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CERTIFICATE OF COMPLETION OF DISSERTATION

I **Thokozile Ruparaganda** hereby certify that this dissertation is the product of my own work and, in submitting it for my MSc programme, further attest that it has not been submitted in part or in whole to another University or for general publication.

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I **Dr VT Munyati** having supervised and read this dissertation, am satisfied that this is the original work of the author whose name it is being presented. I confirm that the work has been completed satisfactorily and is ready for presentation to the examiners.

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List of Acronyms and Abbreviations

- CC: Climate Change
- CI: Confidence Interval
- CSA: Climate-Smart Agriculture
- DF: Degrees of Freedom
- Exp (B): Exponentiation of the B coefficient, also known as the odds ratio
- FAO: Food and Agriculture Organization
- GIS: Geographic Information System
- M&E: Monitoring and Evaluation
- NGO: Non-Governmental Organization
- R&D: Research and Development
- SCA: Smart Climate Agriculture
- SDG: Sustainable Development Goal
- SE: Standard Error
- Sig.: Significance Level
- SPSS: Statistical Package for the Social Sciences
- UN: United Nations
- USD: United States Dollar
- Wald: Wald Chi-Square Test
- ZIMSTAT: Zimbabwe National Statistics Agency

KEY WORDS

CSA	Climate Smart Agriculture
FS	Food Security
UA	Urban Agriculture

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Abstract

Urban agriculture in Harare faces numerous challenges including climate variability, resource constraints, and limited access to agricultural support. Climate-smart agriculture (CSA) practices offer potential solutions by enhancing resilience, productivity, and sustainability. This study aims to provide a comprehensive analysis of CSA adoption and its effects on urban farming and food security in Harare. It focuses on four key objectives: assessing the prevalence of CSA adoption, identifying key CSA practices, determining factors affecting CSA adoption, and evaluating the impact of CSA on household food security. The research utilizes a mixed-methods approach, combining quantitative surveys and qualitative interviews with 275 urban farmers across various neighbourhoods in Harare.

A stratified random sampling technique was employed to select 275 urban farmers. Data collection involved structured questionnaires and in-depth interviews, focusing on farming practices, CSA adoption, production levels, and food security. Statistical analyses, including descriptive statistics, t-tests, and logistic regression models, were used to analyze the data. Prevalence of CSA Adoption: The study found that 60.7% of farmers were aware of CSA practices, and 83.3% had received agricultural training. Key CSA practices such as crop rotation (71.7%), intercropping (73.1%), mulching (93.5%), and water conservation (86.2%) were widely adopted. Key CSA Practices: The most common CSA practices included mulching, water conservation, and the use of weather information. However, only 36.4% of farmers used organic fertilizers. Factors Affecting CSA Adoption: Major challenges to CSA adoption included lack of knowledge (61.8%), limited access to agricultural officers (21.1%), and lack of resources (17.1%). Key improvements needed were more CSA training (57.1%) and financial support (33.5%). Impact on Food Security: CSA adopters had significantly higher production levels of cereals and legumes compared to non-adopters. The logistic regression model showed that CSA adopters were 4.8 times more likely to be food secure. Other significant factors included farm size, frequency of agricultural extension services, and household demographics.

The study concludes that CSA practices significantly enhance food security among urban farmers in Harare. Adoption of these practices leads to higher yields and improved resilience to climate variability. However, challenges such as lack of knowledge and resources hinder widespread adoption. The recommendations are, Increase the availability and accessibility of training programs to enhance CSA adoption. Strengthen the frequency and quality of extension services to support urban farmer’s effectively. Provide financial assistance and

access to affordable farming inputs and technologies. Develop initiatives to improve market access for urban farmers. Incorporate urban agriculture into broader urban planning and development policies.

CHAPTER 1

1.1 INTRODUCTION

Food insecurity is becoming a bigger issue in Harare, Zimbabwe, because of a number of issues, including the city's rising urbanisation. Growing crops and rearing cattle in urban settings, or urban agriculture, has been pushed as a potential answer to these problems. One urban agriculture project in Harare that attempts to increase food security and climate change resilience is called Climate Smart Agriculture. In developing nations like Zimbabwe, food security is a major concern for households in both rural and urban areas. The Zimbabwean government and non-governmental organisations (NGOs) have undertaken various measures to enhance agricultural productivity and, eventually, food security. These measures include cash transfers, climate wise agriculture, and agricultural input packages. Urban farming yields and food security in Harare remain poor despite the adoption of programmes like the Pfumvudza programme, and the effects of climate change continue to have an influence on urban farmers' lives. Nevertheless, there is little data to determine if these initiatives are successful in raising yields and enhancing food security.

1.2 BACKGROUND

In Africa, an estimated 258 million people are food insecure, with rates of hunger and malnutrition highest in urban areas (FAO, 2019). This is due in part to climate change, which is affecting crop yields and causing more frequent and severe droughts and floods (Dube et al., 2018). In Zimbabwe, it is estimated that 60% of the population is food insecure (FAO, 2019).

In Harare, the capital of Zimbabwe, the situation is particularly dire. It is estimated that 74% of households in the city are food insecure (FAO, 2019). This is due to a combination of factors including a lack of access to arable land, low agricultural productivity, a lack of infrastructure and services, and limited access to financial resources (Frenken, 2016). In response to these challenges, the Climate smart agriculture was launched in 2013. The program provides seeds, training, and other resources to urban farmers, with the aim of increasing yields and improving food security.

There is limited evidence on the impact of the Climate smart agriculture on yields and food security. While some studies have found that urban agriculture can improve food security and nutrition (Smith, 2018), the specific effects of the Climate smart agriculture have not been

well documented. In addition, the long-term sustainability of urban agriculture in Harare is uncertain, given the rapid growth of the city and the lack of formal policies and infrastructure to support it (Scoones et al., 2016).

It is estimated that the average yield of maize in Harare is 2.5 tons per hectare, which is below the national average of 3.5 tons per hectare (FAO, 2019). In addition, the prevalence of food insecurity in Harare is estimated to be 74%, compared to the national average of 60% (FAO, 2019). The unemployment rate in Harare is estimated to be 90%, with a majority of the population relying on informal economic activities for their livelihoods (Mangwiro & Jonga, 2018). It is against this imperative that a number of NGOs has been implementing various interventions to address these challenges. One of the interventions has been cash based transfer modalities especially the cash for work activities. It is against this background that the researcher needs to assess the impact of this exerciser.

According to United Nations Children's Fund (UNICEF) and World Food Programme (WFP) 2020, an estimated 828 million people in the world are food insecure with about 2 billion people facing moderate or severe food insecurity. According to United Nations (2019) in Sub Sahara Africa, the prevalence of food insecurity is 25%. However, the national prevalence of food insecurity for Zimbabwe is 32%. (Mhlanga, 2019).IPC report 2022. According to the World Food Programme (WFP), Zimbabwe has one of the highest rates of chronic food insecurity in Southern Africa, with an estimated 5.3 million people (nearly a third of the population) experiencing food insecurity as of 2021. (WFP, 2021)

The goal of this research is to evaluate the impact of the Climate smart agriculture on food security in Harare. The study will use a mixed-methods approach, combining quantitative data on crop yields and food security with qualitative data on the experiences of urban farmers and other stakeholders. The study will also examine the policies and infrastructure that are needed to support urban agriculture in Harare in the long term. By doing so, the study aims to provide evidence-based recommendations for improving the effectiveness of urban agriculture in addressing food insecurity in Harare.

1.3 RESEARCH PROBLEM

Despite the implementation of agricultural input schemes by the government such as the presidential inputs scheme and Agricultural Productive Enhancement Programme, food insecurity remains a major challenge in Harare, Zimbabwe. The rate of food insecurity in Harare is estimated to be more than a third (33%) with many households experiencing chronic food insecurity. Which is higher than the national prevalence of food insecurity which is 32% (Mhlanga, 2019), IPC report (2022). The Food consumption score (FCS) for household in Harare is 35% which shows poor food consumption. This is due to a number of factors, including low agricultural productivity, inadequate access to inputs and markets and limited resources and infrastructure. As a result, many households in the district are unable to meet their basic good food, and are at risk of malnutrition and other health problems (S. Mosely et al, 2018). While there is some evidence that climate smart agriculture can improve food security, there is a lack of data on the specific impacts of the Climate smart agriculture on yields and food security. However some urban farmers have already adopted to smart climate agriculture to improve their production and mitigate climate change. In addition, there are concerns about the long-term sustainability of urban agriculture in Harare, given the lack of formal policies and infrastructure to support it.

It is, however, important to extend the findings in evaluating impact of the alternative programmes targeting the vulnerable communities in fighting poverty and food insecurity.

1.4 Research questions

1. What is the prevalence of people who adopted climate smart agriculture in Harare?
2. What are the key climate smart agriculture practices in Harare?
3. What are the factors affecting adoption of Climate smart agriculture?
4. What is the impact of Climate smart agriculture practise on household food security?

1.5 Study Objectives

1.5.1 Main Objective

To assess the Impact of climate-smart agriculture practices on urban farming yields and food security in Harare.

1.5.2 Specific Research objectives

a. To assess the prevalence of people who adopted climate smart agriculture in Harare

b. To identify key climate smart agriculture practices in Harare.
c. To identify factors affecting adoption of smart agriculture.
d. To assess the impact of smart agriculture practise on household food security.

