the researcher transcribed and typed the data into a computer file to analyse it after interviewing (Creswell, 2013). This was to allow for more consistent transcription. For this research I audio taped all conversations, and two languages were used Sotho and English to accommodate every participant.
2. Verbatim transcription - Every word on the recording including false starts, relevant repetitions, and grammatical errors was transcribed as is, including grammatical errors and false starts. However, extra details like stutters and repetitions were removed. This

was done to get transcripts that are true to the recording yet uncluttered by unnecessary detail.

The interviews were aimed at gaining a deeper understanding of the role of urban agriculture in building climate resilience for the City of Tshwane. The findings were gained from the insight and experience of 9 participants, using scheduled semi-structured interviews as a research tool. Expert interviews are favourable when seeking insider knowledge and group interview techniques are ideal for generating a large amount of information rapidly (Bernard and Ryan 2016).

3.4.2. ANALYSIS OF DOCUMENTS

Document sources were also used to supplement and compliment other methods. Documentary evidence acted as a method to validate information gathered from interviews and observation. In addition, for the purpose of this study, documents provided guidelines that served as an enquiry tool during the interviews. These documents were in the form of urban agriculture policies, city of Tshwane bylaws, media releases and internal press releases, books, and journals.

3.4.3 OBSERVATION

Observation, as the name implies, is a way of collecting data through observing. This data collection method allowed me to immerse myself in the setting where the participants are, while taking notes and/or recording. While conducting the interview I took note of watching, listening, reading, and recording behaviour of the participants to later interpret it into verbal and nonverbal response. Advantages of observation data collection method include direct access to research phenomena, high levels of flexibility in terms of application and generating a permanent record of phenomena to be referred to later.

3.5 QUALITATIVE DATA ANALYSIS

The process of describing, categorizing, and connecting phenomena with the researcher's concepts is known as qualitative data analysis (Graue, 2015). Qualitative data analysis has the following general aims (i) describe a phenomenon in some or greater detail comparing several cases on what they have in common or on the differences between them, (ii) develop a theory of the phenomenon under study from the analysis of empirical material (Flick, 2013). Field notes, interview transcripts, documents, films, and the like are created because of conducting

interviews or gathering data (Dey, 1993). According to Miles and Huberman, who are quoted in Berg (2006: 304), there are three main methods for analysing qualitative data.

1. Interpretative approaches: Where interviews and observational data can be transcribed into written text for analysis.
2. Anthropological approaches: Where the researcher has conducted various sorts of field or case study activities to gather data; and
3. Collaborative social research approach: Researchers operating in this mode work with their subjects in each setting to accomplish some sort of change or action.

There are guidelines for analysing quantitative data, but there aren't any clear guidelines for analysing qualitative data (Bryman and Bell, 2011). In accordance with the four essential processes of qualitative data analysis I data collecting, (ii) data reduction, (iii) data displays, and (iv) conclusion drawing/verification) (Graue, 2015). Every researcher engages in data analysis as a multifaceted process to make sense of the data: dissect it, examine its elements, determine its significance, and interpret its meanings (Patton, 1999; Bailey, 2007). The final dissertation on the contribution of urban agriculture to fostering climate change resilience in the city of Tshwane was produced with the use of the data analysis conducted for this study. The titles for the study findings were produced using the following techniques to develop significant topics. Below steps were followed to create meaningful themes that were developed into headings for the research findings.

3.5.1 FIRST STEP TO ARRANGING DATA

Data was collected using audio recorded semi-structured interviews. The researcher transcribed and typed the data into a computer file to analyse it after interviewing (Creswell, 2012). This was to allow for more consistent transcription (Dahlgren and Fallsberg, 1991). Verbatim transcription, every word on the recording including false starts, relevant repetitions, and grammatical errors was transcribed as is (Sandberg, 1994). However, extra details like stutters and repetitions were removed. This was done to get transcripts that are true to the recording yet uncluttered by unnecessary detail (Dahlgren and Fallsberg, 1991).

Data analysis took place during and after every interview and was modified throughout the study where necessary. The researcher familiarises themselves with the content of each interview, by reading and revisiting transcripts. Condensation of text was used by the researcher to explore and analyse collected qualitative data, such as interviews, observations, and documents.

Comparison and grouping of similar statements were used to analyse data so that aggregate function could be added to summarised data by displaying a subtotal for each group.

Categorisation of similar statements to describe the meaning of the theme and offer a method on theme construction that can be used by qualitative content analysis and thematic analysis in line with the underpinning specific approach to data analysis was undertaken (Krippendorff 1980), this is important in analysing themes, finding meaning of themes, categories, in terms of level of content, and theme development. Responses that were found to vary were analysed and identified into key words and phrases that can be used to validate references regarding the data (Krippendorff 1980). Analytical statements that represent theory generated on urban farming practices and their functions in this study were used to report the process' outcomes. Key problems were identified after each data creation, and various sources were continuously compared in accordance with newly developing categories. The goal of the analysis was to make the data more understandable and comprehensible so that the relationships between the research problems could be examined, validated, and conclusions reached.

3.5.2 DATA CODING

Data may be organised, prepared, and made usable for analysis by being coded (Burnard et al., 2008). Coding is a process used in the analysis of qualitative research, and the following steps were followed in this research: (i) reading through the data and creating a storyline; (ii) categorising the data into codes; and (iii) using memos for clarification and interpretation. Coding was done to ensure that observation and interview conclusions were reliable (White and Marsh, 2006). The researcher was able to make deductions from the coded data and report the findings (Zhang and Wildemuth, 2009). The analysis' main goal was to look at connections between various topics (White and Marsh, 2006). The core function of the analysis was to examine relationships between different themes (Burnard et al., 2008).

The first step in coding was to transfer all the collected data into a spreadsheet. The spreadsheet was divided into different columns according to the participants. I started highlighting data line by line using different colours ranging from red for a different code, yellow for a different code and green for a different code. Key words like vegetable gardening, food production and awareness were highlighted as to the fundamental ideas for the study. A total number of six colours were used. Concepts with different meaning and related to each other were grouped

together. As this continues different codes started emerging which were then developed into different themes in response to the aims and objectives of the study.

3.6. LIMITATIONS OF THE STUDY

A possible limitation of this study was the sample size. Only 9 participants participated in the research interview. During the selection process of participants, the researcher noted that some employees from department of Urban Forestry and Parks and Horticulture, were not willing to participate because they perceive urban agriculture does not fall within their area of responsibilities. Only one section within the Department of Rural Department participated. Other employees felt the interview questions were too long and therefore they cannot participate. Interview scheduling took place during the Covid 19 pandemic, and most employees, especially office bearers were working remotely from home.

During the interview process, participants in the executive positions would pause the interview for some minutes or postpone to the next day. This was due to the nature of their work. Interviews were conducted in a conducive environment within the Tshwane house in personal offices or boardroom. This had a negative impact on time management and scheduling of interviews especially to those in executive positions. The City of Tshwane comprises of seven regions and within each region urban agriculture is practiced in one form or the other. Interviews were only limited to technical experts, management and executives within the Department of Agriculture and Rural Development. It would have been idealistic to see all regions participated as well as farmers themselves. This would have yielded positive results that could have impacted research outcomes.

3.7. TRUSWORTHINESS OF THE STUDY

Ritchie, Lewis and Elam (2003) state that, traditionally the term "validity of findings" has been used to describe the accuracy or precision of the research reading. According to these authors, the validity of findings is traditionally understood to refer to the correctness or precision of the research reading. In this study it will refer to the extent to which the researcher understood and interpreted the research data. It was of the outmost importance to reflect the views of participants as is and clarify that the data transcripts reflected their full views (Ritchie, Lewis and Elam, 2003).

The combination of two methods of data collection assisted in ensuring trustworthiness of the data collected for this study. Semi structured interviews and documentary sources in the form of policies, press release and internal communications about urban agriculture and climate change extracted from the city of Tshwane website were used together to increase credibility for the study. Therefore, there was a need to integrate different combinations of methods to collect accurate and useful data.

3.8 ETHICAL CONSIDERATIONS

Considering the nature of qualitative studies, the interaction between the researcher and participants can be ethically challenging as it involves people engagement in different stages. Before the initiation of field work, a low-risk ethical clearance forms, explanatory statements and consent forms were obtained from MSA research committee. (Refer to appendix i-iii of the research document). To maintain confidentiality, participants were identified by coded alphabets that does not reflect their real names. In addition to that, permission to undertake research was also obtained from research unit within the city of Tshwane to maintain the anonymity of participants and to ensure continual control of research documents (refer appendix iv). Before every interview commenced, participants were further reminded verbally that the interview is voluntarily, and they have the right to withdraw at any time and all proceedings were audio recorded for further analysis.

3.9 DESCRIPTION OF THE STUDY SITE

According to Section 4 of the Local Government Municipal Structures Act, 1998 (Act 117 of 1998), the Municipal Demarcation Board has designated the City of Tshwane as a Category A municipality Jeeva (2019). Several municipalities and councils that had previously serviced the greater Pretoria region and its environs were combined to become the Municipality on December 5, 2000. (Modisane et al.; 2019). On May 28, 2008, a proclamation published in the Government Gazette further altered the city's boundaries by including the old Metsweding District Municipality, which included Nokeng tsa Taemane (Cullinan) and Kungwini (Bronkhorstspuit), within the city's boundaries (Mokebe, 2018). Following the local government elections in May 2011, the city of Tshwane was officially incorporated. This was done in accordance with the Gauteng Global City Region Strategy, which aims to reduce the number of municipalities in Gauteng by the year 2016. The region was expanded to span roughly 6 368 km² when the places were included. This is realistically explained by the fact

that the Metropolis, at the time, was the third-largest city in the world in terms of geographical size, after New York and Tokyo/Yokohama, stretching over 121 km from east to west and 108 km from north to south (Stats SA, 2011). In addition, it covers more than 30% of Gauteng's 19 055 km² area. The city's economy is thriving and varied, allowing it to contribute at least 26,8% of the GDP of Gauteng Province and 9,4% of the GDP of the entire country.

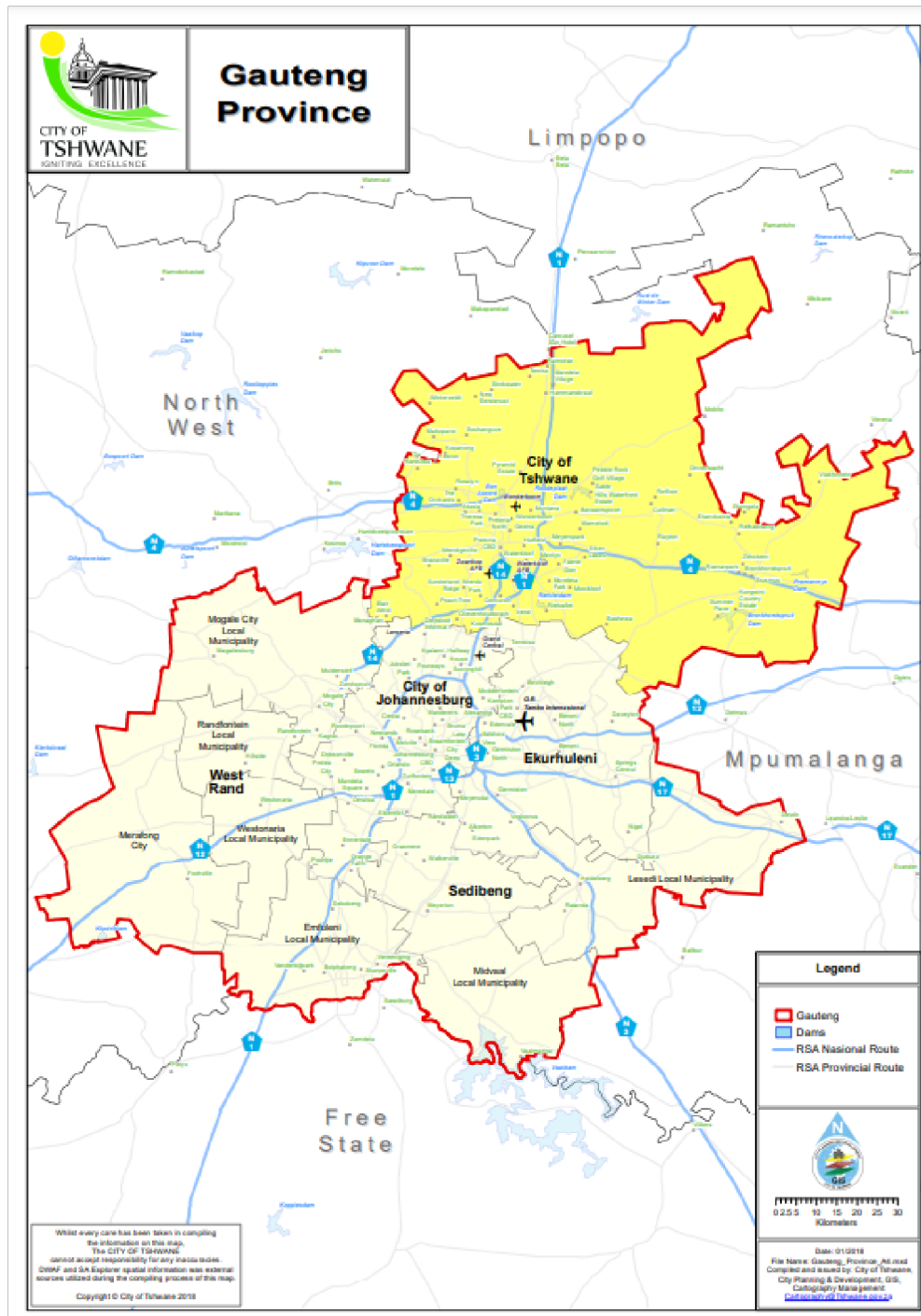


Figure 3.9.1. https://www.tshwane.gov.za/sites/about_tshwane/MapsAndGIS/Pages/General-Maps.aspx

