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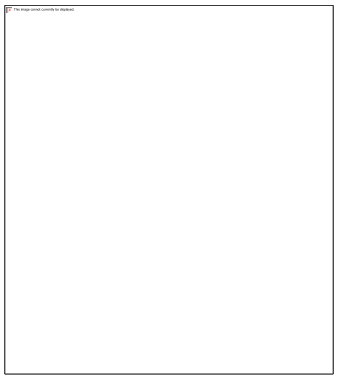

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF SUSTAINABLE DEVELOPMENT

Assessment of the Effects of Climate Change and Variability on Food Security: The Case of Ward 12, Hurungwe District, Mashonaland West Province, Zimbabwe

By

Nigel Tanaka Chikomba

A dissertation submitted in partial fulfilment of the Bachelor of Science Honours Degree in Development Studies

Supervised by

Mr Samukange

2024

Approval Form

The undersigned certify that they have read the dissertation and have approved its submission for marking confirming that it conforms to the departmental requirements on a research entitled: “Assessment of the Effects of Climate Change and Variability on Food Security: The Case of Ward 12, Hurungwe District, Mashonaland West Province, Zimbabwe” Submitted by Nigel Tanaka Chikomba in partial fulfilment of Bachelor of Science Honours Degree in Development studies.

Supervisor:

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Declaration

I hereby declare that this thesis has been the result of my own original efforts and investigations and such work has not been presented elsewhere for the purpose of degree assessment. All additional sources of information have been acknowledged by means of references.

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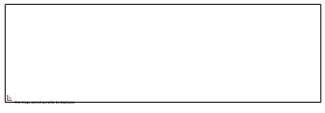
Date ……/……/..……



Dedication

This research is dedicated to my famaily.

Acknowledgement

I would like to express my sincere gratitude to all those who supported and assisted me throughout my dissertation journey. First and foremost, I am deeply grateful to my supervisor, whose expertise, guidance and encouragement from the initial to the final level enabled me to develop an understanding of the subject. I appreciate the useful feedback and constructive criticism provided, which served to strengthen my work.

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I am also thankful to the various individuals who participated in my study. This dissertation would not have been possible without their valuable insights, perspectives and contributions. Finally, I offer my regards and blessings to all of those who supported me in any respect during the completion of my dissertation.

Abstract

The study assessed the effects of climate change and variability on food security Zimbabwe, focusing on Ward 12, Hurungwe District. Climate change poses a significant threat to food security. Rural agricultural communities relying on rain-fed agriculture are particularly vulnerable to the impacts of climate change, with smallholder farmers disproportionately affected. The objectives of the study were to explore the effects of climate change and variability on small-scale agricultural production and food security in Ward 12, Hurungwe District; to examine the coping strategies employed by small-scale farming households in Ward 12, Hurungwe District to deal with climate change effects on crop yields and food availability, as well as to assess the key challenges faced by small-scale farmers in adapting their agriculture practices to the changing climate in order to ensure future food security in Ward 12, Hurungwe District. The study used a mixed methods approach to obtain data from 322 respondents. The study found that while food security has remained stable due to coping strategies and aid, rising temperatures and rainfall changes threaten future production in Ward 12 without improved adaptation. Key findings show diversification has helped buffer impacts but may not suffice as changes intensify. Limited access to resources and poverty discourage adoption of recommended practices and experimentation, constraining adaptive capacity. Unless financial, technological and socioeconomic support addresses these intersectional challenges, adaptive paralysis rather than progression will result—compromising long-term food security.

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CHAPTER 1: INTRODUCTION

1.0 Introduction

This study is an assessment of the effects of climate change and variability on food security in Zimbabwe. Climate change poses a significant threat to global food security. Rural agricultural communities in Sub-Saharan Africa that rely on rain-fed agriculture are particularly vulnerable to the impacts of increasing temperatures, changing precipitation patterns, and more frequent extreme weather events. Zimbabwe has experienced these climate change effects, with smallholder farmers disproportionately affected. Ward 12 of Hurungwe District in Mashonaland West Province demonstrates the complex challenges between climatic stresses and household food security outcomes. As a predominantly rural district where the majority of residents depend on rain-fed maize and small livestock production for their livelihoods, Hurungwe provides an opportune case study location to qualitatively assess how climate change and variability influence local food systems. Through in-depth interviews, focus groups, surveys and document analysis, this research aims to develop an empirically grounded understanding of the climate impact pathways, adaptive strategies employed, and key support needs identified by agricultural stakeholders in Hurungwe district.