1.6 SIGNIFICANCE OF THE STUDY

The significance of the study can be presented in terms of both theoretical and practical contributions. From a theoretical perspective, the study will contribute to the literature on climate-smart agriculture and its impact on urban farming, which is an under-researched area. From a practical perspective, the study will provide valuable insights for policymakers and development practitioners on how to improve the livelihoods of urban farmers through climate-smart agriculture. It will also help to identify the specific challenges and opportunities in Harare, and provide recommendations for addressing these challenges

1.7 STUDY PURPOSE

The purpose of the study was to assess the effectiveness of climate-smart agriculture in improving the livelihoods of urban farmers in Harare, and to make recommendations for scaling up these practices to other urban areas in Zimbabwe and beyond

1.8 LIMITATIONS OF THE STUDY

The study was limited in terms of generalizability, as it would focus on one city in Zimbabwe. Second, it was limited in terms of time, as it would only be able to capture a snapshot of the situation at a specific point in time. Third, it was limited in terms of measurement, as it would rely on self-reported data from farmers. Fourth, it was limited in terms of the scope of the data, as it would only be able to collect data on a limited number of variables.

1.9 CONCLUSION

An overview of the procedures to be followed in order to carry out this investigation is provided in this chapter. The background of the research problem, the goals and purposes of the study, the definition of important words, and the study's significance have all been covered in an introduction.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Due to the agricultural sector's great sensitivity to drought and climate change, there is a global food security concern (Chingono, 2019; FAO, 2013). Compared to the developed world, the developing world's agriculture industry has been most negatively impacted by climate change (Chingono, 2019; Gbegbelelegbe et al., 2018). This has been observed in developing nations like South Asia and Sub-Saharan Africa, where the majority of the population depends mostly on agriculture and it is rain-fed. Thus, climate change agriculture emerged as a means of raising agricultural yield.

2.2 Background

The Climate smart agriculture is a program implemented by the Food and Agriculture Organization (FAO) and the World Food Programme (WFP) in a number of cities in sub-Saharan Africa. The program aims to promote the development of sustainable urban and peri-urban agriculture, with the goal of increasing food security and improving livelihoods. The program works with local governments and communities to improve access to land, water, and other resources, and to promote the use of innovative agricultural practices, such as vertical farming and aquaculture.

The Climate smart agriculture was launched in Zimbabwe in 2012, with the aim of improving food security and nutrition in the country's cities. The program has been implemented in the cities of Harare, Bulawayo, and Mutare. In Harare, the program has focused on developing urban and peri-urban agriculture through initiatives such as establishing community gardens, providing agricultural inputs, and training farmers in sustainable farming practices. The program has also worked to promote the consumption of nutritious foods, such as vegetables and fruits, and to develop value chains for locally produced food.

The Climate smart agriculture in Zimbabwe has had some success in improving food security and nutrition. For example, in the Harare suburb of Mbare, the program has led to an increase in the number of households growing their own vegetables, from 25% to 70% (FAO, 2015).

In addition, the program has helped to increase the availability of nutritious foods, such as leafy greens, in local markets. However, the program has also faced challenges, including a lack of access to land, limited water availability, and inadequate infrastructure.

2.3 Discussion

The persistent alteration in temperature and precipitation patterns put agricultural output at risk and made those who depend on rain-fed agriculture for a living more vulnerable (Dube and Phiri, 2013). Six out of ten significant natural disasters that occurred in Zimbabwe between 1991 and 2013 were caused by drought, making it the most persistent natural disaster in the country (Government of Zimbabwe, 2020). According to Brown et al., Zimbabwe's maize output has decreased since 2000. environment change is posing a challenge to Zimbabwe's agroecological zones, particularly for small-scale farmers who lack the knowledge and means to adapt to the changing environment. Due to climate change's persistent danger to and escalation of severe droughts, it was underlined that CfW was of utmost importance in low-income regions like the Middle East, Asia, and Africa (FAO, 2013; Gbegbelegbe et al., 2018).

A large number of NGOS are emerging in Zimbabwe and putting food security programmes into action. The Foundation of Farming (FfF), a regional non-governmental organisation in the nation, created the pfumvudza, or conservation agriculture, concept to provide a small plot of land over the course of a year for the average household of six members' grain needs (Mujere, 2021).Urban farming has been recognized as an important means of increasing food security and resilience to climate change, particularly in African cities such as Harare, Zimbabwe (Simatele, Manyanhaire, & Mafongoya, 2021; Narh, Obeng, & Ghebru, 2020). A number of studies have documented the benefits of urban farming, such as increasing access to nutritious food, improving food security, reducing poverty, and enhancing livelihoods (Mugabe, Van Averbeke, & Tol, 2020; Narh).

Challenges

Despite the potential benefits of urban farming, there are a number of challenges that limit its success. In Harare, these challenges include limited access to water and land for farming, inadequate waste management systems, and inadequate extension services and other support systems (Gondo, Murwira, & Murwira, 2019). Additionally, many urban farmers in Harare are women, and they often face additional challenges related to gender inequality, such as

limited access to resources and decision-making power (Kaunda, Muchazondida, & Muchazondida, 2020). These challenges have significant implications for the sustainability of urban farming.

The literature on climate-smart agriculture in urban areas is limited, but some studies have been conducted on this topic. For example, Mugabe et al. (2020) conducted a study on the use of climate-smart agriculture practices by smallholder farmers in the Harare Metropolitan Province. The study found that farmers were using a range of climate-smart practices, including crop diversification, intercropping, and conservation agriculture. However, the study also found that the use of these practices was limited by a number of factors, including a lack of knowledge and training on climate-smart practices, a lack of access to inputs and technologies,

Another relevant study is by Gondo et al. (2019), who examined the role of urban agriculture in improving household food security and livelihoods in Harare. The study found that urban farming was an important source of food and income for many households, but that it was not without challenges. The study found that farmers faced a number of challenges related to land tenure security, access to markets, and limited access to credit and other support services. The study also noted that there was limited information and education on urban agriculture available to farmers. These findings highlight the need for further research and

One promising area of research is the use of information and communication technologies (ICTs) to support urban farming. ICTs, such as mobile phones and the internet, can be used to provide information and training on climate-smart agriculture practices, as well as to connect farmers to markets and other support services. A number of ICT-based initiatives have been piloted in Harare and other African cities, but there is limited research on their impact and sustainability (Lukwago & Mooya, 2021). It is important to continue to research and develop ICT-based solutions that are appropriate for the specific context of urban agriculture

Another important area of research is the development of policies and programs to support urban farming. In Harare, there are a number of policies and programs that impact urban farming, including the city's land use planning and development control, urban agriculture regulations, and food safety regulations (Gondo et al., 2019). However, these policies and programs are often fragmented and poorly coordinated, and there is a need for a more holistic approach that recognizes the multiple benefits of urban agriculture. This could include

policies and programs that support farmers' access to land, water, credit, and markets, and that promote the use of climate-smart agriculture practices.

Finally, it is important to consider the issue of gender equity in urban agriculture. Women are often the primary farmers in urban areas, and they face a number of gender-specific challenges, such as limited access to land and resources, time poverty, and limited decision-making power (Gondo et al., 2019). It is important to ensure that policies and programs related to urban agriculture take into account the specific needs of women farmers and provide them with the support they need to be successful. This could include policies that support women's land tenure security, access to credit, and access to training and information.

A review of the global literature on urban agriculture and food security wasgin with a discussion of the rapid urbanization taking place in many parts of the world, and the implications this has for food security. For example, the United Nations estimates that by 2050, 66% of the world's population will live in urban areas, up from 54% in 2014 (UN, 2014). This rapid urbanization, coupled with a growing global population, is putting pressure on urban food systems and creating new challenges for food security.

Food and Agriculture Organization (FAO) estimates that around 828 million people were affected by hunger in 2021, and about two-thirds of these people lived in urban areas (FAO, 2022). In sub-Saharan Africa, it is estimated that around 255 million people are food insecure, with a large portion of these people living in urban areas (WFP, 2021). The urbanization of hunger is a relatively recent phenomenon, and there is a need for further research on the specific challenges and opportunities it presents.

Turning to the African context, a review of the literature would highlight the role of urban agriculture in addressing food insecurity in many cities across the continent. In particular, urban agriculture has been found to have a positive impact on food security and nutrition in cities such as Accra, Ghana; Dar es Salaam, Tanzania; and Kampala, Uganda (UHAS, 2019; WFP, 2018; Ssekamatte-Ssebuliba, 2012).

With regard to specific statistics, a review of the literature would highlight that urban agriculture in Accra, for example, is estimated to provide food for about 7% of the city's population, while in Dar es Salaam, urban agriculture is estimated to provide about 22% of the city's food needs (UHAS, 2019; WFP, 2018). Urban agriculture is also estimated to contribute up to 30% of the income of low-income households in cities like Kampala (Ssekamatte-Ssebuliba, 2012).

2.3.5 Conceptual framework

A conceptual framework is an important part of any research study, as it helps to define the key concepts and relationships that was explored in the study.