According to Section 8(g) of the Municipal Structures Act, Act 117 of 1998, the city of Tshwane combines a mayoral executive administration with a ward participation system. It has 214 elected council members (107 ward councilors' and 107 proportional representation councilors'), 107 geographically defined wards, and little over 3, 3 million citizens. It is split into seven regions for administrative needs and to improve service delivery. City of Tshwane has established itself as a pioneer on the African continent in providing inexpensive industrial sites, a variety of industries, office space, and educational and research institutions in addition to serving as the seat of government and hosting many Embassies. In Tshwane, organizations like Armscor, the Medical Research Council, and the Council for Scientific and Industrial Research, the Human Sciences Research Council, and academic institutions like the University of South Africa, the University of Pretoria, and the Tshwane University of Technology carry out an estimated 90% of all research and development in South Africa. The city, however, acknowledges that anthropogenic climate change is a big issue that the world is presently confronting since it is already having an impact on all facets of human existence and will continue to do so in a negative way from an economic, social, and environmental standpoint. To strengthen its resistance to the effects of climate change and progressively lower its own contribution to global warming, the city strives to be a model African municipality.

All activities associated with cultivating crops, horticulture, animal farming, animal husbandry, veterinary services, forestry, logging, the creation of organic fertilizers, and fishing operations are included in the agricultural sector. Even though it contributes little to the region's output and the GDP of Tshwane, Region 7 boasts some of the best agricultural land in Gauteng. With 4.5 percent, area 7 contributed the most to GVA in 2015, followed by region 2 with 1.7 percent. Region 7 is designated as an agricultural area because it contains a large amount of arable land, of which more than 80% is utilised for raising crops and cattle, but it also has water shortages.

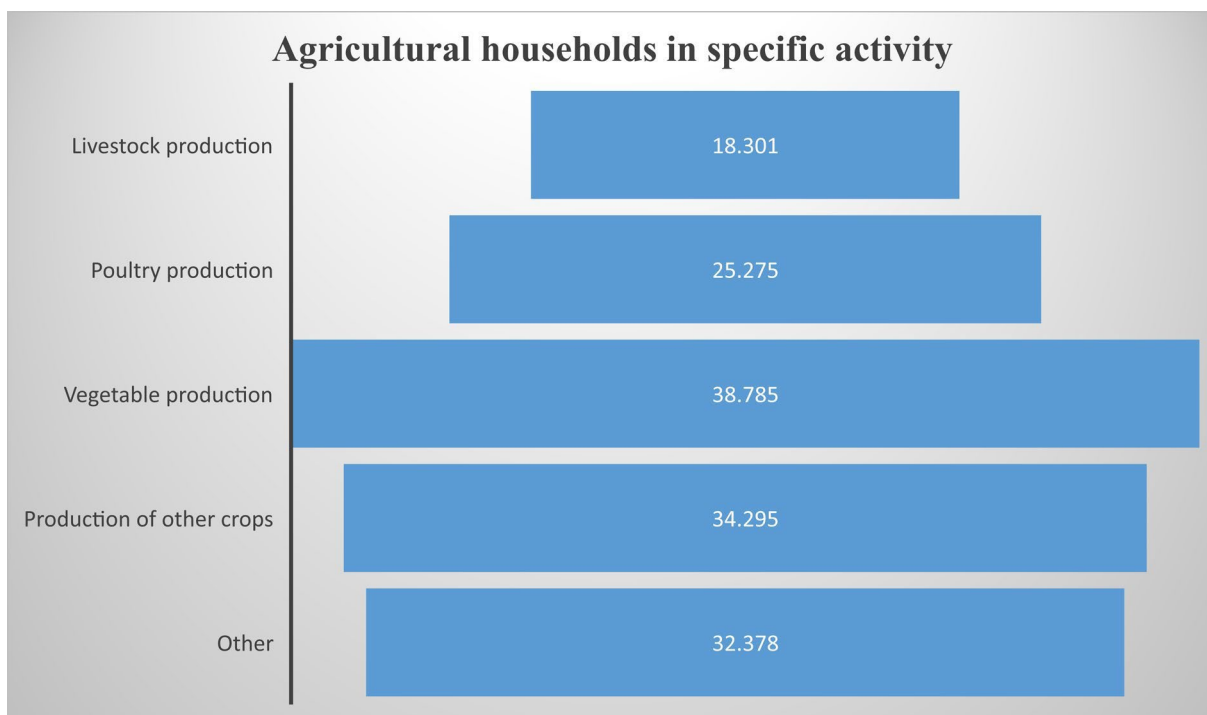


Figure 3.9.2. An agricultural household may engage in more than one agricultural activity.

Source: (Stats SA, 2011)

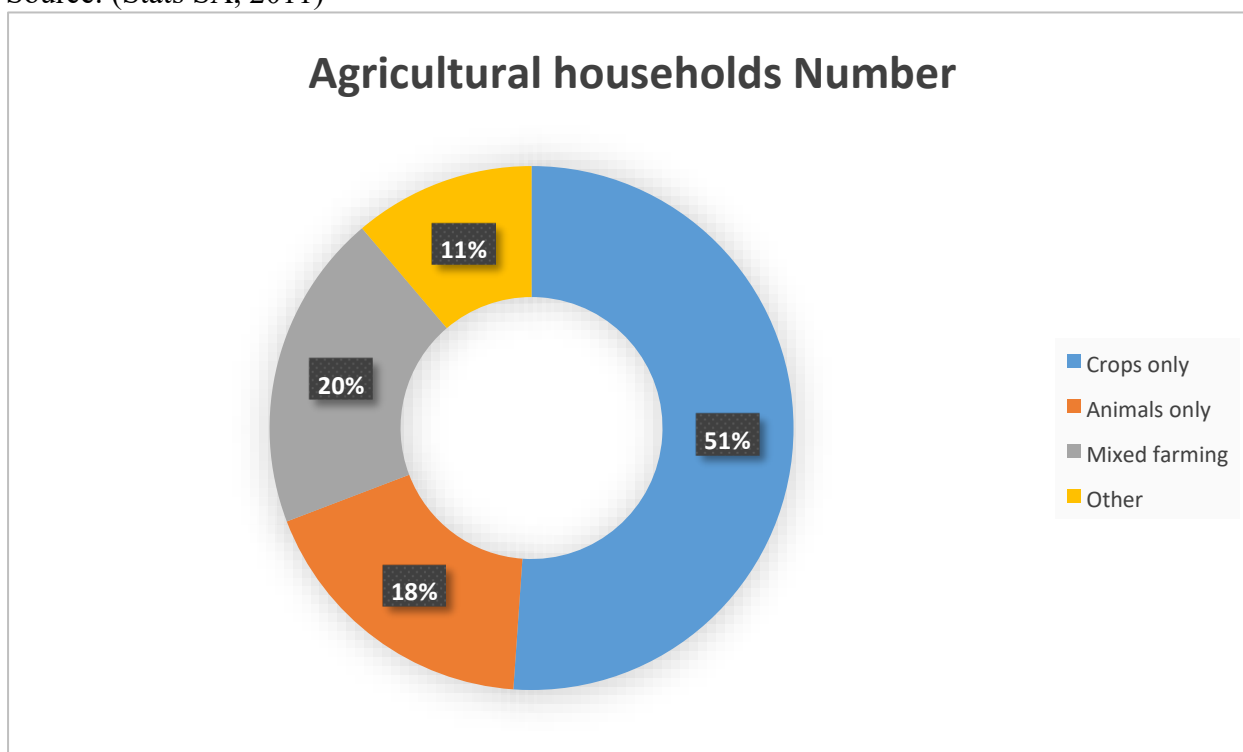


Figure 3.9.3. An agricultural household may not fall under more than one agricultural activity.

Source: (Stats SA, 2011)

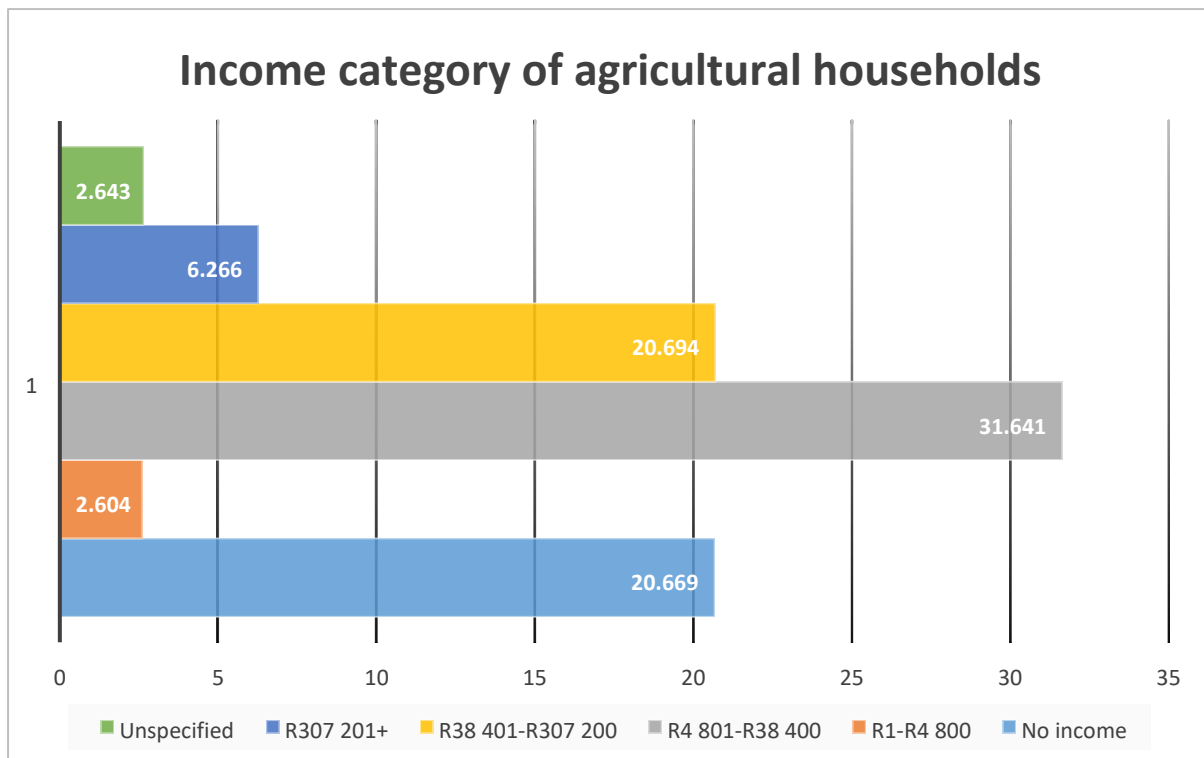


Figure 3.9.4. Annual income category of agricultural household heads. Source: (Stats SA, 2011)

3.10 CONCLUSIONS

This chapter included a general summary of the research's methodology and the methods utilised for data collection, recording, and analysis. Background information for the study and the choice of tools for data collection were chosen through extensive semi-structured interviews and a description of the study region. The research's results will be presented in the next chapter to follow.