1.1 Background to the Study

Climate change and variability poses a dire threat to worldwide food security and agricultural viability according to a wealth of peer-reviewed research. Scholars prognosticate climate disruption will undermine stable yields and nutritional diversity across multiple agricultural zones (Lobell et al., 2015). Rising temperatures, shifting precipitation patterns, and more frequent extreme weather are expected to increasingly stress crop and livestock productivity worldwide over coming decades (Tol, 2018). In Asia, rising seas and more frequent extreme weather severely jeopardize rice farming and food security in densely-populated low-lying nations such as Bangladesh and Vietnam (ADB, 2013; World Bank, 2013). In Bangladesh, crop losses due to climate change-augmented cyclones, flooding and sea level rise already range from 10-15% annually (Banerjee et al., 2019). Similarly, in Latin America maize and bean yields in rain-fed areas are projected to decline steeply under future climate scenarios, posing risks to rural livelihoods and food access (Vermeulen et al., 2013).

Climatological disruptions from anthropogenic climate change have already damaged agricultural outputs and livelihoods across both developed and developing economies. Climate change exacerbated past droughts in the Sahel region of Africa, damaging subsistence farming and food availability (Dagar & Saulnier, 2017). Similar impacts were seen from heatwaves affecting maize harvests across the American Midwest and wheat yields in South Asia (Ahamed et al., 2020). Academic analysis has therefore rightly shifted focus towards bolstering agricultural resilience and food security adaptations that can help mitigate effects of a changing climate (Nyborg et al., 2016). Interventions around heat/drought-tolerant crops, improved farming techniques, climate-smart agriculture, infrastructure investments, social safety nets and aid programs have all garnered attention as means to improve system robustness amid disruptions (Wheeler & von Braun, 2013). However, risks remain substantial for many communities reliant upon climate-sensitive livelihoods, particularly in developing regions (Rosenzweig et al., 2014).

Sub-Saharan Africa faces severe threats to food security from climate change due to its heavy reliance on rain-fed agriculture (USAID, 2019). Rising temperatures and shifting precipitation patterns are altering agricultural production patterns across the continent (Thornton et al., 2011). For instance, higher temperatures have reduced maize yields by over 20% in some areas of South Africa (MacKellar et al., 2014). Meanwhile, droughts exacerbated by climate change have significantly decreased millet and sorghum yields by over 25% in West African nations such as Nigeria, Mali and Burkina Faso since 1960 (Sultan and Gaetani, 2016). Moreover, increased frequency and intensity of extreme weather events linked to climate change pose additional risks. In East Africa, devastating floods and landslides due to heavy downpours have destroyed crops and livelihoods in countries like Ethiopia, Somalia and South Sudan in recent years (IFPRI, 2019). Similarly, climate change-augmented cyclones and flooding in coastal nations like Mozambique, Madagascar, and Gambia have incurred substantial agricultural losses (USAID, 2015). For instance, crop damage from intensifying cyclones in Mozambique averages 10-15% yearly (Banerjee et al., 2019).

Beyond production impacts, climate variability also reduces food availability and access in Africa through other pathways. Post-harvest losses of staple grains like maize, millet and sorghum are elevated across the region during recurring climate change and variability (Diouf et al., 2019). In addition, climate shocks weaken food systems and drive up prices, curbing affordability and nutrition outcomes especially for vulnerable groups (Tibesigwa and Visser,

2016). Considering over 60% of Africa's population rely on climate-sensitive smallholder agriculture for their sustenance, the continent will likely witness growing food insecurity due to climate change in coming decades absent concerted adaptation efforts (World Bank, 2013; FAO, 2018).

The Southern African region faces considerable climate change challenges to ensure stable food production and access. Countries such as South Africa, Mozambique, Zambia, Zimbabwe and Malawi have primarily rain-fed agriculture-based economies that are highly sensitive to climate fluctuations (Tadross et al., 2005; Nicholson, 2014). Erratic rainfall and rising temperatures associated with climate change threaten the livelihoods of nearly two-thirds of Southern Africans who rely directly on smallholder farming (World Bank, 2018). Maize is a staple crop throughout the region, yet climate change is adversely impacting yields. For example, temperature increases have reduced maize harvests by over 20% across the rainfed production zones of South Africa according to MacKellar et al.'s (2014) analysis of yield trends. Similar declines have been observed in Zambia and Zimbabwe due to Terminal droughts exacerbated by climate change (Saïd et al., 2020; Tadross et al., 2009). Meanwhile, heavy rainfall events linked to climate change have damaged maize fields through flooding in low-lying areas of Mozambique and Malawi in recent years causing annual losses of 10-15% of production nationally (Banerjee et al., 2019; UNCDF, 2019).

Beyond production impacts, the food security of vulnerable groups is threatened through other climate change pathways. For instance, more frequent droughts in Southern Africa diminish post-harvest grain reserves, aggravating food insecurity (UNEP, 2007). Climate shocks also drive up staple food prices across the region due to supply disruptions, reducing dietary quality particularly for low-income, agricultural laborers (Tschakert, 2007). Given persistent poverty and lack of robust social safety nets in much of Southern Africa, climate change impacts pose tremendous risks to sustainable development goals of eradicating hunger (FAO, 2015). This study thus aims to assess climate vulnerabilities across agricultural value chains from the field to household level across Southern African nations.