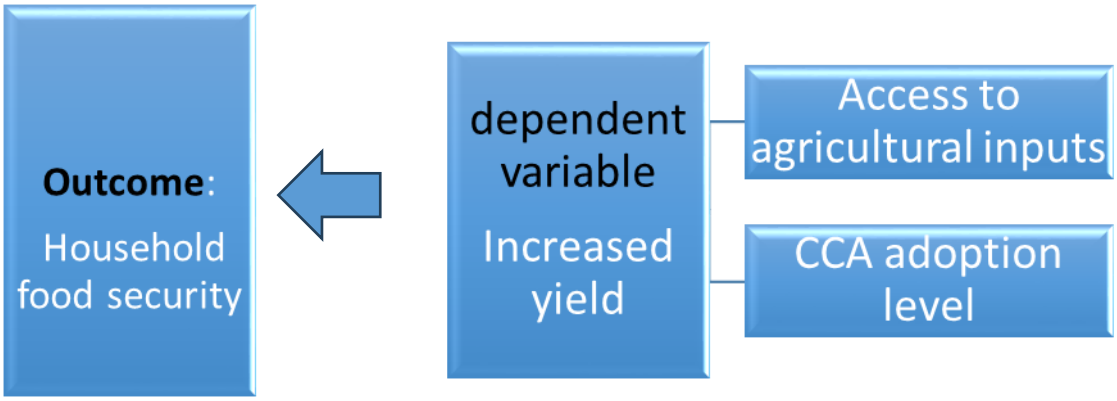

Figure 1: Conceptual framework

It's also important to consider the contextual factors that may influence the relationship between the food security and CCA adoption levels. These could include factors such as the political and economic environment, the availability of resources, and the level of institutional support.

2.3.6 Theoretical framework.

A theoretical framework that was used to guide research on urban agriculture in Harare is the concept of food sovereignty. Food sovereignty is a framework that emphasizes the importance of democratic control of food systems, and it recognizes that food is more than just a commodity, but is also a means of achieving social justice and environmental sustainability (Patel, 2009). This framework can be used to explore how urban agriculture can be used to empower farmers and improve their livelihoods, while also promoting social and

environmental sustainability. It can also be used to assess the extent to which existing policies and programs are achieving these goals.

Another theoretical framework that was used to guide research on urban agriculture in Harare is the concept of agroecology. Agroecology is a systems-based approach that integrates ecological, social, and economic principles to promote sustainable agriculture (Wakefield et al., 2013). This framework was used to explore how urban agriculture can be used to promote the sustainable production of food, while also enhancing the resilience of cities to climate change and other shocks. It can also be used to assess the potential of urban agriculture to contribute to social and economic development in Harare.

A possible conceptual framework for research on urban agriculture in Harare was based on the following key elements:

-The physical and socio-economic context of Harare, including the urban population growth, land availability, and access to resources such as water and electricity.

- The policy and institutional environment, including the relevant policies and programs related to urban agriculture, land use, and food security.

- The ecological and environmental context, including the impacts of climate change and urbanization on land and water resources, and the potential for urban agriculture to promote environmental sustainability.

- The social and economic benefits of urban agriculture, including the potential to

Harare is the capital of Zimbabwe and is home to more than 1.5 million people. The city is located in the Mashonaland region, in the northeastern part of the country. The physical environment of Harare is characterized by a tropical savannah climate, with an average temperature of 22°C and annual rainfall of around 750 mm. The city is surrounded by a green belt of land that includes agricultural land, water bodies, and wetlands. Within the city, there are a number of urban farms that are located in both formal and informal settlements.

The socio-economic context of Harare is shaped by a number of factors, including a rapidly growing population, high levels of poverty, and limited employment opportunities. The urban population has been growing rapidly, from about 700,000 people in 1990 to over 1.5 million people in 2020. This has led to an increase in the number of informal settlements, as well as a high demand for housing, water, and other basic services. Unemployment is high, particularly

among youth, and many people earn their living through informal economic activities. These factors have led to a high demand for affordable and nutritious food.

A theoretical framework for this research was based on a number of different approaches. One possibility is to use the sustainable livelihoods approach, which has been used in previous research on urban agriculture and food security. This approach would consider the various assets and capitals that are needed for urban farmers to achieve food security, such as natural, human, social, and financial capital. Another option was to use a capabilities approach, which would focus on the individual and collective capabilities of urban farmers to achieve food security.

The sustainable livelihoods approach has been used in research on urban agriculture in cities such as Accra, Ghana (Abankwah et al., 2017), Nairobi, Kenya (Musyoki, 2020), and Maputo, Mozambique (Ruysenaars & van Veenhuizen, 2010). The capabilities approach has been used in research on food security in urban areas in Ghana (Bilson, 2014), Ethiopia (Bentley et al., 2015), and other parts of sub-Saharan Africa (Taruvinga & Mangoma, 2018).

A theoretical framework based on the sustainable livelihoods or capabilities approach would have several implications for the research design. First, it was important to consider the multiple dimensions of food security, including availability, access, and utilization. Second, it was important to consider the broader context of urban agriculture, including social, economic, and political factors. Third, it was important to consider the diversity of urban farming households and the factors that influence their ability to achieve food security. Finally, it was important to consider the role of government policies and programs in supporting urban agriculture and food security.

2.4 CONCLUSION

The chapter began with a succinct literature review, which is a written synopsis of data compiled from earlier, related investigations.

CHAPTER 3: RESEARCH METHOD

3.0 Introduction

Chapter three describes the research design, sample size, sampling technic, ethics and reliability test.

3.1 Study design

The study design is a mixed-methods approach that combines quantitative and qualitative research methods. The quantitative methods included surveys and spatial analysis to understand the extent of urban agriculture and its economic and environmental impacts. The qualitative methods included interviews and focus groups with urban farmers and other stakeholders to understand their perspectives and experiences. This approach allows for a comprehensive understanding of the topic and would provide both quantitative and qualitative evidence to support the research findings.

3.2 Study setting

The study was conducted in the city of Harare, the capital of Zimbabwe. Harare is a rapidly growing city, with a population of over 2 million people. The city faces significant challenges in terms of urban poverty, unemployment, and food insecurity. However, it also has a vibrant urban agriculture sector, with an estimated 50,000 households involved in urban farming (FAO, 2015). Harare is a diverse city, with a mix of formal and informal settlements, and a variety of agricultural production systems.

3.3. Study limitations setting

The study was limited in terms of generalizability, as it would focus on a single ward one district in Zimbabwe. Second, it was limited in terms of time, as it would only be able to capture a snapshot of the situation at a specific point in time. Third, it was limited in terms of measurement, as it would rely on self-reported data from farmers. Fourth, it was limited in terms of the scope of the data, as it would only be able to collect data on a limited number of variables.

3.4 Sampling method

The sampling technique for this study involved a multi-stage sampling approach. In the first stage, a purposive sample of informal and formal settlements was selected based on the presence of urban agriculture. In the second stage, urban farmers were sampled within these settlements using a simple random sampling approach. This would ensure that the sample is representative of urban farmers in Harare. The total sample size was determined based on the desired level of precision and confidence level. This sampling strategy for the study was a combination of random and purposive sampling. Random sampling was used to select a representative sample of urban farmers in Harare. Purposive sampling was used to ensure that the sample includes a diversity of farmers, including those involved in different types of agricultural production systems and from different socioeconomic backgrounds. The sampling frame was based on a list of urban farmers compiled by the FAO and other relevant organizations. The target sample size was 200 urban farmers.

3.5 Sample size

Excessive sample sizes will not conserve resources, which are typically scarce (Araoye 2003, pp. 115, 116). The sample size was then determined using the Slovin formula when the population, which is around 10,000, was taken into consideration.

using n=N / (1+N*e^2)

Where:

n = desired sample size

N = the target population estimated =10 000

Therefore, e = 0.05 margin of error

Therefore, n = 10 000 / $\underline{(1 + 10\,000 * (0.06)^2}$ =271

(Araoye 2003, p.119)

Hence n = 271.

If including the response rate of 99% the sample size will be 275.

3.6 Data collection

The process of locating respondents and the exact, methodical acquisition of information pertinent to a study's specific goals, purpose, or research topic is known as data collection (Burns & Grove 2007, p.536). A key informant study guide and a structured questionnaire were used to gather data.

3.6.1 Data collection instrument

The quantitative data was collected through face-to-face interviews using a structured questionnaire. The questionnaire was translated into the local languages, Shona, and English to ensure that all respondents understood the questions. The questionnaire was pre-tested with a small sample of farmers to ensure that the questions are clear and understandable. Qualitative data was collected through in-depth interviews with the key informants and lead farmers. The interviews was semi-structured, allowing for flexibility and probing. The interviews was audio-recorded and transcribed.

Secondary data on agricultural production, food security was collected from the Ministry of Agriculture, the Zimbabwe Vulnerability Assessment Committee, and other relevant organizations. Primary data was collected through the surveys and in-depth interviews. The primary data was analysed using descriptive statistics and content analysis. The quantitative

and qualitative data was triangulated to gain a more complete understanding of the research topic.

3.6.2 Pilot study

A possible pilot survey could involve conducting a smaller-scale survey of 10 urban farmers in a few settlements in Harare. This pilot survey would allow for the refinement of the research questions, survey instruments, and sampling strategy. It would also allow for the assessment of the feasibility of the study and the identification of any challenges that may arise during the main study. The findings of the pilot survey was used to make adjustments to the main survey before it is implemented.

3.7 VALIDITY AND RELIABILITY

Since they have an impact on every step that leads to the credibility of research findings, validity and reliability are essential components of research. These are crucial standards for assessing the suitability and quality of a research instrument.