4. RESEARCH RESULTS

4.1 INTRODUCTION

This chapter seeks to present the results of the study. It provides an analysis of the data to highlight research findings. After the data gathering, classification, ordering and narrative presentation of the data was undertaken. The findings were gained from the insight and experience of 9 participants, using scheduled semi-structured interviews as a research tool (see annexure v).

The study aimed at gaining a deeper understanding on the role of urban agriculture in building climate resilience for the City of Tshwane.

The chapter presents the findings to answer the following research questions:

- 1 To establish the status of Urban Agriculture practices in the city of Tshwane.
- 2 To describe the Urban Agriculture practices among managers at the city of Tshwane.
- 3 To determine factors influencing the implementation of Urban Agriculture policies in the city of Tshwane
- 4 To understand the impact of Urban Agriculture policies on building resilience in the city of Tshwane
- 5 To recommend ways of improving urban agriculture practices to assist policy makers in making informed decisions to respond to climate change.

Table 4.1.1. Position and designation of key informants

Participant	Position / designation
Informant 1	Specialist Sustainable Rural Enterprise Development
Informant 2	ARD Specialist
Informant 3	ARD Specialist
Informant 4	ARD Specialist
Informant 5	Deputy Director Department of Agriculture
Informant 6	Deputy Director of the Climate Change Unit in the Climate Change and Disaster Management directorate
Informant 7	Scientist Manager Department of Agriculture and Rural Development
Informant 8	Crop Production Specialist

4.2 Status of Urban Agriculture practices in the city of Tshwane

4.2.1 Urban agriculture exists in the City of Tshwane

The study established that urban agriculture exists within the city of Tshwane. All participants confirmed that they were actively involved in the urban agricultural activities in the various communities around the city of Tshwane. Every participant mentioned vegetable gardening and farming practices are used throughout the city in spaces such as schools with the main aim to save space and containing soil erosion. All participants were able to give a response, which is a good indication that agricultural practices are (i) widely practiced (ii) familiar to everyone and (iii) there is variation of practices which means that the city has made climate change a priority. For example, one of the informants indicated that,

“We are implementing climate change programmes, policies, and projects in accordance with the National Climate Change Response Policies. And our sector climate change sector plans, strategic framework, programmes, and projects. Their mandate is not specifically for the City of Tshwane, district, or municipality level but our focus start at national level and in terms of protocol implementation start at a national level and in partnership with relevant stakeholders and agencies and provinces. The province must cascade to the municipality level”. Informant Mat

However, most participants in this study were not aware of the actual policies, yet the existing ones known to participants were informed by the National Development Plan (NDP). This can also be used to show that some participants might perceive urban agriculture and climate change as exclusive of each other. In terms of the type of Urban Agriculture practices, the study revealed that crops (9) were the most prevalent with one livestock and one chicken farming throughout the various regions. Limited to number of livestock and chicken farming practices were due to lack of advancement in technology. While some farmers did not have sufficient land for urban farming, those who had space, as mentioned earlier, focused on chicken farming, and livestock farming with limited quantities, this was specifically mentioned for Rooiwal area. For example, two of the informants stated that:

“We have bylaws in the city they limit what can be done around the communities. When it comes to poultry or livestock, they need to be done far from communities they limit the numbers for example with chicken you need to have 20 chicken which limit the number of productions. At least what is doable is the vegetables”. Informant K
“Open land agriculture (irrigated) and rainfed agriculture. Through innovative

agriculture such as hydroponics, tunnels, shade nets, vertical and roof gardening”.
Informant Fa

Crop production was practiced using innovative technologies such as hydroponics, tunnels, shade nets, vertical, Agriparks and roof gardening were the most common. Vertical space and bag techniques were used because of lack of space or open land to plant the crops. Technologies being used in the Agri-parks development include tunnels and greenhouses that are aligned to environmentally friendly products. In terms of footprint, the urban agriculture is a national practice, with customised technologies for the various areas nationally. Innovative technologies such as tunnels, shade nets were opted as they tend to protect crops from harsh climatic conditions. Poultry is the major livestock that was under urban agriculture, while vegetables are the most common crops. On the overall, there are vibrant urban agricultural activities going on in the City of Tshwane. Most participants acknowledge how climate change impacts the environment which helps us identify the need for urban agricultural practices that will combat it.

4.2. Legislative Framework

4.2.1 Urban Agriculture policies to address climate change problems within the city of Tshwane.

Some participants were not aware of urban agriculture policies to address climate change in place, however acknowledged that there are overarching strategies that deals with climate change. For example, one of the informants indicated that:

“Rural Development Strategies that has many sections in it. It includes most of the things we have then we have the strategy that deals with Agriparks are those projects that closely address climate change and issues like in-house production of vegetable in a tunnel on different levels. Bigger strategy Agricultural Rural Development”.

Informant EG

Those who responded to have knowledge about the current policies in place were found to be the main custodian of the policies working within the Department of Agriculture. Two of the informants observed that:

*“Food security strategy and Food and Security implementation strategy. Informant Fa
Ours is not responding to climate change but to food security we have programmes of urban agriculture related to farmer support programmes”. Informant C.*

The followings points were inferred from the documentary analysis:

1. The city of Tshwane Agriculture Policy and Development Strategy was developed in 2008, with the main goal to eradicate hunger and poverty in light with the Millennium Development Goal 1.
2. Integrated Food Security Programme was approved in 2009 with the purpose to fight poverty, build clean, healthy, safe, and sustainable communities. Section 2 (2.3) on the problem statement of the policy acknowledge that, though maize, sorghum, sunflower and wheat are not produced locally by the municipality, it is equally affected by the global trends on the use of these crops for biofuels. This can only highlight the linkages between urban agriculture practices and its impact on climate change.
3. Tshwane Integrated Environmental Policy (TIEP) was passed in 2005 towards sustainable development and the protection of the environmental resources of the area.
4. Agricultural Pests Act, 1983 (Act No. 36 of 1983). This Act provides for measures to prevent the introduction and establishment of pests. The act ensures that import of controlled goods is done in such a way those exotic pests and diseases are not imported and established in South Africa as well as preventing their spread to other countries. This legislation has both environmental and economic impacts by minimizing risks posed by possible spread of pests and diseases, and thus protection of the agricultural from adverse effects of these pests and diseases.
5. Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983). The Act provides for the control over the utilization of the natural agricultural resources of South Africa to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants. This legislation has environmental impact by promoting sustainable use of natural resources to ensure long-term productivity of the plant production sector.

Though climate change is not clearly defined within the Department, its impact has compelled the need to raise awareness using policies as guidelines that influence proper implementation and efficient use of resources in terms of agricultural practices that are resilience and adaptable to climate change and be able to respond. Tshwane municipality has embarked on various

greening projects around the city such as Sustainability week, Greening economy and strategic framework as highlighted in the table below.

Table 4.2.1.1. Greening projects for the city of Tshwane

YEAR IMPLEMENTED	NAME OF THE PROJECT(S)
January 2013	The City Sustainability Unit is established to guide the transition to a green economy and to promote city sustainability
July 2013	the Green Building Policy and Bylaw is promulgated rendering City of Tshwane the first municipality in South Africa to gazette such a bylaw
August 2013	the city launches its Strategic Framework for a Transition to a Green Economy
November 2013	first phase of the supply of free Wi-Fi services in strategic public places such as tertiary institutions and schools
December 2013	request for Information (Expression of interest) on Green Economy interventions issued
March 2014	a sod turning for the establishment of a multi-purpose Material Recovery Facility to be supported by a separation at source programme in regions 3 and 4.
June 2014	City Sustainability Unit unveils its Tshwane Green programme aimed at all raising sustainability awareness among all city stakeholders
July 2014	The Carbon Footprint for 2012/13 Financial Year is announced and a social vulnerability assessment undertaken.
July 2014	City of Tshwane is announced as the most livable city by the Gauteng City Region Observatory.
October 2014	first ever Tshwane Green Ride, a 30km family fun ride from Mamelodi to Rietondale and back to demonstrate benefits of cycling and connecting diverse localities.
November 2014	City of Tshwane announced as 70th member of the C40 joining as an Innovator City, a category reserved for cities that have shown leadership in climate action.

Despite these initiatives and several policies being developed within the Tshwane municipality, there is still a gap in the linkage and successful implementation of those policies with respect to different portfolios and integrated into operational requirements of the business units (Houng Li, 2015).

4.3 Resilience building goals of Urban Agricultural practices within the city of Tshwane.

Cities, which now host most of the global population, are vulnerable to environmental and socio-economic disturbances, which are likely to increase in number and severity soon. Urban agriculture (UA) could serve as a platform to improve food production, while increasing better chance of the city to withstand lots of pressures and acute shocks. This will assist in improving food security and public health, creating social imbalance, and promoting cost cutting.

Most participants explained the resilience building goals of Urban Agricultural practices and policies within the city of Tshwane as follows:

- ✓ To keep the farmers numbers up and make sure that the produces are of quality.
- ✓ Contribute to suitability via economic, social, and environmental aspects.
- ✓ To improve food production and produce more.
- ✓ To addresses food security, and
- ✓ Protect the environment.

During the interview, three resilience goals were highlighted as the main emerging ones and were outlined below as follows: production, economic and environmental.

“Not to destroy our infrastructure and protect the environment”. Informant MP

“Is to make sure that people food is secured and access to food in urban areas because they don’t have enough land and farms in urban areas the idea is to provide enough food for people”. Informant C

“To keep the farmers numbers up and make sure that our produces are quality and to make sure that we meet the quantities needed by the market”. Informant M

On the production goals, participants indicated they were targeting the best quality and volume to enable food security for communities. Due to the high unemployment levels in South Africa, and insufficient farming land, participants indicated that urban agriculture was key for food security in communities and at schools. According to Stats SA (2022), second quarter report, the official unemployment rate was 33, 9% in the second quarter of 2022. The City of Tshwane

was also said to be behind with rural development, thus urban agriculture helped to backyard gardens.

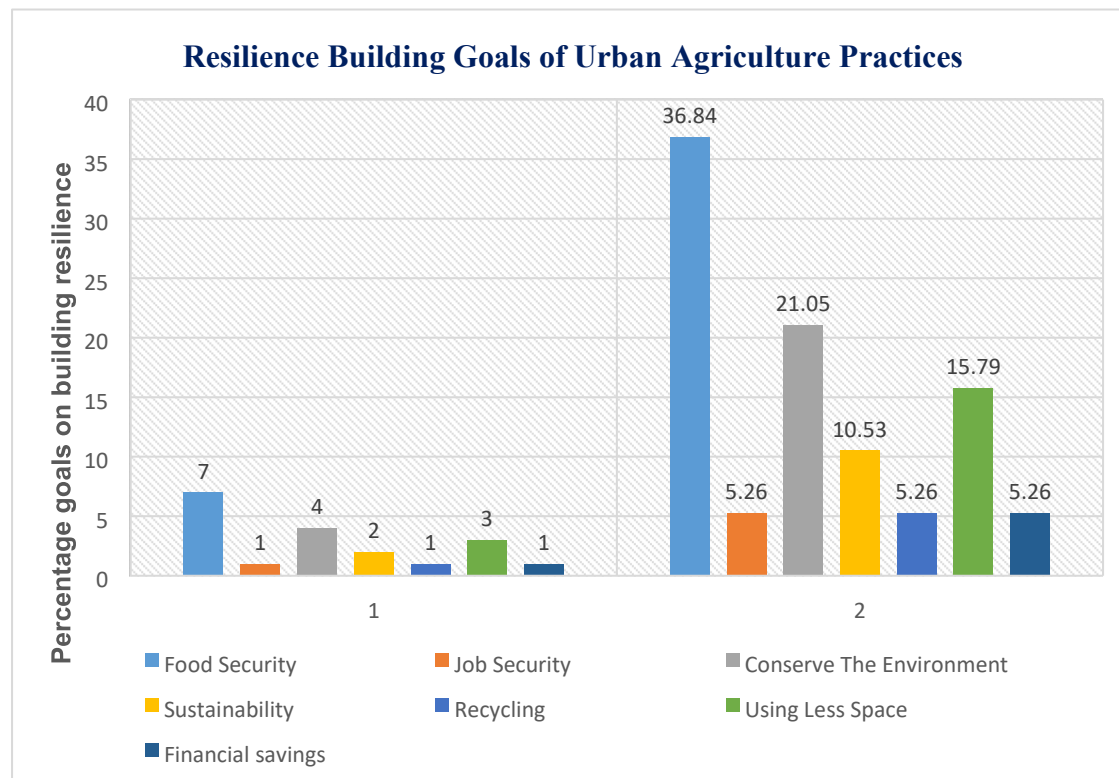


Figure 4.3.1. Resilience building goals of urban agriculture in the city of Tshwane.