Agriculture plays a crucial role in the Zimbabwean economy and society. According to the Food Association Organisation (FAO) (2021), over 70% of Zimbabwe's population derives their livelihood from agricultural activities which contribute 17% to the national gross domestic product (GDP). However, Zimbabwe's agricultural sector is highly sensitive to weather variability and changing climatic conditions (Mubaya et. al, 2012). Over the past few decades,

there has been an increasing trend of warmer temperatures, unpredictable rainfall patterns and recurrent drought events being experienced across the country (Makadho, 1998; Mlambo & Dube, 2016). Such climatic aberrations have had devastating consequences on Zimbabwe's food production systems and levels of food security.

Historically, Zimbabwe experienced occasional drought episodes once every 10-15 years. However, over the past 20 years, severe drought events have occurred almost every 5 years, adversely impacting agricultural livelihoods and food production levels (Ngongondo et al., 2011). For instance, the droughts of 1991/1992, 2002/03, 2014/15 and 2020 resulted in widespread crop failures and acute food shortages across the country (WFP, 2021). The subsequent hunger and malnutrition incidences pushed millions of vulnerable Zimbabweans into conditions of food insecurity and undernourishment (FAO, 2013). Analysis of long-term meteorological records by Makaudze (2004) found that rainfall patterns have become unpredictable and temperatures exhibited a warming trend of 0.8°C from 1960-2004 across most agro-ecological zones of the country. These findings were corroborated by regional climate modeling studies which projected continued warming and decreases in precipitation for Zimbabwe under future climate change scenarios (Ziervogel & Calder, 2003). Scholarly works have demonstrated how climate variability exacerbates food insecurity in developing agrarian economies like Zimbabwe through reductions in agricultural productivity and yields, loss of livelihood sources as well as increased vulnerability of poor communities (Thornton et al., 2014).

Hurungwe District is located in northern Zimbabwe within Mashonaland West province. It comprises one of six districts in Mashonaland West, bordered by Makonde to the south and Guruve to the north, with Mashonaland Central to the north. At 19,678 km2, Hurungwe is the largest district (ZimStat, 2020). The landscape encompasses three agro-ecological zones. Communal lands primarily occupy zones 3-4 with low, erratic rainfall while commercial farms in zones 2 experience favorable conditions (Togarepi, 1997). The economy of the majority of people in Hurungwe is centered around subsistence crop and livestock farming. Staple crops include maize, sorghum, groundnuts, and roundnuts. Cattle, goats, sheep, and chickens are the main livestock reared. The district has experienced significant changes in climate and increases in climatic variability in recent decades. The district has experienced declining rainfall trends as well as rising temperatures throughout the growing season. There is an increase in the frequency and intensity of extreme weather events such as climate change and variability

negatively impacting agricultural production. It is against this background that this study seeks to assess of the effects of climate change and variability on food security in Zimbabwe.

1.2 Statement of the Problem

Climate change and variability undermines agricultural productivity which is the mainstay of rural economies in Ward 12, Hurungwe District, Zimbabwe, posing a serious threat to food security. As an agrarian economy relying heavily on subsistence rain-fed agriculture, Ward 12, Hurungwe Ditrict is highly vulnerable to the impacts of climate change. Over the past few decades, Zimbabwe has experienced increasing temperatures, unpredictable rainfall patterns, and recurrent drought events that have devastated agricultural production and food security. Historically, severe droughts occurred every 10-15 years but now occur almost every 5 years, significantly reducing crop yields and pushing millions into hunger. Climate change effects like rising temperatures and shifts in rainfall patterns are projected to continue worsening agricultural conditions according to climate modeling. Understanding climate change vulnerabilities can help design adaptation strategies to bolster Zimbabwe's agricultural resilience and food system stability in the face of a changing climate. It is from this reason that this study seeks to assess of the effects of climate change and variability on food security in Ward 12, Hurungwe District, Mashonaland West Province, Zimbabwe.

1.3 Research Objectives

The main objective of this study is to assess of the effects of climate change and variability on food security in Ward 12, Hurungwe District.

The study is also informed by the following subresearch objectives:

1. To explore the effects of climate change and variability on small-scale agricultural production and food security in Ward 12, Hurungwe District.
2. To examine the coping strategies employed by small-scale farming households in Ward 12, Hurungwe District to deal with climate change effects on crop yields and food availability.
3. To assess the key challenges faced by small-scale farmers in adapting their agriculture practices to the changing climate in order to ensure future food security in Ward 12, Hurungwe District.