3.7.1 Validity

The multiple choice questions in this study were formulated in accordance with the study's aims and drew from a variety of instruments that have been used in previous studies of a similar nature, ensuring the validity of the questionnaire.

The question of how representative or sufficient the multiple choice questions are for the construct being measured is known as content validity (Dawson and Trapp 2004, p. 289). The statistician and the study supervisor's help made sure of this.

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Polit & Beck (2008, p. 753) define external validity as the extent to which the findings of a study can be applied to contexts or populations different from the one under investigation. This affects how respondents are chosen, since they need to be a good representation of the study population.

3.7.2 Reliability

A measurement tool's dependability indicates the degree of random error in the measurement instrument approach as well as the consistency of measurements produced when using that particular instrument (Burns and Grove 2005, p. 374). The absence of random and unsystematic measurement error is what makes it such (Stommel and Wills 2004, p. 209). A

reliability coefficient of 0.70 is adequate for a recently developed psycho-social instrument, while 0.80 is thought to be the lowest acceptable value for a well-established psycho-social instrument, according to Burns & Grove (2005, p. 374).

3.8 Data Analysis

The quantitative data was analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, such as frequencies, percentages, and means, was used to describe the data. Inferential statistics, such as chi-square tests and t-tests, was used to test for differences between groups and a regression model. The qualitative data was analyzed using content analysis and thematic. The transcripts was read and coded, and themes was identified. The quantitative and qualitative data was integrated to gain a holistic understanding of the research topic. The findings was presented in both narrative and tabular form.

Data analysis refers to techniques used to reduce, organise and give meaning to data (Burns & Grove 2005, p.43). In quantitative studies, data analysis relies heavily on statistical analysis tools. Regardless of the types of data collected and the orientation of the researchers, data analysis always involves 2 steps: a summary of the results and an interpretation (Stommel & Wills 2004, p.27).

Data was downloaded from kobo collect and imported into SPSS. Data was cleaned and analysed in SPSS. Descriptive statistics, percentages, frequency tables and figures were used in the data analysis and interpretation. Chi-square analysis test for association and correlation show the relationships strength. A two-tailed p-value of less than 0.05 was considered statistically significant.

3.9 ETHICAL CONSIDERATIONS

In research ethics, scientific integrity is upheld along with the rights of participants and the organisations conducting the study (Burns and Grove 2005, p. 181, 207). There are no hazards associated with the study—physical or psychological. Perhaps the discomfort is only a temporary nuisance. The following areas of research ethics were sufficiently covered in the study:

Protecting the rights of the respondents.

The responders gave their informed consent. According to Burns and Grove (2005), on page 181, the right to self-determination is based on the ethical concept of respect for persons. All respondents were treated as autonomous agents and were informed about the intended study,

giving them the option to willingly participate or not. Coercion and secret data gathering were refrained from. Right to privacy: Respondents' thoughts and other personal data were kept secret. Right to autonomy and confidentiality: respondents' privacy was protected, and the researchers' handling of their personally identifiable data was kept private. Right to fair treatment (based on the moral precept of justice): Respondents were fairly chosen and received impartial care. The selection of genders was equitable. Based on the ethical principle of beneficence, the right to protection from discomfort and injury maintains that one should do well and, above all, do no harm. (Page 190, Burns & Grove, 2005). Scientific integrity ensured by truthful behaviour, documentation, and study publication. There would be no fabrication of data or falsification of study materials or procedures. Giving proper credit for using someone else's concepts, methods, output, or language is expected.

3.10 CONCLUSION

The research design and methodology were covered in this chapter, along with talks of the population, sampling and sampling procedure, data collecting, instrument validity and reliability, data analysis, and ethical considerations.

Chapter 4: To assess the prevalence of people who adopted Climate Smart Agriculture in Harare

Abstract

This study investigates the impact of climate-smart agriculture (CSA) practices on urban farming yields and food security in Harare. The primary objective was to assess the prevalence of CSA adoption among urban farmers and its effects on food availability. The study collected data on social and demographic characteristics, food sources, and agricultural practices from a sample of 275 urban farmers. Results indicate a male majority (53.8%) among respondents, with 43.4% having completed ordinary level education. About 66.2% of farmers reported being food secure, with agriculture being the main food source for 70.5% of respondents. The study highlights the significant role of urban agriculture in food security and suggests targeted interventions to enhance CSA adoption.

4.1 Introduction

Urban farming in Harare plays a crucial role in enhancing food security and improving livelihoods amid rapid urbanization and climate change challenges. This study aims to assess the prevalence and impact of climate-smart agriculture (CSA) practices among urban farmers in Harare. CSA practices are essential for improving resilience and productivity in urban farming, thereby ensuring food security. This chapter outlines the study's methodology,

including the description of the study area, research design, sampling procedure, data collection, analysis methods, and challenges encountered during data collection.

4.2 Material and Methodology

4.2.1 Description of Study Area

Harare, the capital city of Zimbabwe, experiences a subtropical highland climate with distinct wet and dry seasons. The city's urban farming landscape includes various crops grown in backyards, open spaces, and peri-urban areas. Urban farming in Harare is characterized by diverse socio-economic backgrounds, making it an ideal setting to study the impact of CSA practices.

4.2.2 Research Design

This study employed a descriptive research design to assess the prevalence of CSA practices among urban farmers in Harare. The design allowed for the collection of quantitative data to analyze demographic characteristics, food security status, and agricultural practices.

4.2.3 Sampling Procedure

A stratified random sampling technique was used to select a representative sample of 275 urban farmers from different wards in Harare. The sampling ensured diversity in terms of gender, education level, and farming experience.

4.2.4 Data Collection Procedure

Data were collected through structured interviews and questionnaires administered to urban farmers. The questionnaire covered demographic information, food security status, sources of food, types of crops grown, and details on CSA practices.

4.2.5 Data Analysis Procedure and Methods

Descriptive statistics were used to analyze the collected data. Frequencies, percentages, means, and standard deviations were calculated to summarize the demographic characteristics, food security status, and agricultural practices of the respondents. The data were analyzed using statistical software to identify patterns and relationships.

4.2.6 Challenges Encountered During Data Collection

The primary challenges encountered during data collection included logistical issues, reluctance of some farmers to participate, and language barriers. To mitigate these challenges, local enumerators familiar with the community and language were engaged, and adequate time was allocated for data collection.

4.3 Results and discussion

4.3.1 Social and Demographic characteristics

Table 4.1 Frequencies

Variable	**Value**	**Frequency**	**Percentage**
Gender	Male	148	53.8
	Female	127	46.2
Education	Primary	85	30.9
	Junior secondary	46	16.7
	Ordinary level	119	43.4
	Tertiary	25	9.1
Food availability	Food insecure	93	33.8
	Food secure	182	66.2
	Agriculture only	194	70.5

	Non-agricultural activities	4	1.5
Food source	Both Agricultural and non-agricultural activities	75	27.3
	Agriculture only	2	0.7
Grow own food	yes	229	83.3
	no	46	16.7
Food grown	cereals	115	41.8
	Cash crops	2	0.7
	Cereals and legumes	125	45.5
	Cereals and cash crops	31	11.3

This output above shows that majority are males with 53.8 % against females with 46.2%. Majority of 43.4% followed by primary with 30.9% then 16% junior secondary. However, the least as usual are tertiary with 9.1%. In this case 66.2% of the farmers are food secure and 33.8 are food insecure. About 70% mentioned their food source as agriculture and 1.5 % non-agriculture as main income source. Just 27.3 % mentioned that both % non-agriculture and agriculture activities provide as their main source of food. In terms of food, 83.3 grow their own food and on16.7 do not grow their own food. Most farmers in Harare grow cereals only (41.8%) then cereals and legumes (45.5%) followed by cereals and cash crops combine (11%).

Table 4.2: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation

Household head age	275	25.00	95.00	57.1709	16.40044
Family Size	275	1.00	9.00	4.3382	2.03577
How much land was use for the crops	275	.00	6.00	1.3597	1.04932
Number of Agricultural trainings attended	275	.00	7.00	1.2909	1.52680
How long have you been in farming	275	1.00	3.00	1.1418	.44175

The table 4.2 is showing the average age of 57.1 with standard deviation f 16.40. The average family size is 4.3 with standard deviation of 2.0. The average land for crop use is 1.3 hectors and standard deviation of 1.05. The average agriculture trainings are 1.2 with standard deviation of 1.5. Average majority of the farmers have been farming for 1.1 years.

4.4 Conclusion

The study reveals a significant adoption of urban farming practices in Harare, with a majority of farmers growing their own food and relying on agriculture as their primary food source. However, the adoption of climate-smart agriculture practices remains limited. The findings underscore the need for increased promotion and support for CSA practices to enhance food security and sustainability in urban farming.

4.5 Recommendations

1. Promotion of CSA Practices: Increase awareness and training programs on CSA practices to enhance their adoption among urban farmers.
2. Policy Support: Develop and implement policies that support urban agriculture and CSA practices.
3. Access to Resources: Improve access to agricultural inputs, land, and water resources for urban farmers.
4. Research and Development: Encourage further research on CSA practices and their impact on urban farming and food security.