Urban agriculture contributes to sustainability through economic, social (poverty alleviation) and environmental aspects (conservation and preservation) as well as recycling and reducing food wastage. Food production is the main contributory factor to healthy lifestyle and social welfare of the society. On the other hand, unhealthy food are the main cause of non-communicable ailments and related deaths worldwide. Thus, having a resilience system for urban areas to ensure continual supply of fresh nutritious food to urban areas without interruptions in accessing enough nutritious food for urban populations in the face of disturbance as a fundamental part of resilience. Urban agriculture is crucial in the sense that it can help improve systems that use less resources to create food given the limited amount of productive land and the challenge of the country's limited resources, such as water. Make use of strategies that are resilience and preventative action should include water sensitive urban designs to promote climate resilience agriculture and ecosystems.

4.4. Climate change problems associated with the development of Urban Agriculture policies.

While some informants indicated that they were not aware of climate change problem associated with urban agricultural activities, others affirmed that flooding, extreme temperatures, and pollution were major problems. For example, those who affirmed observed that:

“For us is maximum rainfall, flooding, at some point it affected the tomato production. Some crops do not need a lot of water”. Informant M

“Sometimes the weather is too hot and cause high mortality rate and when it is too cold, we make the heaters it increases the bill electricity”. Informant MP

“We do have a problem of inconsistency work. You will find that issue of pollution. How does application of fertilisers impact on the development of urban agriculture? How does climate change affect urban agriculture? Informant Fa

Extreme weather conditions such as too much rain associated with flooding are directly linked to urban agricultural practices, where too much rain poses a threat to crops at their seedling stage and can cause severe damage, or at harvesting stage of tomatoes which is also harmful to tomatoes because they require a lot of water. One of the participants revealed that he is not aware of any climate change problems associated with the development of urban agricultural practices but view climate change as a phenomenon that happens over a period. This revelation was captured in the following quote:

“Not aware because climate change is a phenomena that happens over a period of time for example in a practice where we have poultry, piggery and cattle farming which produce a lot of waste which contribute to climate change not in urban farming and hydroponics that emits a lot of gases through their heating systems”. Informant C.

According to Bulkeley, H (2012), the impacts of climate change are not spread evenly, but rather occur in a particular location, such as those prone to flooding or drought, and affect different groups of society in radically different ways, depending on their capacity to cope with, and adapt to, risks. With thus, the implementation of climate change programmes, policies, and programmes in line with the National Climate Change Response Policies helps in mitigating the adverse effects of climate change. Study conducted for South African municipalities on the

review of climate change resiliency found that prolonged dry periods, followed by heavy downpours, exacerbated by increased temperatures and sea levels, are set to present new challenges for municipalities across the country. For example, dry periods experienced by the Western Cape with no rain for months, severely limiting water supplies in urban areas. According to the Department of Environmental affairs, the central part of the country will experience dry conditions which are likely to cause water scarcity along the northern and southwestern regions (DEA 2013a). As a result of these projections, city developments are seen under enormous strain which compelled the need for interchange between urban, agricultural, and industrial use (DEA 2013a). Although the linkages between urban agriculture and climate change are complex and indirect, the effects and variability are felt through changes in the natural ecosystems, land capability and land use systems. Given the powers, and their democratic mandate as the local level of government, municipality such as city of Tshwane can therefore be seen as in a position to address the challenges of mitigating and adapting to climate change.

4.5 Urban Agriculture practices among managers at the city of Tshwane

4.5.1 Urban Agriculture roles and responsibilities shared amongst employees in the city of Tshwane.

There are four key levels of responses used by managers to carry their duties for urban agriculture activities in the city of Tshwane. Two of the informants indicated that:

“We have different levels of authority. We have field worker and supervisor and then the report back to the director”. Informant TR

“It depends on the level of your qualifications and your expertise”. Informant MP

In terms of responsibilities, each official was allocated a region (7) given responsibility for school gardens, backyard gardens, community gardens and farmers under the supervision of a supervisor. Participants indicated that roles and responsibilities are depended on several factors, geography, job level, educational level or one' profession. As such, there were varying levels of authority, ranging from field workers and supervisors with reporting lines for accountability to the director. According to one informant:

“They are shared based on specialisation of the individuals like in my case I am dealing with production of crops; we have someone dealing with skills development because with policy development then comes implementation and people to be trained. Research unit to prove that things are doable and working and skills transfer”.
Informant EG

Meetings and workshops were being held, with pamphlets distributed on farmer’s day every month to update them on any new activities. On specialisation, participants indicated that production and manufacturing, processing, harvesting, infrastructure development, market access specialists played a role in the urban agriculture value chain.

4.5.2 The champions behind the design and implementation of Urban Agriculture practices and policies

Champions were described as government, NGOs, beneficiaries, or private sector. As observed by some informants:

“As a department all technology we use are from the private sector or Agricultural Research Council (ARC). There is an engineering department called Agricultural Research Council in Silverton most of the technologies used comes from there or Department of Land and rural Development. Informant M

We work with different stakeholders like Provincial, Department of Agriculture and Rural Development and National Department. NGO Ranyaka. Informant TR

As the City of Tshwane, we work with various stakeholders like Department of Agriculture and Rural Development, ARC for new innovation to comply with climate change and research institutions. Informant RU

Table 4.5.2.1: Stakeholders behind implementation of Agricultural Practices and policies

Government	Civil Society	Market
International	NGOs	Farmers Association
National	Non-profit Organisations	Private actors
Regional	Funders	Funders
Local	Educational Institutions	Vendors
Government-led Organization	Individuals	Distributors
Government led Institution	Volunteers	Entrepreneurs

Farmers take initiative and the city officials give technical advice and communities also make use of services and initiatives supported by the different stakeholders such as the private sector. Department of Land and rural Development and the Agricultural Research Council (ARC) were mentioned as key stakeholders in the supply of technology equipment used for urban agriculture. Government departments were involved at both provincial and national levels. At provincial level, the Department of Agriculture and food security unit were actively involved in urban agriculture projects to address food security issues for subsistence at household level. At the metropolitan level, support was being rendered through the sustainability office, working at the schools' gardens, homestead gardens together with NPOs in instances. Urban agriculture is not a mandate for the City of Tshwane, but they rely on various stakeholders to supply all technology needed to implement Urban Agriculture practices. As such government relies on end users which are the farmers in terms of implementation at national and local levels. Therefore, there is growing recognition of urban and peri-urban agriculture (UPA) as an important strategy for climate change adaptation and mitigation, to a lesser extent. Metropolitan, municipal, and other local government institutions can play a proactive and coordinating role in enhancing urban food security and cities resilience by:

- ✓ Integrating urban food security/UPA into climate change adaptation and disaster management strategies
- ✓ Maintaining and managing agriculture projects as part of the urban and peri-urban green infrastructure
- ✓ Identifying open urban spaces prone to floods and landslides and protecting or developing these as permanent UPA/multi-functional areas
- ✓ Integrating UPA into comprehensive city water(shed) management plans.
- ✓ Including UPA in social housing and slum upgrading programmes
- ✓ Developing a municipal urban agriculture and food security policy and Programme

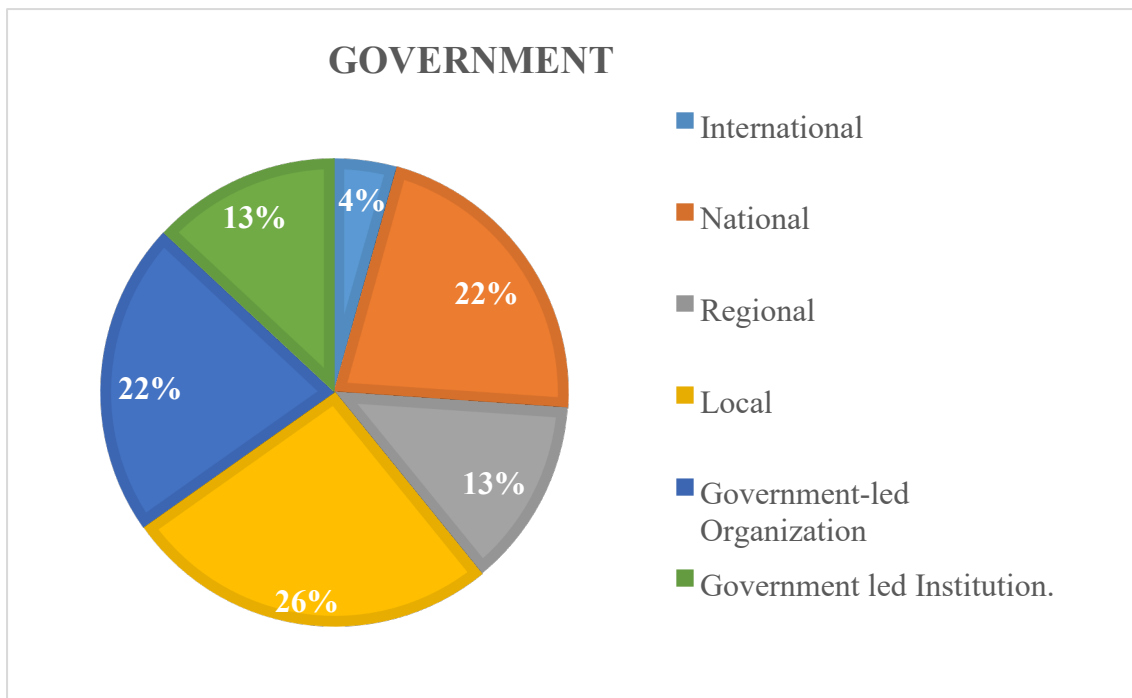


Figure 4.5.2.2 government related stakeholders in the city of Tshwane

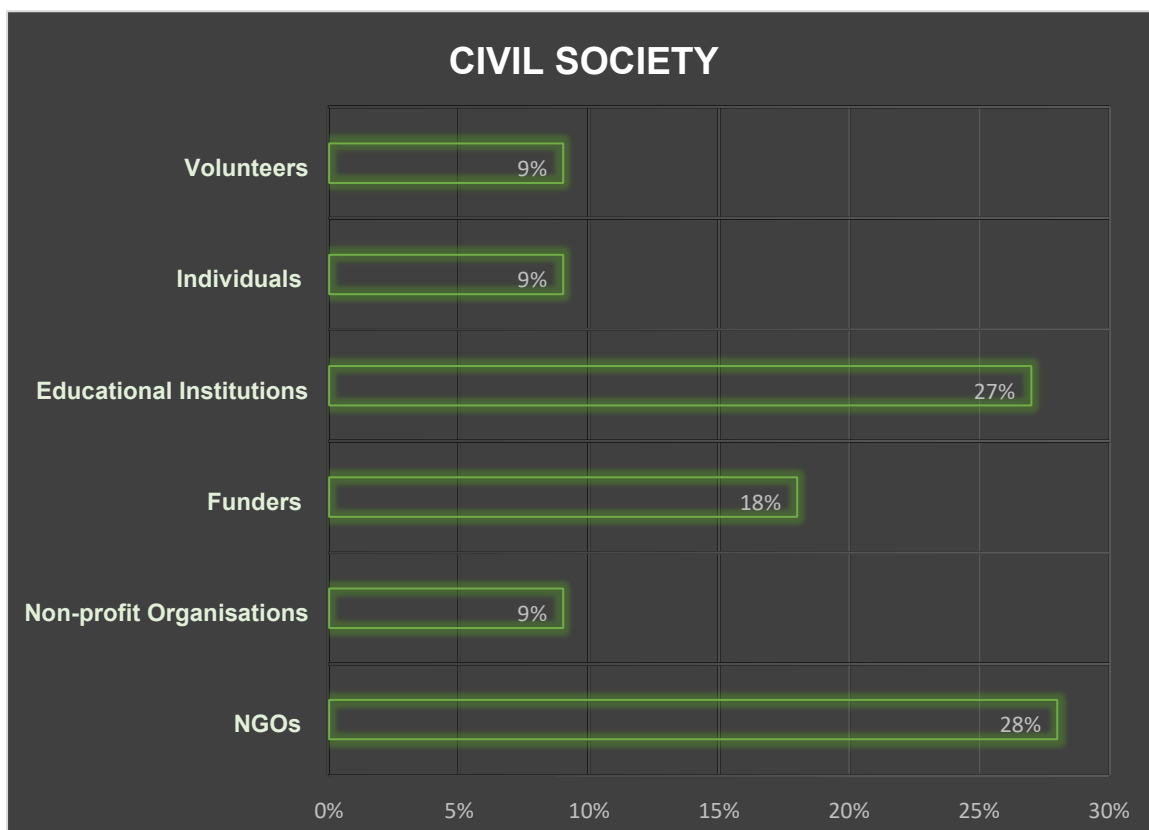


Figure 4.5.2.3 civil society stakeholders in the city of Tshwane

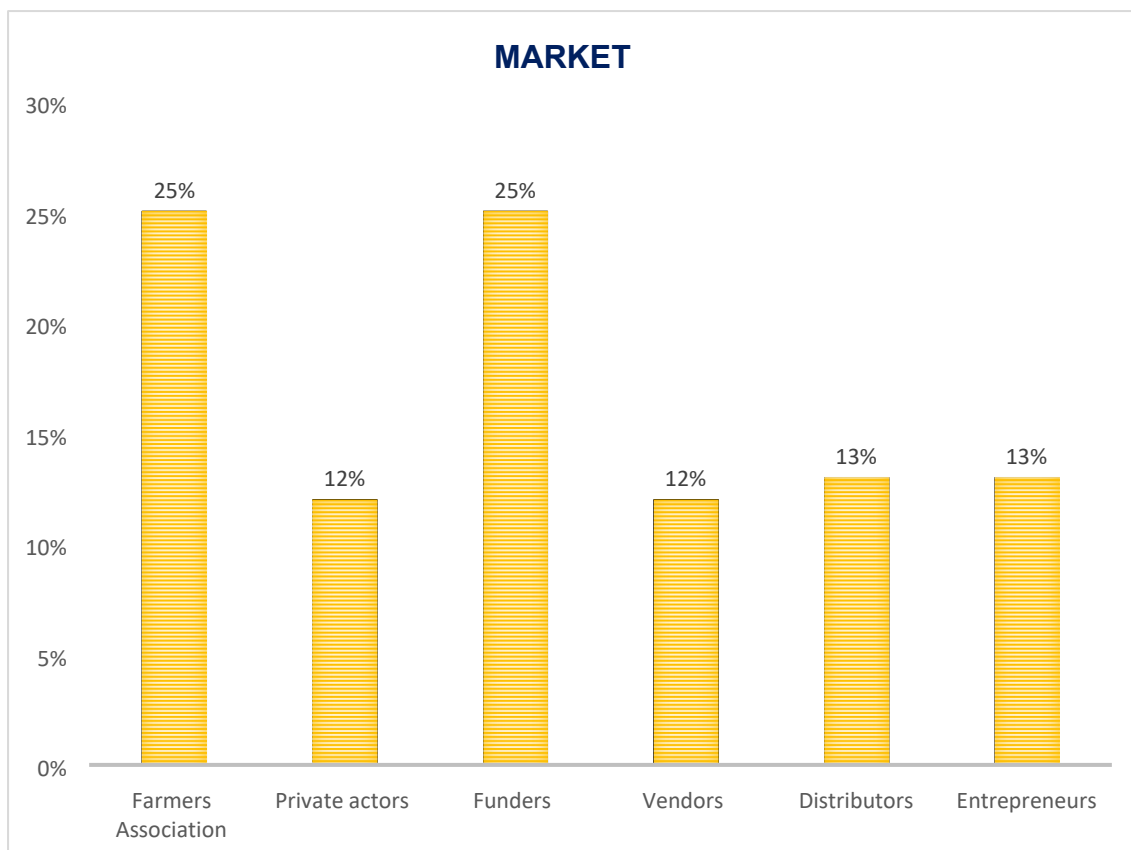


Figure 4.5.2.4 Champions behind the development of urban agriculture

4.5.3 Unit or section is responsible for the development of Urban Agriculture policies within the city of Tshwane.

There were processes in place for the development of urban agriculture policies through internal departments or government departments. As observed by two informants:

Farmer support section which is a wing section. Informant M

Department of Agriculture, Land reformed and Rural Development. Informant Mat

Internally the farmer support section, was also involved in the development of policies. It is commendable that participants indicated that urban agriculture policies are developed within the stakeholder framework. The internal farmer support section works together with their allied government departments like Ministry of Agriculture, Land Reform and Rural Development (DALRRD) at provincial and national levels in the process.

4.5.4 Processes being followed during the initial stage of Urban Agriculture policy development.

Participants in this study stated that there were several processes involved in the initial stage including verification of vacant land by Agri-park, Environmental Impact Assessments, Obtain the zoning certificate, approval, and making the funding application. According to two informants:

The first step when an Agri-park has to be identified a report is written to the Mayoral Cluster Committee first we must establish that the land does not belong to the municipality if it does we get the zoning certificate and should states what function the land is made for and a letter I sent to Mayoral Cluster Committee for approval and application for funds will follow if the budget is approved the EIA, It's EIA (Environmental Impact Assessment) has to be done before you can do any agricultural activities, especially on virgin land will be done followed by water testing and soil testing. Informant M

When the need arises, we put a report for approval, engage with relevant stakeholders, followed by consultation with local government led by the speaker and submit to mayoral committee. Informant Fa

Participants described the application process as involving a series of steps, including assessing ownership of the identified piece of land with appropriate steps, engagements, and consultations as well as approvals. These steps are crucial in ensuring land is not unlawfully grabbed, a common and complex phenomenon which has caused public uproars against the government in South Africa (Sauti & Lo Thiam, 2018).

4.5.5 Mechanisms to ensure urban agricultural policies are implemented in the City of Tshwane

Key mechanisms mentioned by participants to ensure urban agricultural policies are adhered to. These include setting up internal communication, stakeholder engagement sessions, monitoring and evaluation exercises as well as putting in place standard operating procedures. Therein, participants indicated that they shared messages on internal departments' communication platforms like WhatsApp groups. Farmers were also given observation forms to monitor if they were following procedures, as well as the engagements with farmers during site visits and debriefings. Internally, the City of Tshwane had an annual performance plan for

all employees with key performance indicators measuring how many projects, programmes, outputs for each employee. Two informants indicated that,

After public engagement there is issues of advertisement for a period of three years after that then the other group will come in on a contractual basis that is circulated to benefit everyone. Informant EG

Implementation guidelines. Communicate with the implementers regularly and main challenge is the means of implementation like resources is not always there. Informant RU

4.5.6 Ensuring Urban Agriculture policies are properly addressed or communicated.

While one Informant indicated they were not ware, it was mentioned that the communication was done with a specific focus, and through stakeholder engagements. Two of the informants suggested that:

Before strategies are finalized it needs to be presented to different stakeholders for inputs and farmers needs to be informed. They need to be consulted. Informant K

Consultation with public. Agricultural events with famers and study groups presentation on how people they can participate, operate, and get access to make use of structures and farmers day. Informant EG

The targeted communication was done during farmers' days and workshops, for input and during the monthly meetings with farmers. Consultation sessions with the public were also done, study groups presentations, and during other agricultural events with famers. The different role players within the department would conduct these communication sessions.

4.5.7 Section or department responsible for the communication of Urban Agriculture policies

There was a consensus among participants that internal departments were largely responsible for these communication drives. Wither the Policy and research unit, sustainability section, the Internal Communication department, and one Informant mentioned the department of agriculture.

4.6 Policy implementation

4.6.1 How information regarding the implementation of Urban Agriculture practices is analysed.

Participants in this study were not aware of the processes involved in ensuring the implementation of the urban agriculture policies. According to two informants:

Internal policy and development and not sure how It's done. Informant M

By interact with them and advise them and on job observation. Informant K

All Informant where not aware of how the analysis process of urban agriculture practices was done.

4.6.2 How these results communicated and distributed within the city of Tshwane.

All participants indicate that there was an internal reporting system used. For example, two of the informants observed that:

Send report to the managers on different levels like weekly report will be gathered and sent it to the immediate supervisor and end of the month will be consolidated into monthly or quarterly reports and assessed to check progress. Informant EG

Well, there various method of communication via emails, telephone engagement. Informant Mat

Confidential internal reports were being done by specialist in the form of a C9 report, sent to directors, and to the managers on different levels, weekly report and later consolidated into monthly or quarterly reports and assessed to check progress. These internal reports were also shared with the provincial government, for structured support, monitoring and evaluation. The results would be communicated within specified timeframes, monthly, quarterly, bi-annually, annually or in instances, after some meetings. These results would be documented or archived on internal computer platforms, on the Q drive an internal software or in booklets or manuals.

4.6.3 Measuring performance standards pertaining to Urban Agriculture policies

Performance standards were done using a performance management system. For example, two of the informants revealed that:

Each and everything there are set goals per quarter like visiting four community projects and report back to address the gap. Informant TR

Measured based on set targets. Monthly reports and SDIP reports. Informant RU

There was a performance agreement and set targets which were reviewed every quarter with the supervisor responsible for the respective community projects and s/he would also give inputs on those projects. The indicators that would be designed in a way to enable effective engagements in terms of quality and quantities, in consultation with the respective subordinates.

4.6.4 How are the tested results used in decision making?

All participants could recall how the results were used in decision making, mainly as a progress checking tool. For example, two of the informants suggested that:

They do assist when we have meetings in terms of progress to date. Informant M

If there is a room for development like starting a poultry farm all necessary information needs to be factored in. Informant TR

The results were used as a guideline on performance reviews and ongoing programmes, and in monthly progress meetings. They also aid as progress measuring tool comparing previous results with current results and judge the rate of progress. Results influence action planning and timeline measurements on projects to help minimize unproductivity.

Let's take previous year they were using certain technology and after getting the results or outcome of the results they will be able to improve or reduce it can be used as a measure to see if we are going forward or to improve on what we are having or if we need to change something to be more successful. Informant EG

The study found that tested results serve as reference for many issues that may occur and set the standard for the expected work results. Overall results offer a guideline for performance reviews for future projects.

4.7 Monitoring

4.7.1 Describe how Urban Agriculture policies are currently controlled and monitored.

Standard operating procedures and performance management systems were used to monitor urban agriculture policies. Specialist working in community with farmers would be involved together with the beneficiaries.

Our policies are being monitored and evaluated as per the policies within the policy there is an M&E and the review. Section that talks as to when the policy will be reviewed whether is a five- or ten-year period but since things are changes and technologies the review is done as and when required. Consult with end users.
Informant C

4.8 Factors influencing the implementation of Urban Agriculture policies in the city of Tshwane.

Participants highlighted more (6) negative factors than positive (3) factors influencing the implementation of urban agricultural policies.

4.8.1 Positive factors

Positive factors include market proximity, market access and stakeholder engagements.

Factors that best support is the provincial they offer training, workshops and technical support. Informant M

Participants in this study indicated that they had sessions to solicit responses from farmers and their buy-in so that they understand what is expected from them and adapt easily. Farmers as beneficiaries also underwent training which helps them improve their knowledge. In urban areas, the availability of urban space is a limitation, due to high demand from housing and sanitation needs, the city of Tshwane was also promoting knowledge and information dissemination through agricultural hubs and partnerships with universities. This enables human capital resources to be available within the community which is also the market. The World Resources Institute (2014) pointed out five principles of good governance towards successful implementation of climate policy, effective information sharing can contribute to the attainment of three, namely, policy coordination, transparency, and stakeholder engagement, the other two being clarity of role and responsibility, and institutional capacity.