4.6 References

1. FAO. (2013). Climate-Smart Agriculture Sourcebook. Food and Agriculture Organization of the United Nations.
2. IPCC. (2019). Climate Change and Land. Intergovernmental Panel on Climate Change.
3. Mugandani, R., Wuta, M., Makarau, A., & Chipindu, B. (2012). Re-classification of agro-ecological regions of Zimbabwe in conformity with climate variability and change. African Crop Science Journal, 20(2), 361-369.
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5. Zimbabwe National Statistics Agency (ZIMSTAT). (2020). Zimbabwe Demographic and Health Survey 2019-20.

Chapter 5: To identify key climate smart agriculture practices in Harare.

Abstract

This chapter identifies key climate-smart agriculture (CSA) practices in Harare and examines their adoption among urban farmers. Data were collected from 275 respondents to analyze their farming practices, awareness, and impact of climate change. The results indicate that most farmers have been engaged in farming for over 10 years (43.3%) and commonly practice crop rotation (71.7%), intercropping (73.1%), mulching (93.5%), and water conservation (86.2%). Despite noticeable climate changes, such as altered rainfall (52.4%) and temperatures (45%), 77.8% reported decreased livelihood activities. Government support and CSA awareness are significant, with 64.4% acknowledging governmental assistance and 60.7% being aware of CSA practices.

5.1 Introduction

The urban farming landscape in Harare is evolving in response to climate change. This chapter aims to identify key climate-smart agriculture (CSA) practices among urban farmers in Harare and assess their prevalence. Understanding these practices is crucial for promoting sustainable agriculture and enhancing food security in urban settings.

5.2 Material and Methodology

5.2.1 Description of Study Area

Harare, the capital of Zimbabwe, features a subtropical highland climate with distinct wet and dry seasons. Urban agriculture is practiced extensively in the city, contributing significantly to household food security and income. The study area includes various neighborhoods where urban farming is prevalent.

5.2.2 Research Design

A descriptive research design was employed to identify and analyze the CSA practices among urban farmers in Harare. This design facilitated the collection of quantitative data to assess the prevalence and effectiveness of different farming practices.

5.2.3 Sampling Procedure

Stratified random sampling was used to select a sample of 275 urban farmers from different wards in Harare. This method ensured a representative sample, capturing diverse demographics and farming experiences.

5.2.4 Data Collection Procedure

Data were gathered through structured questionnaires and interviews with urban farmers. The questionnaire covered various aspects, including demographic information, farming practices, CSA awareness, and perceived impacts of climate change.

5.2.5 Data Analysis Procedure and Methods

Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to analyse the data. Statistical software was employed to process the data, providing insights into the adoption and impact of CSA practices among urban farmers.

5.2.6 Challenges Encountered During Data Collection

Challenges included logistical constraints, respondent availability, and variations in understanding CSA practices. To address these, local enumerators were trained, and the questionnaire was pre-tested to ensure clarity and relevance.

5.3 Results and discussion

5.3.1 Farming Practices

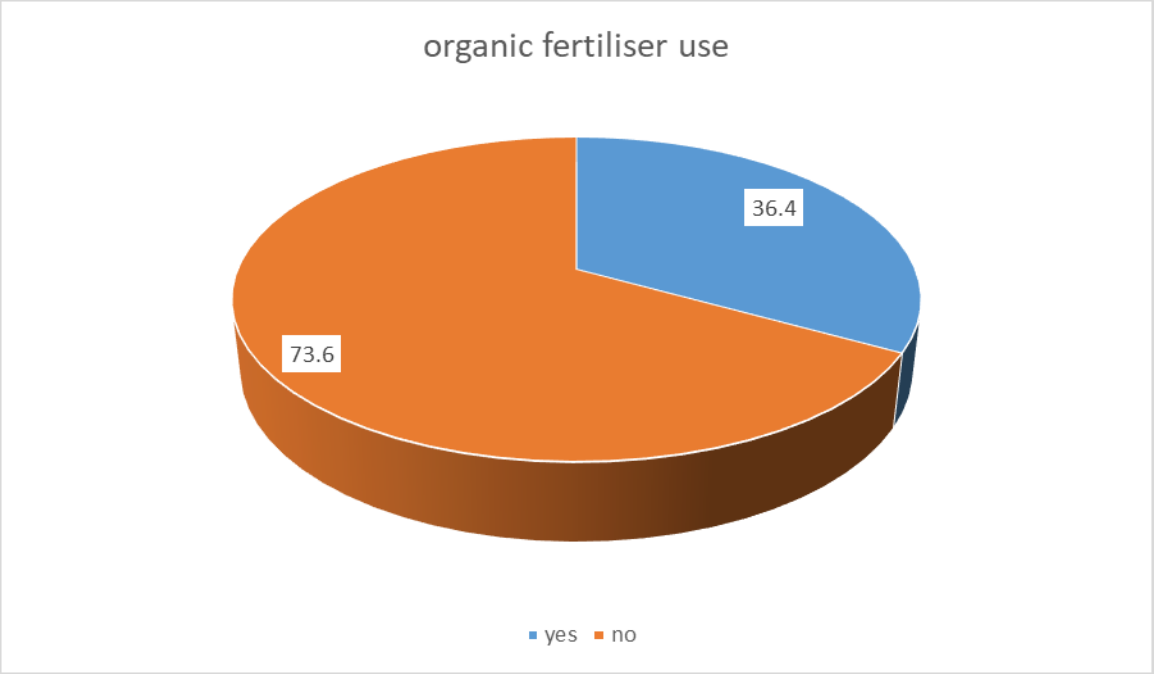
Table 5.3 Farming practises

Factors	**Values**	**Frequency**	**Percentage**
Period of farming	0-2years	117	42.5
	6-10years	39	14.2
	More than 10 years	119	43.3
Crop rotation	yes	197	71.7
Intercropping	yes	201	73.1
Organic fertilisers	yes	100	36.4
Mulching	yes	257	93.5
Water conserving in farming	yes	237	86.2
Cover crop	yes	222	80.7
Use weather information	yes	275	100
Farming practices	yes	171	62.2

changes			
Climate changes noticed	rainfall	144	52.4
	temperatures	125	45
	winds	6	2.2
Impact of climate change	Decreased livelihood activities	214	77.8
	No change	61	22.2
Government assisting in Climate Change	agree	177	64.4
Climate Smart Agriculture awareness	yes	167	60.7
Training in Agriculture	yes	229	83.3

Majority of 43.3% have been in farming for more than 10 years, while 14.2% have 6 to 10 years. And 42.5 % have been in farming for at most 2 years. The table 5.3 show that majority than 75% are practicing Crop rotation, intercropping, Mulching, Water conserving in farming, Cover crop and Use weather information except use of Organic fertilisers 36 %. About 62.2 % have changed their farming practices due to climate change in the past 10 years. Majority of those (52.4 %) have noticed change in rainfall and 45 % have noticed much change in temperature, however 2.2 % noticed winds. The climate change affected 77.8% livelihood activities as mentioned to decrease. However, 64% agree that government is support farmers in climate change. This is reflected by 60.7 who are very aware of smart climate agriculture and 83% being trained on agriculture in general.

Fig 5.1 use of organic fertiliser



Among all the practises of smart climate agriculture, the use of organic fertiliser is very low (36.4%). The major cause of this low adoption is due to lack organic manure in the areas compared to rural were majority farm keep livestock that produce organic manure. Adding to that the distances to get manure are too long until you get a farm with manure, most probably its out of town at least 40 km out of town compare to organic fertilisers available at every corner of hardware's. However, majority make use of organic fertilisers.

5.4 Conclusion

The study found widespread adoption of CSA practices among urban farmers in Harare, with a significant number practicing crop rotation, intercropping, mulching, and water conservation. Despite these practices, climate change continues to impact livelihoods, underscoring the need for enhanced support and training. Government assistance and increased awareness of CSA are crucial for improving urban farming resilience.

5.5 Recommendations

1. Enhanced Training Programs: Expand training on CSA practices to increase adoption and effectiveness among urban farmers.

2. Government Support: Strengthen government initiatives to support urban farmers in implementing CSA practices.

3. Resource Access: Improve access to resources such as organic fertilizers and water-saving technologies.

4. Climate Monitoring: Develop systems for real-time climate monitoring and dissemination of weather information to farmers.

5. Community Engagement: Foster community-based approaches to share knowledge and resources related to CSA.

5.6 References

1. FAO. (2013). Climate-Smart Agriculture Sourcebook. Food and Agriculture Organization of the United Nations.
2. IPCC. (2019). Climate Change and Land. Intergovernmental Panel on Climate Change.
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5. Zimbabwe National Statistics Agency (ZIMSTAT). (2020). Zimbabwe Demographic and Health Survey 2019-20.

Chapter 6. To identify factors affecting adoption of smart agriculture.

Abstract

This chapter examines the factors influencing the adoption of climate-smart agriculture (CSA) practices among urban farmers in Harare. The study identified major challenges, such as lack of knowledge (61.8%), limited access to agricultural officers (21.1%), and lack of resources (17.1%). Farmers highlighted the need for more CSA training (57.1%), financial support (33.5%), and improved access to markets (5.1%). The findings underscore the importance of addressing these barriers to enhance the adoption of CSA practices and promote sustainable urban farming.

6.1 Introduction

The adoption of climate-smart agriculture (CSA) practices is crucial for improving the resilience and productivity of urban farming in Harare. This chapter aims to identify the factors affecting the adoption of CSA practices among urban farmers. Understanding these factors is essential for developing strategies to enhance the uptake of CSA practices and improve food security and sustainability in urban agriculture.