4.8.2 Negative factors

Several negative factors were identified as deterring the implementation of urban agriculture, including financial constraints, lack of resources, vandalism, misaligned priorities, unclear policy, and lack of training. For example, according to several of the informants:

We don't dwell too much on chicken farming because of lack of technology to resilience to climate change. Informant Fa

Vertical space and bag technique due to space constraints or open land if there is space. Only farmers who qualified are exempted to get space. Informant TR

Availability of funds and human resources and availability of land and buildings. Uptake of technology by the users and vandalism of infrastructure and load shedding. Informant C

Finance will hinder processes for example in the city Agriculture is not prioritized. Informant M

“Lack of knowledge and responsiveness around of climate change issues” is a major factor resulting in poor strategic planning of agricultural policies (Ampaire et al., 2017). Because of their inability to articulate climate change issues, local officials can struggle to obtain finance from non-government sources (Ampaire et al., 2017). This understanding was enlightened in the following statement by one of the informants:

When you advertised the programmes then you find appointed people don't have financial knowledge on how to run the projects. The provincial office supports the projects with funds on production inputs. So, to support those farmers that comes into the projects and Government will only support for a short period of time afterwards the farmers find it difficult to continue on their own. When farmers don't have money and many skills in terms of financial management to continue with the production on their own. Informant EG

Participants in the study indicated the limitations of urban agricultural space, which were being optimised on spaces like 10x13 meters tunnel and innovative structural technologies like greenhouses were utilised. While poultry farming is one of the widely practiced urban agricultural activity, Wahyono and Utami (2018), observed that technologies for urban agriculture were very limited. Poultry meat is one of the most affordable protein sources, providing healthy meals for the majority of South Africans (Silva et al., 2022). It is therefore important that technology prospects be sought to support research and innovation for poultry urban agricultural activities. Other institutional challenges included lack of coordination, capacity constraints and lack of knowledge and expertise. According to (Smith et al., 2009), having politician supporting urban agriculture projects is a milestone to overcome bureaucratic

resistance and risk aversion in confronting complex problems like climate change. In the end, the sporadic climate change had caused the City of Tshwane to review its mitigation strategies against climate change, more often than expected. The lack of finance would hinder the programmes planned for urban agriculture, and participants had a perception that urban agriculture was not prioritised by the City of Tshwane. This is because there was said to be no finance budget to implement the strategy and urban agriculture in the city was regarded as a responsibility of national departments thus not priorities. Financial capacity emerged as a major determinant of successful policy design and implementation, with indirect impacts on institutional, informational, and technical barriers (Adger et al., 2007; Biesbroek et al., 2013; Phuong et al., 2018). This caused some misalignments of priorities and expectations. Urban agriculture is not a mandate for the City of Tshwane, but they rely on various stakeholders to supply all technology needed to implement Urban Agriculture practices. As such government relies on end users which are the farmers in terms of implementation at national and local levels. Further, participants highlighted the lack of clarity on policy pertaining to Urban Agriculture and that departments were working in silos, with lack of uniform communication across the organisation. Lack of resources was caused by load-shedding and vandalism of infrastructure in the communities, and farmers who were short staffed. While livelihoods had less access to organic materials, they relied on fertilisers due to proximity to firms. This had a negative impact on the environment as they cause environmental pollution.

4.9 Benefits of Urban Agriculture practices

The major advantages identified were close proximity to market, technology uptake, education and training, environmental sustainability, economical, and resource utilisation. According to most of the informants, environment greening like planting trees, was important aspect of urban greening rather than having bare land as it assists in preventing soil erosion:

When you do a policy, you want a people to change. Benefits can bring a lot in terms the way people perceive things and the way of reducing cost because nowadays in the modern days we are looking at innovation it can save a lot on terms of saving cost. In terms people gaining knowledge and skills and capacitated new approaches or strategies and if we talk climate change, we talk about the environment and see people reducing carbon emissions or footprint. Informant Mat

Food security at an umbrella level. You use technology (agricultural innovation like maximise urban space to competing needs. Application of promote recycling use

recycled water and compost. It teaches you to apply Best Agricultural Management Practices. Informant Fa

They have more impact because in Soshanguve the farm is in township where people can reach easily and buy quality produce without even spending petrol, so the farms are within reach. Informant M

Participants alluded to the use of the latest technology for urban agriculture, at the farmers' exposal to learn and grow their businesses for improved food production and optimising the available space. City of Tshwane relies heavily on urban agriculture for perishable goods such as green vegetables, poultry, and dairy products, by doing so the urban poor can improve their access to nutrient-dense food and the nutritional value of their diets by growing their own food and raising livestock. With proper implements, communities were able to carry out their urban agricultural activities correctly saving the available water courses. Urban agriculture was also important for food sustainability, poverty alleviation as locals would produce for own consumption and sell the excess to close by markets. Food security at an umbrella level, compels the need to use innovative technology such as green houses to maximise urban space and to accommodate other competing needs such as housing. Urban agriculture was found to be viable in promoting Best Agricultural Management Practices such as water recycling and convention of brown and green waste materials into compost. The current farming methods also allowed farmers to be able to produce all year round regardless of the current production season.

4.10 The impact of Urban Agriculture policies on building resilience in the city of Tshwane

The impact of urban agricultural policies in building resilience was on economy, education and training, misaligned priorities, and environmental sustainability. This understanding was captured in the following quotes from informants:

Because crop production is forever fresh fruits, food production reduces food insecurities within the community. Informant EG

The impact is complex because the beneficiaries are not the ones that are losing you only see when you remove the starting point. The farmers do not really benefit. Informant C

It something that you can see over time and will guide you to make quick changes and might change the way we do things and adapt to new ways. Informant Mat

Urban agriculture was said to be important to address food security and creating job opportunities, especially in townships where there is a high level of unemployment. Urban Agriculture programmes were effective over time in giving people knowledge, helping to alleviate poverty, uplifting local farmers thereby reducing food insecurities within the community. The programmes were designed to guide communities to be able to make quick changes and adapt to changing environments. On the other side, urban agriculture was also described as complex phenomenon due to its challenges not being prioritised by the city of Tshwane. Nevertheless, sudden change in climate change exacerbated by climatic variability trigger meteorological hazards such as drought which will require adaptation to enhance resilience in the production of food and taking into consideration the need to act timeously and respond quickly. Urban agriculture can also help with the long-term management of green open spaces, water courses, risky land, and other unsuitable land for development. Ongoing agricultural support programmes designed for local communities were found to be the driving force for encouraging farmers to ensure continual food supply. This was done to improve food production, secure job opportunities and efficient use of space to address environmental conservation and sustainable use of natural resources. Urban agriculture innovations were found to be powerful instruments for the adaptation and minimising the effects of climate change.

4.11 The role of Urban Agriculture practices in building resilience to climate change in the city of Tshwane

The importance of urban agriculture on resilience was described in line with efficiencies in resource utilisation, economic, technology uptake and environmental sustainability. For example, according to some of the informants:

One of the reasons is food security like people need food and people don't have jobs and they are finding way to take care of their families by producing their own food. Around communities there are open spaces where people use them as dumping site. And people will use those spaces fruitfully. Informant K

I think is very important that the environment we have is the only one and we must that we take care of it and use it sustainably for future generation whatever we do we must do we do it without compromising for tomorrow. Informant RU

There are different practices that we encourage our farmers or beneficiaries like for examples most will opt to use chemicals or fertilisers. So, we encourage them to use manures and when it comes to pest control, we encourage them to use IPM. Rather than identifying a pest and use a chemical look at other measures that can be put in place in order to control the pests. Informant M

It was acknowledged that the City of Tshwane was facing challenges of high unemployment, in line with national trends, where people did not have jobs and they were finding it difficult to take care of their families. To address food security and unemployment, ongoing agricultural support programmes for local communities and rural development, to ensure good quality produce and enough quantity needed by the market. Thus, urban agriculture would assist to increase crop production volumes. The programmes were also aimed at cushioning farmers against losses. Urban agriculture also solved the issues of open spaces that were occasionally used as dumping sites, thus protecting the environment, and reducing strain to the ecosystems. Due to the limited space available for urban agriculture, the programmes relied on vertical farming, roof top, and planting in pots. Other roles that urban agriculture played were recycling the soil, use of hydroponics systems to control climatic variation so that crops are not damaged. Furthermore it has assisted in saving water for crop production using growing media under controlled environment. Farmers were encouraged to use bag planting techniques, tyre filled with soil, pest control with IPM, organic manure, recycling old materials to make compost, subsoil, kraal manure and poultry manure to ensure farmers or beneficiaries would use less chemicals or fertilisers. There was minimal technology required to reduce entry barriers. All these practices are ideal fundamental factors to food security and sustainable food production because food is produced continuously throughout the year in a controlled environment while mitigating climate change. The available policies were also enablers to focus on the key result areas such as institutional arrangement, education, adaptation, and staff capacity resilience. Key result areas such as adaptation at all spheres of the government helped to increase awareness and create capacity to ensure that urban agricultural practices were being promoted and implemented properly.

4.12 Influence of climate change policies on the management of Urban Agriculture projects within the city of Tshwane

The influence of climate change policies was on limited resource utilisation, education and training, optimum production, economy, and efficiencies. Most of the informants indicated that:

It has affected highly. We have vast amount of land in Agriparks that we use to use to produce in open land but since we have global warming, we have to use spaces that are protected. Within tunnels or shade nets is not easy to use open land anymore because you might lose your crops. Informant M

Our policies are there to guide the efficient use of resources also the infrastructure in terms of our policies they influence implementation so that there is proper planning because if we talk resilience when we talk adaptation polices must be properly planned and implemented. Informant Mat

Only to brief farmers about climate change for example excess use of fertilisers deplete the environment. Informant K

Policies in the city would guide the efficient use of resources and infrastructure to influence the implementation of proper planning on adaptation for resilience. There were also programmes on agricultural practices for plants that are resilient to climate change, crops that are adapted to climate change and the appropriate infrastructure to respond to climate change particularly water management like recycling, harvesting and storage of water. Cities, which now host most of the global population, are vulnerable to environmental and socio-economic disturbances, which are likely to increase in number and severity soon. Participants in this study indicated they had to use spaces that are protected, within tunnels or shade nets, brief farmers about climate change to ensure continual food supply regardless of the season and to raise awareness on the efficient use of resources. Urban agriculture (UA) could serve as a platform for continual food production in the urban areas to withstand intense pressure and severe shock to enable the resilience of cities food security and public health, building social investments, and promoting circular economies.

4.13 Ways to improve urban agriculture practices to respond to climate change.

Several approaches were suggested by informants in this study on ways to respond to climate change like education and training, environmental sustainability, clear policies, and suitability of programmes. For example, according to some informants:

If we experience the problem first get to the bottom of the problem, root cause analysis and come up with the solution. Informant TR

We can have urban projects but not have budget. Like in Soshanguve we have Agriparks where we build tunnels, irrigation system so it can be done in all areas as long as there is enough budget. Informant RU

We have a programme compatible to a particular area like for example spinach production and cabbage in open land in urban areas we design to accommodate the dynamics of that particular environment so that it will determine whether to go for vertical design or hydroponics. Informant C

Through training and understanding, farmers and communities would be empowered by extension and advisory services with new trends on limited use of mechanisation, minimal use of chemicals and fertilisers, and ensure that the programmes are aligned with target communities to be able to work on them. The city bylaws were stricter on the farming of livestock such as cattle and chickens, stipulating what can be done within walking distance from the communities. For example minimum of 20 chickens produced within that range, making it easier to accommodate vegetable farming. The availability of a finance was also mentioned as a key enabler for urban agriculture. The study also discovered that the agricultural strategy needed to be reviewed as well as the food security strategy.

4.14 Integration of developed urban agriculture policies and programs into operational requirements

Resource availability, education and training, stakeholder engagement, agility, and environmental sustainability were key factors for integration of developed agriculture policies and programs into operational requirements. As some informants revealed:

The cost of producing food is becoming expensive in urban areas. Department must look into subsidizing or incentivize the farmers in terms of reducing water bill. Informant C

Adapt quickly to climate change impacts and try new approaching that are working especially in urban areas where population is high. New concept like Urban Agriculture, vertical, roof tops we can do a lot of things in a small space. People must learn to adapt to new ways of doing things using less resources. Prioritise the use of carbon footprint and green agriculture and renewable energy by that will become more resilient. Because of problems of land and others I would recommend every development that happen in urban space should make provision for agricultural activities and development. Informant Mat

Participants in this study recommended that the agricultural synergies from province and national were supposed to be cascaded down to local government. Agricultural graduates should be absorbed to get a better knowledge of agriculture on land practical skills and that highly potential agricultural land in the city of Tshwane should be preserved for urban agriculture. There was a need for more funding, more research from ARC, learnership programmes, raising awareness on climate change, encourage farmers to use less chemicals and have a way to incentivise the farmers to reduce the water bill. The city would also give more support rather than just advocacy particularly in matters of climate change champions in communities. This would assist communities and farmers to be agile to learn to adapt to new ways of doing things, adapt quickly to climate change e.g., being conscious of the concept of the carbon footprint. Furthermore, participants recommended the strengthening of programmes to communicate overarching policies, motivating for government to fund the development of new Urban Agriculture production.