6.2 Material and Methodology

6.2.1 Description of Study Area

Harare, the capital city of Zimbabwe, is characterized by a subtropical highland climate. Urban farming is prevalent across various neighborhoods, contributing significantly to food security and livelihoods. The city's farmers face numerous challenges, including climate change impacts, which necessitate the adoption of CSA practices.

6.2.2 Research Design

A descriptive research design was used to identify and analyze the factors influencing the adoption of CSA practices among urban farmers in Harare. This approach facilitated the collection of quantitative data on the challenges and support needs of farmers.

6.2.3 Sampling Procedure

Stratified random sampling was employed to select a representative sample of 275 urban farmers from different wards in Harare. This method ensured diversity in the sample, capturing a wide range of demographic and farming characteristics.

6.2.4 Data Collection Procedure

Data were collected using structured questionnaires and interviews with urban farmers. The questionnaire included sections on demographic information, farming practices, challenges faced in adopting CSA practices, and support needs.

6.2.5 Data Analysis Procedure and Methods

Descriptive statistics, including frequencies and percentages, were used to analyze the data. Statistical software was employed to process the data, allowing for the identification of key challenges and support needs related to CSA adoption.

6.2.6 Challenges Encountered During Data Collection

Challenges encountered during data collection included logistical constraints, varying levels of farmer engagement, and difficulties in understanding certain CSA concepts. To mitigate these issues, local enumerators familiar with the community and language were utilized, and efforts were made to simplify the questionnaire.

6.3 Results and discussion

6.3.1 Social and Demographic characteristics

Table 6.4 Top three challenges

Themes	**Frequency**	**Percentage**
Lack of knowledge	170	61.8
Lack of resources	47	17.1
Limited access to Agriculture officers	58	21.1

According to the table 6.4, most challenges faced are lack of knowledge (61.8%) limited access to agriculture officers (21%) and lack of resources (17%).

Table 6.5 improvements

Themes	**Frequency**	**Percentages**
Financial supply	92	33.5
Policy support	12	4.4
More climate Smart Agriculture trainings	157	57.1
Access to market	14	5.1

The farmers need support in climate smart agriculture trainings (57%), finance (33.5%) ,access to markets (5.1%) and policy (4.4%)

Conclusion

The adoption of CSA practices among urban farmers in Harare is influenced by several key factors, including knowledge gaps, resource limitations, and insufficient support from agricultural officers. Addressing these barriers through targeted training, financial support, and improved market access is essential for promoting sustainable urban agriculture.

Recommendations

1. Increase CSA Training: Expand training programs to improve farmers' knowledge and skills in CSA practices.
2. Financial Support: Provide financial assistance to farmers to facilitate the adoption of CSA practices.
3. Enhance Extension Services: Improve access to agricultural officers and extension services to support farmers in implementing CSA practices.
4. Market Access: Develop initiatives to improve market access for urban farmers, ensuring they can sell their produce effectively.

References

1. FAO. (2013). Climate-Smart Agriculture Sourcebook. Food and Agriculture Organization of the United Nations.
2. IPCC. (2019). Climate Change and Land. Intergovernmental Panel on Climate Change.
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5. Zimbabwe National Statistics Agency (ZIMSTAT). (2020). Zimbabwe Demographic and Health Survey 2019-20.

Chapter 7: To assess the impact of smart agriculture practise on household food security.

Abstract

This chapter assesses the impact of climate-smart agriculture (CSA) practices on household food security among urban farmers in Harare. The study employs statistical analysis to compare production levels between adopters and non-adopters of CSA practices. Results indicate that CSA adoption significantly enhances cereal and legume harvests, contributing to greater food security. A logistic regression model reveals that CSA adopters are 4.8 times more likely to achieve food security compared to non-adopters. Key factors influencing food

security include farm size, frequency of agricultural extension services, and household demographics.

7.1 Introduction

Climate-smart agriculture (CSA) practices are increasingly recognized as essential for enhancing food security and resilience among urban farmers. This chapter investigates the impact of CSA practices on household food security in Harare, exploring how these practices influence production levels and identifying key factors that contribute to successful adoption and improved food security.

7.2 Material and Methodology

7.2.1 Description of Study Area

Harare, the capital city of Zimbabwe, features a subtropical highland climate and is a hub for urban agriculture. The study focuses on various neighborhoods within Harare where urban farming is prevalent, providing a diverse sample of farming practices and household conditions.

7.2.2 Research Design

A mixed-methods research design was employed to assess the impact of CSA practices on food security. Quantitative data were collected through surveys and analyzed using statistical methods, while qualitative insights were gathered through interviews and focus group discussions.

7.2.3 Sampling Procedure

A stratified random sampling technique was used to select 275 urban farmers from different wards in Harare. This approach ensured a representative sample that included a variety of demographic and socio-economic backgrounds.

7.2.4 Data Collection Procedure

Data were collected using structured questionnaires and in-depth interviews. The questionnaire covered aspects such as farming practices, CSA adoption status, production levels, and household food security. Interviews provided deeper insights into the experiences and challenges faced by farmers.

7.2.5 Data Analysis Procedure and Methods

Quantitative data were analysed using descriptive statistics, t-tests, and logistic regression models. The t-tests compared production levels between CSA adopters and non-adopters, while the logistic regression model identified factors influencing food security. Qualitative data were analysed thematically to complement and enhance the quantitative findings.

7.2.6 Challenges Encountered During Data Collection

Challenges included logistical difficulties, variability in farmer availability, and potential biases in self-reported data. To address these issues, local enumerators were trained, and multiple data collection methods were employed to triangulate findings and ensure robustness.

7.3 Results and discussion

7.3.1 Social and Demographic characteristics

Table7.1: The effect of climate smart agriculture on production (mean test)

Group Statistics

	SCA_ladoption_status	N	Mean	Std. Deviation	Std. Error Mean
cereals_harvest	not adopted	42	744.0476	838.78559	129.42743
	adopted	233	1492.1073	1539.00162	100.82335
legumes_harvest	not adopted	42	173.5714	256.76051	39.61901
	adopted	233	372.8283	513.63563	33.64939

This table 7.1 shows that there is more production in those who adopted the climate smart agriculture more than those who did not by comparing means.

Table 7.2 comparing groups with different mean (turkey)

		Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
cereals_harvest	Equal variances assumed	.002	-748.05968	243.99198	-1228.40464	-267.71471
legumes_harvest	Equal variances assumed	.015	-199.25690	81.10831	-358.93415	-39.57965

The difference in both cereals sig=0.002 and sig=0.015 legume production 0.015 (harvest) is statistically significant since value are less than 0.05.

Logistic regression model

Table .7.3 Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	143.777[a]	.435	.621

The Nagelkerke R Square confirms that the model is moderate and acceptable

Table 7.4 variables in the equation

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
b2_area_farming	2.469	.813	9.216	1	.002	11.812	2.399	58.162
b17_freq_agricext	-.643	.264	5.922	1	.015	.525	.313	.882
SCA_ladoption_status (1)	1.577	.707	4.984	1	.026	4.843	1.212	19.346
a1_age	-.087	.026	11.079	1	.001	.917	.871	.965
a3_familysize	-.365	.151	5.867	1	.015	.694	.516	.933
legumes_harvest	.006	.002	6.193	1	.013	1.006	1.001	1.011
a5_income	-2.051	.635	10.412	1	.001	.129	.037	.447
Main crop grown	.338	.191	3.118	1	.077	1.402	.964	2.040
Harvest production status	-1.060	.394	7.253	1	.007	.346	.160	.749
Constant	2.560	2.559	1.001	1	.317	12.938		

Only significant variables were used in the model. The model help to control for other possible confounders. However the model

Food security = 0.16 harvest+ 0.9 crop Grown +0.037 income+0.013 legume harvest+0.6 family size +0.917 age+4.8 Climate smart agriculture Adoption+0.5 frequency agric officer+11.8 area farming

This model tells us that those who adopted the Climate smart agriculture farming are 4.8 times more likely to be food secure than those who did not adopt the Climate smart agriculture.

Model validation

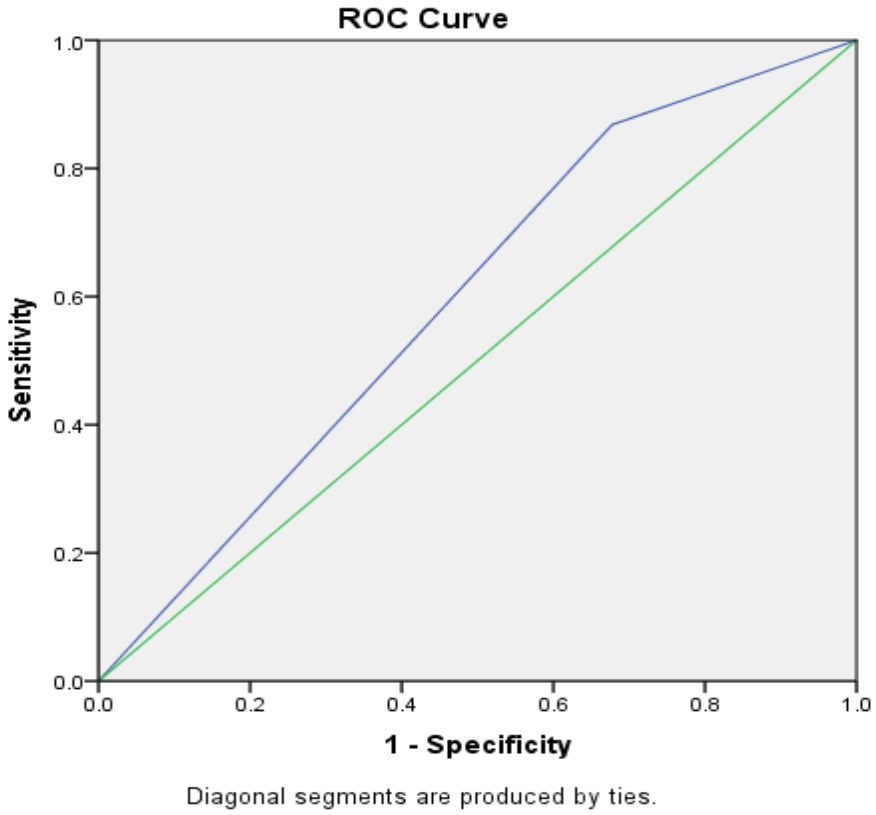

Figure 2: ROC curve

In this case the Area is 0.6 which is acceptable for the model to be reliable.

7.4 Conclusion

The study demonstrates that CSA practices significantly enhance food security among urban farmers in Harare. Adopters of CSA practices achieve higher production levels for both cereals and legumes, leading to improved household food security. Key factors contributing to food security include farm size, frequency of agricultural extension services, and household demographics. The logistic regression model confirms that CSA adoption increases the likelihood of achieving food security by 4.8 times.

7.5 Recommendations

1. Expand CSA Training Programs: Increase the availability and accessibility of training programs on CSA practices to enhance adoption rates among urban farmers.

2. Improve Agricultural Extension Services: Strengthen the frequency and quality of agricultural extension services to provide ongoing support and guidance to farmers.

3. Financial Support and Resource Provision: Provide financial assistance and access to resources, such as seeds and tools, to support the implementation of CSA practices.

4. Enhance Market Access: Develop initiatives to improve market access for urban farmers, enabling them to sell their produce more effectively.

5. Community Engagement and Awareness: Foster community-based approaches to share knowledge and resources related to CSA, and increase awareness of its benefits.

7.6 References

1. FAO. (2013). Climate-Smart Agriculture Sourcebook. Food and Agriculture Organization of the United Nations.
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Chapter 8: Summary, Conclusion and Recommendations

8.1 Introduction

This chapter gives the research summary, research conclusion and Policy implications and recommendations and lastly the area for further research.

8.2 Research Summary

Demographic Characteristics and Food Security

The demographic profile of urban farmers in Harare, as revealed by our study, reflects trends observed in similar contexts. The predominance of males in urban agriculture aligns with findings from studies in other African urban areas, where men often play a significant role in agricultural activities due to socio-cultural norms and economic factors (Drechsel et al., 2014). Moreover, the higher prevalence of primary education among farmers underscores the importance of tailored agricultural extension programs that address the specific knowledge gaps and needs of urban farmers (Mujawamariya et al., 2018).

The observed food security status, with a majority of farmers being food secure, suggests a certain level of resilience within urban farming systems in Harare. This resilience could be attributed to various factors, including the diversity of crops grown, as well as the adoption of climate-smart agricultural practices. However, the significant proportion of food insecure farmers underscores the persistent challenges faced by urban agriculture, particularly in the context of rapid urbanization and climate variability (Mabhaudhi et al., 2017).

Adoption of Climate-Smart Agriculture Practices

Our findings highlight the widespread adoption of climate-smart agriculture (CSA) practices among urban farmers in Harare, with notable implications for food security and resilience. The high prevalence of practices such as crop rotation, intercropping, and mulching reflects an awareness among farmers of the need to mitigate climate-related risks and enhance agricultural productivity (Rurinda et al., 2014). Additionally, the reliance on weather information underscores the role of information and communication technologies in supporting adaptive capacity and decision-making in agriculture (Moyo et al., 2019).

The observed changes in farming practices in response to climate change corroborate existing literature on the adaptive strategies of smallholder farmers in the face of environmental challenges (Morton, 2007). However, the disparities in CSA adoption across different demographic groups underscore the importance of targeted interventions to promote inclusive and equitable access to climate-smart technologies and knowledge (Giller et al., 2017).

Challenges and Support Needs

Despite the positive impact of CSA adoption on food security, our study identifies key challenges hindering sustainable urban agriculture in Harare. The prevalence of limited access to agricultural extension services and resources highlights systemic barriers that impede the uptake of innovative farming practices (Mujawamariya et al., 2018). Moreover, the persistent gap in knowledge underscores the need for capacity-building initiatives that empower farmers with the skills and information necessary to adapt to changing climatic conditions (Vanlauwe et al., 2014).

Addressing the identified challenges requires a multi-dimensional approach that integrates policy support, financial incentives, and market access opportunities. Government interventions aimed at enhancing agricultural extension services and providing targeted financial assistance can play a crucial role in promoting the widespread adoption of CSA practices among urban farmers (Lipper et al., 2014). Furthermore, fostering partnerships between government agencies, research institutions, and civil society organizations can facilitate knowledge sharing and technology transfer, thereby strengthening the resilience of urban farming systems (Kurwakumire et al., 2017).

In conclusion, our study underscores the importance of climate-smart agriculture as a pathway towards enhancing food security and resilience in urban areas. By addressing the socio-economic, institutional, and environmental dimensions of urban agriculture, policymakers and stakeholders can contribute to the sustainable transformation of urban food systems in Harare and beyond.

8.3 Conclusion

Urban agriculture plays a vital role in enhancing food security and resilience in rapidly urbanizing contexts like Harare. Through an examination of the impact of climate-smart

agriculture practices on urban farming yields and food security, this study has provided valuable insights into the dynamics of urban agriculture in Harare.

Our findings reveal a complex interplay of demographic characteristics, farming practices, and challenges faced by urban farmers. Despite the predominance of males in urban agriculture and the prevalence of primary education among farmers, food security remains a persistent concern, with a significant proportion of farmers facing insecurity.

The widespread adoption of climate-smart agriculture practices among urban farmers underscores the importance of proactive adaptation strategies in mitigating climate-related risks and enhancing agricultural productivity. From crop rotation to mulching, farmers are actively engaging in practices that not only improve yields but also contribute to environmental sustainability and resilience.

However, our study also highlights the systemic barriers and challenges hindering sustainable urban agriculture in Harare. Limited access to agricultural extension services, resource constraints, and knowledge gaps pose significant obstacles to the widespread adoption of climate-smart agriculture practices.

Addressing these challenges requires a concerted effort from policymakers, researchers, and stakeholders to support urban farmers in Harare. Investments in agricultural extension services, targeted financial assistance, and capacity-building initiatives are crucial for promoting inclusive and equitable access to climate-smart technologies and knowledge.

In conclusion, this study underscores the importance of climate-smart agriculture as a pathway towards building resilient urban food systems in Harare. By addressing the identified challenges and leveraging the potential of innovative farming practices, policymakers can contribute to the sustainable transformation of urban agriculture, ensuring food security and livelihood resilience for urban communities in the face of climate change and urbanization.

This conclusion summarizes the key findings of your study and emphasizes the importance of addressing challenges to promote sustainable urban agriculture in Harare.

8.4: Policy Implications and Recommendations

Policy Implications

The findings from this study have several important policy implications for enhancing food security and promoting sustainable urban agriculture in Harare through the adoption of climate-smart agriculture (CSA) practices:

1. Promotion of CSA Practices: Given the significant positive impact of CSA practices on food security, there is a need for policies that actively promote the adoption of these practices. This could include subsidies for CSA inputs, such as organic fertilizers and water-conserving technologies, as well as incentives for farmers who adopt sustainable farming techniques.

2. Capacity Building and Training: The study highlights the necessity of increasing CSA training programs. Policies should focus on building the capacity of agricultural extension officers and providing regular training sessions for farmers. This could be facilitated through partnerships with agricultural colleges, NGOs, and international development agencies.

3. Improvement of Extension Services: The frequency and quality of agricultural extension services need to be enhanced. Policies should ensure adequate staffing, training, and resources for extension officers to support urban farmers effectively. Mobile-based advisory services and community-led extension models could also be explored to reach more farmers.

4. Financial Support and Access to Resources: Lack of financial resources is a major barrier to the adoption of CSA practices. Policies should focus on providing financial support to farmers through grants, low-interest loans, and microfinance options. Additionally, access to affordable farming inputs and technologies should be improved.

5. Market Access: To ensure the economic viability of CSA practices, policies should aim to improve market access for urban farmers. This could involve the development of urban markets, cooperative marketing strategies, and support for value-added processing of agricultural products.

6. Integrated Urban Agriculture Policies: Urban agriculture should be integrated into broader urban planning and development policies. This includes zoning regulations that support urban farming, provision of farming spaces within urban areas, and policies that encourage the use of vacant land for agriculture.

7. Climate Change Mitigation and Adaptation: Policies should align CSA practices with national and local climate change mitigation and adaptation strategies. This includes

supporting research and development of CSA technologies that are specifically suited to the local context and climate conditions.