4.15 Principles of design suitable for the development of Urban Agriculture policy

Most participants (6) were not aware of principles of design that could be used for developing urban agricultural policies. However, resource availability, stakeholder engagement, and clear processes were suggested by other participants. As the following quotes suggest:

Not sure. Informant K

Mitigation factors when there is hail, there is a need for advance in technology like building shade nets and greenhouse. Budget is the problem when it comes to Agriculture because it is not an essential service. Rely on the sister department of Rural and Development. Informant RU

When you develop policies, you have to consult first and do your research and the outcome of the research will determine what type of policy is needed. Methodologies are there to guide the process of policy development processes but will have to be guided by internal policies practices. Informant Mat

Most participants were not sure. For those that contributed, it was mentioned that methodologies were there to guide the process of policy development, research to determine the type of policy needed and ensure policy development was in consultation with stakeholders.

In the mix, it was mentioned that the major challenge would be the lack of funding because urban agriculture because was not an essential service for the city of Tshwane.

4.16 Incorporating skills and development programmes into operational programmes

A needs analysis, resource availability, education and training, optimised resources, and clear process were said to be important functions in incorporating skills development into operations.

Financial management, business management, production training based on what you are producing let's take you are producing cucumber then will be offering training on cucumber production and management and general financial management and business skills. Informant EG

Within our policies there are enablers that can talk to how can people be empowered and trained, and skills are required. Regular capacity building looking at different sectors of the society. Informant Mat

Before the programmes starts there are manuals developed that shows how construction is done and standard operating procedure and different food production skills manuals. Informant C

Participants in this study suggested conducting skills audit to identify gaps, choosing the right for people for the right programmes, working with Department of Agriculture and Rural Development on training of different aspects of Agriculture, training farmers with few intake students per term, and conducting in house training. Such courses included financial management, business management, and production training. It was also important to develop manuals before the programmes starts on how construction is done and to put in place standard operating procedures. The different food production skills manuals would include the target crop to be produced, like cucumbers.

4.18 CONCLUSION

The following chapter presented the results of the study based on in-depth semi-structured interviews with participants of the Department of Agriculture in the city of Tshwane. It explored the status of urban agriculture practices in the city and the impact posed by these practices in building resilience towards climate change. There is growing recognition of urban and peri-urban agriculture (UPA) as an important strategy for climate change adaptation and mitigation, to a lesser extent. Urban agriculture (UA) could help increase the resilience of cities to a range of pressures and acute shocks by improving food security and public health, building

social capital, and promoting circular economies. Urban agriculture is widely practiced in Tshwane in various regions such as Regions 4, 5, 6 and 7. Although these areas are prone to extreme events such as flooding and intense thunderstorms, which can have a detrimental impact on agricultural infrastructure, incorporating innovative agricultural technology such as tunnels will protect crops from harsh climatic conditions as well as continual supply of fresh produce.

5. DISCUSSION

5.1 INTRODUCTION

The following discussion is based on the research findings regarding the roles of urban agriculture in building resilience towards climate change in the city of Tshwane. Though urban agriculture is widely practiced within the city of Tshwane in both spheres of government, the success behind its implementation relies on various stakeholder such as NGOs, private sector, government department as well as farmers. This is because urban agriculture is not a mandate for the Tshwane municipality. The study revealed that urban agriculture plays a bigger role in addressing national priorities like food security, however existing policies that serves as a guideline to influence implementation are not clearly defined. These findings synthesize with the main aim of the research as well as the purpose of this study and can help create the framework that will show how we can start moving to create policies around the mandate to improve and widen the scope of urban agriculture practices because of their prevalence in this study. Therefore, the findings for this study were discussed under the following four headings which conforms the research objectives. First heading to be discussed will be to establish the status of Urban Agriculture practices in the city of Tshwane. Secondly, will look at the benefits of Urban Agriculture practices in the development of Climate Change strategies. Thirdly, will look at factors influencing the implementation of Urban Agriculture policies in the city of Tshwane. And lastly but not least, the impact of Urban Agriculture policies had on building resilience in the city of Tshwane. Finally, I complete this chapter by concluding the findings as well as recommending ways of improving urban agriculture practices that will assist policy makers in making informed decisions to respond to climate change. This study was to determine the role of urban agriculture in building resilience towards climate change in the city of Tshwane. First, the study established that agriculture exists in Tshwane but not everyone has knowledge about the agricultural policies in place to address climate change. Urban areas in developing countries are faced with big challenges and resources are often rather limited, extreme weather conditions such as too much rain associated with flooding are directly linked to urban agricultural practices, where too much rain poses a threat to crops at their seedling stage and can cause severe damage, or at harvesting stage of tomatoes which is also harmful to tomatoes because they don't require too much water.

This chapter will focus on the discussion of urban agriculture and its role towards building resilience towards climate change.

5.2. Status of Urban Agriculture practices in the city of Tshwane

Urban agriculture is becoming a way of life for most regions within the city of Tshwane. So far, the city has made more contributions in addressing social cohesion, economic development with little data available to address environmental issues such as climate change (Anafo & Akolgo, 2018). It has been observed that urban agriculture exists within mixed situations, where water is a scarce resources and land is unavailable. There is growing interest in the Urban Agriculture from a range of academic, advocacy, policy and community groups and associates to scale up Urban Agriculture policies. At the local level, participants noted a changing narrative about how people view food and how farmers produce food because of the food shortages. They acknowledged that urban agriculture is a conscious response to pressing concerns about food security, climate resilience and the general well-being of people amidst urbanization and increasing urban populations. While urban agriculture may not be the only solution to addressing food security worldwide, it is certainly part of the solution to feeding 70% of the urban poor in South Africa, e.g., contributing to the development of sustainable, socially responsible, and safe and healthy cities. The study calls for the need to establish urban agriculture in the context of local government, with more emphasis on implementing the best agricultural management practices with more options and money to implement each project. Moreover, various designs of urban agriculture systems would be crucial to ensure compatibility, scalability, and applicability to support for innovation of the target adopters. Agricultural technologies and smart data and analysis should increase food production within cities. They will also help meet the growing global demand and logistical distribution of food without further disrupting the urban environment. New technologies enable food to be grown in places where it was previously difficult or impossible, making urban agriculture a viable option for cities where space is limited.

Processes are needed in urban centers to shut open loop systems where consumables are brought in from a distance. Through ground, air, and coastal water pollution, disease, and other cascading impacts, post-consumer packaging and other waste products have an impact on nearby and far-off biospheres in these open loop systems. It is necessary to decrease the flow of resources in towns and cities. Urban agriculture could minimise these throughputs by connecting cities and their ecosystems. Urban agriculture is becoming a more popular, practical, and successful technique for sustainable urbanisation (Girardet et al. 1999). Food sovereignty, ecological restoration, urban greening, water purification and recharge, the promotion of social cohesiveness, and general urban rejuvenation are all potential advantages.

Urban agriculture meets the demands of city people from a range of diverse urban modes and economic origins, rather than being restricted to underdeveloped regions of the urban form. Urban gardening has numerous challenges while appearing to be a relatively straightforward procedure. The success or failure of urban agricultural practices largely depends on how urban agriculture is incorporated into the development and policy plans already in place in urban neighborhoods', as well as how planners and other important decision-makers perceive urban agriculture. Chapter 4 provided an answer to these queries.

5.3. Benefits of Urban Agriculture in the development of Climate Change Strategies

Various theorists researched on the benefits of urban agriculture towards local economic development. However, the lessons learnt, and challenges posed by the implementation were not well covered (Freeman, 1991, Mougeot, 2000, Maranya, 2006). Fox et al 2012, indicate that urban farming could aid in addressing a city's social, economic, and environmental problems. By decreasing heat during the summer season and retaining water during heavy rains, plants can enhance the Earth's climate and lower the risk of flooding. Urban parks and gardens can serve as a haven for birds and other beneficial insects, preserving the urban biodiversity. Cities produce a lot of organic garbage, such as leftovers from recent meals. Compost made from organic waste can be used in urban gardens. Additionally, it is possible to gather used coffee grounds from pubs and restaurants, which are excellent for mushroom cultivation. Malnutrition and food insecurity coexist with urban poverty (Mougeot 2005). Since metropolitan areas generally experience better economic and social situations than rural areas, this is frequently ignored (FAO 2004). Both rural and urban poor have been impacted by the recent financial/economic crisis and rising food, gasoline, and energy prices, while the urban poor have been disproportionately impacted more than their rural counterparts. Because food accounts for a sizable portion of their family expenses, the latter group is especially susceptible to fluctuations in food prices and variations in income. (De Zeeuw, Van Veenhuizen & Dubbeling, 2011). When city dwellers engage in urban gardening, their health frequently becomes better. These urban dwellers typically consume a wider variety of foods, including more nutrient-dense fruits and vegetables. These foods are healthy for us! People feel more a part of the community when they participate in urban gardening. Urban agricultural initiatives are now expanding globally and adding jobs (Figure 5.3.1). Some eateries solely serve food grown nearby. Urban agriculture has also been successful in school gardens and cookery classes

that employ locally grown ingredients. Urban farms develop into locations where technology advancements can occur.

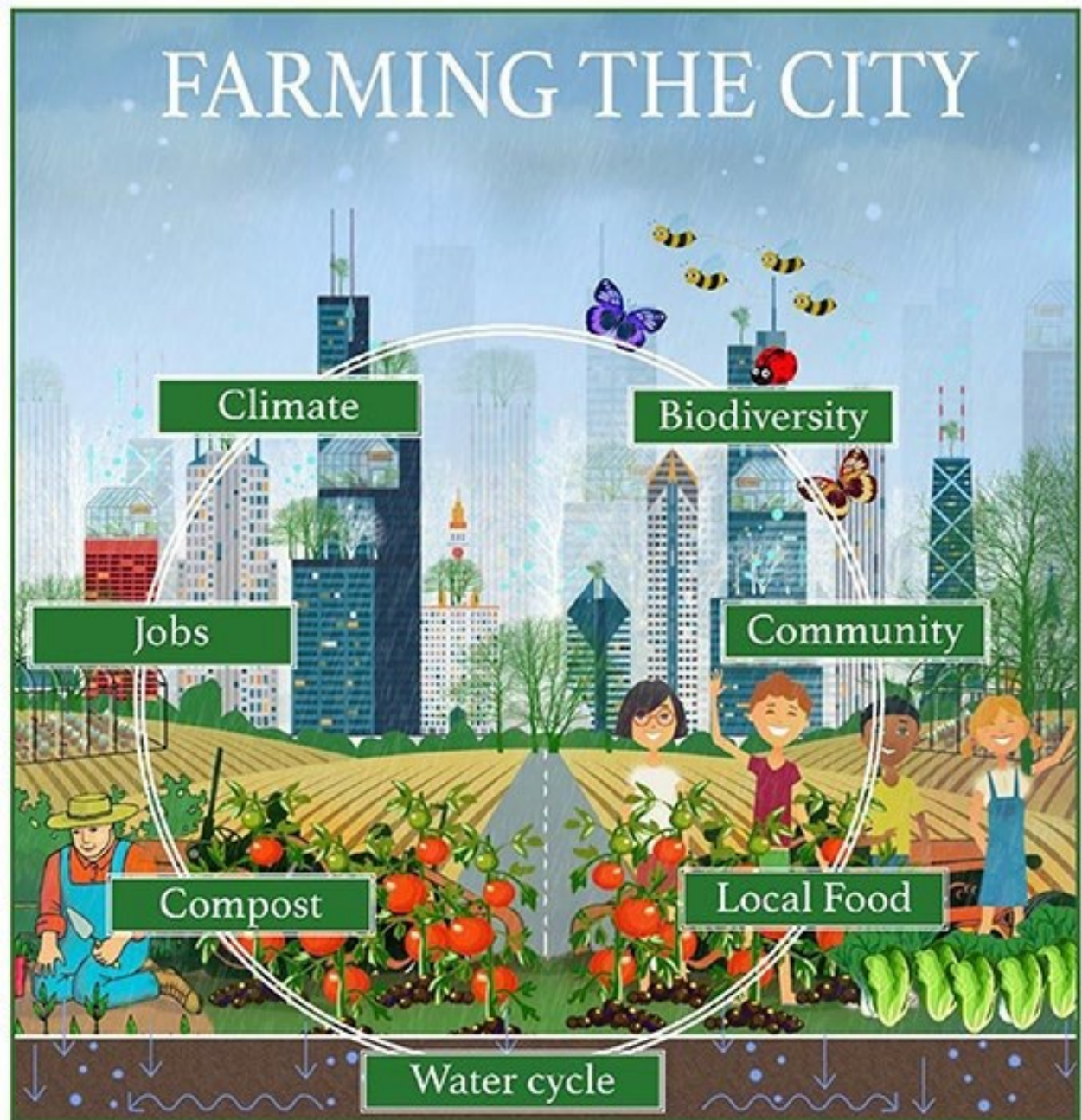


Figure 5.3.1: Farming in the city. Source: Orsini F and D'Ostuni M (2022) The Important Roles of Urban Agriculture. *Front. Young Minds.* 10:701688. doi: 10.3389/frym.2022.701688

Arguably, in this study, the importance of urban agriculture is to build resilience towards climate change and that Food Security guarantee exists when everyone has access to enough food to meet their requirements. Fresh fruit and vegetable need in a city might be met through urban gardening.