Recommendations

1. Enhance Access to Agricultural Extension Services:

- Government and non-governmental organizations should prioritize the improvement of access to agricultural extension services for urban farmers in Harare. This includes increasing the number of extension officers and establishing outreach programs tailored to the needs of urban farmers.

2. Promote Climate-Smart Agriculture Adoption:

- Policymakers should incentivize the adoption of climate-smart agriculture practices by urban farmers through targeted training programs, subsidies for inputs, and demonstration plots showcasing successful implementation of these practices.

3. Invest in Knowledge Transfer and Capacity Building:

- Efforts should be made to bridge knowledge gaps among urban farmers by providing training and educational resources on climate-smart agriculture, sustainable farming techniques, and weather-smart decision-making.

4. Facilitate Access to Financial Resources:

- Financial institutions and government agencies should develop tailored financial products and services to meet the specific needs of urban farmers, including access to credit for investment in climate-smart technologies and infrastructure.

5. Strengthen Market Linkages:

- Initiatives should be implemented to enhance market access for urban farmers, including the establishment of farmers' markets, value-added processing facilities, and partnerships with retailers and restaurants.

6. Integrate Climate Change Adaptation into Policy Frameworks:

- Climate change adaptation strategies should be mainstreamed into agricultural policies and urban development plans to ensure the resilience of urban food systems in the face of changing climatic conditions.

7. Foster Multi-Stakeholder Collaboration:

- Collaboration between government agencies, research institutions, civil society organizations, and community groups is essential for the successful implementation of climate-smart agriculture initiatives and the sustainable transformation of urban agriculture in Harare.

8. Monitor and Evaluate Impact:

- Continuous monitoring and evaluation of climate-smart agriculture interventions are necessary to assess their effectiveness, identify areas for improvement, and inform evidence-based decision-making for future interventions.

Implementing these recommendations will contribute to building the resilience of urban food systems in Harare, enhancing food security, and improving the livelihoods of urban farmers in the face of climate change and urbanization.

These recommendations offer practical steps to address the challenges identified in your study and promote sustainable urban agriculture in Harare.

8.5 Area for further study

While this study provides valuable insights into the impact of CSA practices on urban farming and food security in Harare, several areas warrant further research:

1. Longitudinal Impact of CSA Practices: Future research should focus on the long-term impact of CSA practices on food security and livelihoods. Longitudinal studies would provide deeper insights into the sustainability and long-term benefits of CSA adoption.

2. Economic Analysis of CSA Practices: Detailed economic analyses of CSA practices could help in understanding the cost-benefit ratio and economic viability of these practices for urban farmers. This includes assessing the return on investment and the impact on household incomes.

3. CSA Adoption and Gender Dynamics: Further research is needed to explore the gender dynamics in the adoption of CSA practices. Understanding how gender influences access to resources, training, and support services can help in designing more inclusive policies.

4. CSA Practices and Nutritional Outcomes: Investigating the impact of CSA practices on the nutritional quality of food produced and consumed by households can provide a more comprehensive understanding of their benefits. This includes assessing dietary diversity and nutritional status of urban farming households.

5. Technological Innovations in CSA: Research on innovative CSA technologies and practices that are locally adapted and cost-effective can contribute to the development of more efficient and sustainable farming methods. This includes the use of digital tools, precision farming, and climate-resilient crop varieties.

6. Policy Implementation and Effectiveness: Evaluating the implementation and effectiveness of existing policies related to urban agriculture and CSA can identify gaps and areas for improvement. This includes assessing the impact of policy interventions on the adoption rates and success of CSA practices.

7. Socio-Economic and Environmental Impacts: Comprehensive studies that examine the broader socio-economic and environmental impacts of CSA practices can provide a holistic view of their benefits. This includes assessing impacts on community cohesion, biodiversity, and urban ecosystems.

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APPENDIX: DATA COLLECTION TOOLS

KEY INFORMANT INTERVIEW GUIDE

1. How has food security changed in Harare urban agriculture setting in last 2 years?

   ……

   ……

   ……..

2. What are the main sources of food insecurity in Harare

   ……

   ……

   ……..

3. What impact have CCA had on food secure in Harare

   .....

   .....

   .....

4. What are the main challenges faced by farmers in Harare

   ……

   ……

5. How can the farmers be supported to improve food security?

   ……

   ……

6. What can be done to improve climate smart agriculture in Harare?

   ……

   ……

   ……

Section A

Socio-Demographics

1. Household head age ……
2. Gender of household head (1=male; 2=female)
3. Family size ……...
4. Education level of Household head ……..
   (1=Primary; 2=Junior Secondary; 3= Ordinary level; 4=Tertiary)
5. Main source of family income ……
   (1= agriculture only; 2= non agriculture; 3= combination of agriculture and non-agriculture)
6. Last season Yearly agricultural income US$ ……
7. Last season's Total Income US$ ……...

Section B

Farmers characterisation and practises,

1. Do you own or rent your land…….[rent] [own]
2. How much land did you use for farming crops?.....ha [ ]
3. How long have you been engaged in urban farming? [ ] 0-5 years [ ]6-10 years [ ]more than 10
4. Do you use crop rotation in your farming? …...[1=yes] [0=no]
5. Do you practice intercropping? …...[1=yes] [0=no]
6. Have you ever used organic fertilizers or compost? …...[1=yes] [0=no]
7. Do you use mulching methods? …...[1=yes] [0=no]
8. Do you do water-conserving irrigation …...[1=yes] [0=no]
9. Do you use cover crops to prevent soil erosion? …...[1=yes] [0=no]

10. Distance to the nearest village market (km) .....minutes of walking time.....
11. Distance to the nearest main market (km)……minutes of walking time…….
12. Quality of road to the main market……
    (1= Very poor; 2= Poor; 3= Good; 4=Average; 5= best)
13. Distance to the nearest source of inputs (km) .....
14. Distance to the nearest agricultural extension office (km……
15. Major source of drinking water……...
    (1=Piped; 2=Borehole; 3=Protected dug well/spring; 4=Unprotected dug well/spring; 5=Rivers/lakes/pond/stream; 6=Rain harvested,)
16. Distance to major water source for drinking (km)……
17. Frequency of extension contact; how many times does extension worker visit you per month? ……..
18. Number of agriculture trainings attended ……
19. Have you ever received any free inputs? …… (0= yes 1= no)
20. If yes under which programme have you been a beneficiary?

    (1= Command agriculture; 2= Presidential input scheme; 3= Social welfare; 4= Input subsidy shops)
21. How long have you been a beneficiary of these input programmes?
    (1= only once 2= at least twice 3= more than five years)
22. If yes, what type of inputs? (1=seed; 2=fertiliser; 3=agrochemicals; 4=tillage services; 5=fuel; 99=other specify

Section C: Food Access

1. How many meals do you eat per day? …….
2. What is your primary food source? [1=agriculture 2=non-agriculture 3=both agriculture and non-agriculture activities]
3. Do you grow food on your own? 0=No; 1=Yes; 3=Sometimes
4. If yes what are the main crops you grow? 1=cereals; 2=legumes; 3=cash crops; 4=a combination of cereals and legumes

How much did you harvest on your main crop last season?

Crop	**Area planted (HA)**	**Harvest (Kg)**
5. Maize		
6. Groundnut		
7. Sorghum		
8. Beans		

9. Has your harvest decreased, increased in the past 5 years? ..... (1= decreased 2= almost stagnant 3= increased)

Section D:Food diversity

Food source	In the last 24 hours , have household consumed **1=yes 0=no**	In the last 7 days how many times did household eat? Put 0 where item was not eaten	How was item obtained **code** **1=own produced** **2=bought** **3=gift** **4=other (specify)**
1.Staples (millet, sorghum, maize, rice, wheat, bread, noodles)			
2. Roots and Tubers e.g. potato, sweet potato etc			
3.Green leafy vegetables (covo, rape etc.)			
4.Vegetables(carrots rape etc)			
5.Fruits (apples bananas etc)			

6.Legumes/ pulses (bean, peas, cowpeas, nuts)

7.Meat and fish (beef, pork, lamb, goat, wild, poultry etc.)

8.Oils and fats

9.Milk and milk products

10.Eggs

11.Sugars (sugar , honey, biscuits etc)

12.Condiments (e.g. coffee, tea)

Section E: Climate change and Support

1. What the most change in the weather have you observed in recent years? [1] change in rainfall [2] change in temperature [3] change in winds
2. How have these changes impacted your farming activities? [1] reduced [2] no change [3] increased
3. Have you made any changes to your farming practices in response to these changes? .[1] yes [0] no
4. Do you feel that the government is doing enough to help farmers adapt to climate change? .[1] yes [0] no
5. Have you heard of the term "climate-smart agriculture"? .[1] yes [0] no
6. I f yes Have you ever received any training or education on climate-smart agriculture practices? .[1] yes [0] no
7. Do you think climate-smart agriculture practices are applicable to urban farming? [1] yes [0] no
8. What challenges do you face in adopting climate-smart agriculture practices? [1] Lack of knowledge, [2] lack resources, [3] limited access to agric officers

9. What would you like to see change in order to improve urban farming in Harare?
   [1] financial support [2] policy support [3] Agric training support [4] access to markets
10. How do you think the government can support in climate smart agriculture in urban farmers more effectively? [1] free inputs [2] supportive farming policy [3] access to agric officers [4] farming loans

Thank you so much for participating in my study.