5.4 Factors influencing the implementation of Urban Agriculture policies.

A rising number of local and national authorities now acknowledge UPA (Mougeot 2006). Numerous towns and nations (Brazil, Sri Lanka, Sierra Leone, to name a few) have created UPA policies and launched expansive programs to aid in the growth of secure and sustainable UPA (Mougeot 2006). For examples, urban agriculture was included in Brazil's "Zero Hunger" strategy and program, and many urban districts are creating UPA programs aimed at improving food security, eradicating poverty, and integrating the urban poor into society (C. de Moreira, personal communication, 2008). As part of its "National drive to inspire domestic food production," the Sri Lankan government is actively supporting home and community gardening as well as aquaculture on unoccupied municipal and private land (Ministry of Agricultural Development and Agrarian Services 2007). The Bulawayo city council in Zimbabwe recognized the value of urban farming to increase the urban poor's access to wholesome food and established new municipal by-laws on horticulture, livestock, and aquaculture in urban and peri-urban areas (replacing existing restrictive rules). Disadvantaged urban households were given access to almost 450 ha of unoccupied municipal land on the outskirts of the city for (permanent) use in urban agriculture. Countries and cities applying an ecological perspective on UPA mainly focus on its role in urban environmental management (storm water storage and flood management, urban greening, and microclimate, reuse of organic wastes and wastewater, reduction of the urban energy/water footprint, capturing CO₂ and dust). With this perspective in mind, policies and strategies are developed that seek to integrate/maintain open spaces in the urban structure and promote ecological and multi-functional types of UPA that can provide environmental and other services to the city (De Zeeuw, Van Veenhuizen & Dubbeling, 2011).

5.5 Impact of Urban Agriculture policies to build resilience.

One of the most significant impacts of humanity's civilization on the globe has been the shift in the global climate brought on by the rise in greenhouse gas emissions because of human activity. Climate change and global warming are no longer just theories. Agricultural, food security, biodiversity, the economy, security, and public health are all seriously impacted (Sivakumar, 2021). Fresh water supply is becoming a severe issue in metropolitan areas as freshwater demand is rising quickly (UNESCO, 2003). The most crucial of that is climate change, environmental, sociological, and economic concerns currently facing cities, adding to an already extensive list of difficulties (IPCC, 2007). UPA can help with climate change adaption and enhancing the urban environment (and to a lesser extent in mitigation). More urban farming should be practiced, according to the World Meteorological Organization (WMO), as a response to climate change and to create more resilient cities (WMO, personal communication 2007). One of the most concerning problems the world is currently dealing with is climate change. A rise in global temperature, unpredictable rainfall patterns, and extreme weather events are just a few of the effects that have already begun to be felt around the world. These factors pose serious threats to agriculture, food security, safety, and human health, including the emergence of new diseases. Humans have altered the earth's surface, used up a variety of natural resources, damaged the ecosystem, and impeded the planet's life support systems, endangering its sustainability. The City of Tshwane has demonstrated profound political commitment to addressing climate change, stimulating the green economy, and elevating overall sustainability action at an institutional level. The City has put this commitment into action through policy development, resource mobilisation, research and awareness raising and the implementation of demonstration projects. The city has adopted an evidence-based approach to climate change management, and its mitigation and adaptation programmes are underpinned by extensive studies, namely the Greenhouse Gas Emissions Inventory and emissions reduction scenario modelling, as well as the Climate Risk and Vulnerability Assessment (CRVA). The City's 2015/16 Greenhouse Gas Emissions Inventory (GHGEI) shows that the Tshwane generates 19.5 million tCO₂e per year. The biggest emitters are the energy, transport, and waste sectors. The City's mitigation programme therefore focuses on avoiding and reducing emissions in these three sectors. Mitigation measures include promoting circular economy practices, energy efficiency and clean energy, green transportation (such as

non-motorised transport (NMT) or electric buses), and densification and compaction strategies, among others. The City's climate action planning efforts began with the development of the 2006 Climate Strategy, but only gained significant momentum after the establishment of the CSU. The City's Climate Response Strategy and the Green Economy Framework provided initial guidance on climate change. This case study has shown that climate change remains one of the biggest challenges, it can still be combated through agriculture by learning to practice mixed farming agricultural methods. Sudden change in climate change exacerbated by climatic variability trigger meteorological hazards such as drought which will require adaptation to enhance resilience in the production of food and taking into consideration the need to act timeously and respond quickly. The city will continue taking significant steps to understand climate risk factors (such as the specific factors that increase/decrease exposure and vulnerability to climate hazards). This will ensure that the city is able to identify appropriate actions that will improve the resilience of Tshwane's economy, people, and natural resources, as well as their ability to adapt to climate impacts.

5.6 CONCLUSION

This chapter presented findings from previous literature and results drawn from interviews conducted as explained in chapter 4 (see annexure v).

Sivakumar et al. (2000) observed that agriculture sector is mostly affected by climatic variation and regarded as the most sensitive weather industry. Given the high population, vast number of people are experiencing food insecurity, and the anticipated effects of climate change, there are many parts of the world that are particularly vulnerable. Strategies for coping with climate change are now urgently needed, especially for the most vulnerable areas. It is crucial to emphasise the requirement to make more effective use of natural resources while also maintaining the conservation of the environment to enhance and stabilize agricultural production to satisfy the rising demand for food. To improve the adaptive capacity to handle present and future climate hazards, immediate action is required. The background of shifting demand brought on by population expansion as well as the socioeconomic and environmental repercussions of potential adaptation alternatives will need to be considered simultaneously by the adaptation methods. The user communities' essential requirements and potential for assistance in effectively coping with the effects of climate change might be identified through thorough profiling of the user communities in partnership with social scientists and regular interaction with the users.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

Successful implementation of urban agriculture practices within the City of Tshwane requires multiple stakeholder engagement in all spheres of government to supplement with advanced technology to maintain the existence of urban farming. In urban space more factors compete with agricultural practices like housing, complex and malls. The development in the concept of urban agriculture has been driven by social, political, and economic factors, impacting the role of agriculture in the urban environment. As such government should depend on end users which are the farmers in terms of implementation of urban agriculture at the local level. In return, farmers rely on government for grants as they don't qualify for loans from independent institutions and Provincial Department. The impact is complex because the beneficiaries are not the ones that are losing, but farmers themselves. Overall agriculture projects are given less budget and not regarded as a priority. It is critical to emphasize that the management of urban agriculture practices in relation to climate mitigation strategies is complex, because when you are moving with another mitigation three years down the line another phenomenal occur and you will be forced to review your strategy. Informed communities are better positioned to provide the necessary support and cooperation in the management of urban agriculture in terms of agricultural practices on what plants are resilient to climate change and other crops that are adapted to climate change and to have correct infrastructure to respond to climate change water management.

Urban agriculture policies are there to guide the efficient use of resources, infrastructures in terms of policy implementation so that there is proper planning in terms of resiliency and adaptation. Adapt quickly to climate change impacts and try new approaching that are working especially in urban areas where population is high. Most farmers do not have adequate knowledge when it comes to climate change, however technical support programmes such as annual performance plan that outlines the expected achievement from program implementations and set measurable standards, identifying key elements in the program could outline various gaps needed to address those key areas. Farmers have to adapt to learn new ways of practicing urban agriculture using less resources. Lack of clearly defined policy pertaining to Urban Agriculture and departments working in silo. To ensure that stakeholders are educated about the policy, initiated development projects could also be used as vehicles for educational campaigns. This is evident from the large number of participants who expressed positive attitudes towards the protection of environmental resources but at the same time were

not familiar with the policy itself. Educate the people about new trends in the agricultural practices which contributes towards climate change and mixed methods of farming. Use of policies as enablers that put more emphasis on key result areas such as institutional arrangement to clearly define roles and responsibility in terms of education, adaptation, staff capacity resilience as well as raising awareness on policy implementation and adaptation of urban agricultural practices.

This research will upon completion contribute to urban agriculture roles in building resilience to climate change. This is based on the premise that, an appreciation and understanding of the barriers and challenges to implementation are necessary for successful interventions. It is apparent that successful implementation of urban agricultural practices requires huge financial and human resource investments. It also requires prevalent engagement and persuasion of various stakeholders in all spheres of government to be involved. Urban agriculture plays a vital role in the food systems and should therefore be integrated into urban planning as a social capital in support of food production and food security as well as job creation, The benefits associated with the implementation of urban agriculture should provide the rationale for the research proposing a set of financial enticements in advancing locational opportunities. Ultimately, this links to the objective of the research in realization of urban agriculture roles in building resilient city amid climate change.

6.2 RECOMMENDATIONS

6.2.1. Resource allocations and availability

- (i) More funding and more research from ARC as the support system. Put more emphasis on research and learnership programmes.
- (ii) The government should fund the development of new Urban Agriculture production because it needs more financial impact for most of the farmers, they are not practicing this because they don't want to but have enough funds for Urban Agricultural projects to have more impact in the agricultural sector.
- (iii) Agricultural graduates should be absorbed to get a better knowledge of agriculture on land practical skills. All high potential agricultural land to be preserved for that purpose.
- (iv) Because of problems of land and others I would recommend every development that happen in urban space should make provision for agricultural activities and development
- (v) Department must investigate subsidizing and the cost of producing food.

6.2.2. Education and training

- (i) Learnership programmes
- (ii) Awareness - Awareness around climate change is lacking. Give support rather than advocacy.
- (iii) Through vertical planting and encourage our farmers to use less chemicals and opt for organic fertilisers and integrated pest management (IPM).
- (iv) People must learn to adapt to new ways of doing things using less resources.

6.2.3. Stakeholder engagement

- (i) Communicating of overarching policies
- (ii) Agricultural synergies from province and national what is happening on province should come down to local.
- (iii) Incentivise the farmers in terms of reducing water bill.
- (iv) Climate change champions need to be included in the policy development of Agricultural practices, projects implementation, continuous learning on agricultural practices towards climate change.

6.2.4. Environmental sustainability

- (i) Adapt quickly to climate change impacts and try new approaching that are working especially in urban areas where population is high. New concept like Urban Agriculture, vertical, roof tops we can do a lot of things in a small space.
- (ii) Prioritise the use of carbon footprint and green agriculture and renewable energy by that will become more resilient.

6.2.5. Innovation

New concept like Urban Agriculture, vertical, roof tops we can do a lot of things in a small space.

Implementation of these recommendations will address the city on challenges faced by urban agriculture, and it is envisaged that this research will contribute to the generation of knowledge that can be used to address urban agriculture challenges in the city to mitigate against consequences.

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