1.4 Significance of the Study

To the Local Communities:

The proposed research study is significantly important for providing insights into how climate change is impacting the agricultural livelihoods and food security of small-scale farming communities inWard 12, Hurungwe District, Zimbabwe. Understanding these impacts through local farmers' perceptions and lived experiences is crucial. The findings could help community members better understand climate risks and adopt appropriate adaptation strategies to build resilience in fields and homes. Additionally, by exploring existing coping mechanisms, the research may help strengthen vital support networks between farmers.

To the Government:

At a policy level, the Government of Zimbabwe stands to greatly benefit from the results of this case study. The research would furnish evidence-based knowledge to guide the development of targeted climate adaptation policies, programmes and projects focused on supporting smallholder agriculture and food security. In particular, the research could aid key ministries in prioritizing climate action plans and allocating resources appropriately. By identifying knowledge gaps, it also presents opportunities to boost climate-smart agricultural research, education and extension.

To the Academia:

This study contributes to academic literature on the relationship between climate change and food security. It provides empirical data on how climate factors like rainfall and temperature variations are influencing agricultural production and livelihoods in Hurungwe district. The findings add to the body of knowledge around climate change vulnerability and adaptation in Zimbabwe and similar agro-ecological regions. Academics and researchers interested in climate change impacts on food systems will benefit by utilizing the results of this study. It also provides a basis for further research on effective adaptation strategies and policies to enhance food security under climate change..

To the Researcher:

Conducting this study provided an opportunity for the researcher to contribute practically to climate change adaptation discourse. It was a valuable learning experience on undertaking field

research and employing appropriate methods to assess climate change vulnerability. The researcher gained first-hand understanding of challenges smallholder farmers face due to climate impacts. The results of the study will support the researcher's academic progress by forming part of publications and conference presentations. It also provides basis for continuing engagement with relevant stakeholders through dissemination and future collaborative work.

1.5 Delimitations of the Study

The variables of the study will be delimited to focus on assessing the impacts of climate change and variability on the three main dimensions of food security, namely agricultural production, food availability and access to food. Other socio-economic factors that also affect food security levels in the district will not be investigated in great detail. By concentrating on these key climate-sensitive variables, the study will be able to provide useful insights into how climatic factors alone impact food supply and demand dynamics in rural communities. The geographical boundary of the study area will be delimited to Ward 12, Hurungwe district in Mashonaland West Province. While climate change will have implications for food security across Zimbabwe, confining the research to just this district will make data collection feasible within the study duration. Examining impacts across multiple and dispersed locations would dilute the depth of inquiry. Concentrating on Ward 12 in Hurungwe Disrict will allow for a more thorough understanding of local vulnerability and adaptation contexts specific to that locale. Furthermore, the time period considered will be from 2015 to the present date. Focusing on the more recent past and current time period from 2015 will allow for analyzing climate trends over a delimited yet relevant timeframe. Assessing impacts from 2015 to date will provide sufficient data on historical weather patterns and food security conditions in Hurungwe district. This temporal scope of 8 years will suitably meet research needs for a master's study within current time boundaries.

1.6 Limitations of the Study

Obtaining reliable historical climate and weather data from meteorological stations will be challenging since record keeping in the past may not have been as systematic. However, the researcher will triangulate any available station data with other sources of information like reports from the ministry of agriculture and interviews with long-time residents to get a more comprehensive picture of historical climate trends. Participants may not recall past climate and weather conditions and impacts accurately due to fallibilities of human memory over long

periods of time. To address this, the researcher will focus discussions on notable extreme climate events that are more likely to be remembered and cross-check responses across multiple interviews. The researcher will also complement interviews with reviews of secondary data sources. There is a risk of respondents giving socially desirable answers or responses they think the interviewer wants to hear rather than being completely open and honest. The researcher will build rapport and trust with respondents and assure anonymity to get more candid responses. The researcher will also look for non-verbal cues and consistency across responses. The study being confined to one district limits generalizability of findings to a wider population. By employing rigorous and triangulated methods while being aware of limitations, the researcher will aim to conduct a study that generates robust, reliable and meaningful insight into how climate change is affecting food security in the local context.

1.7 Definition of Terms

Climate Change and Variability

According to the IPCC (2021), climate change refers to significant and lasting changes in weather patterns over long periods of time primarily caused by increasing levels of carbon dioxide and other anthropogenic greenhouse gases in the atmosphere. Climate variability, as defined by Trenberth et al. (2007) relates to variations in the mean state and other statistics (such as standard deviations, frequency of extremes, etc.) of the climate on temporal and spatial scales beyond that of individual weather events. For the purposes of this study, climate change and variability will be defined as deviations from normal precipitation and temperature patterns over multiple decades that disrupt agricultural production.

Food Security

Food security is a complex socio-economic and environmental issue. Amartya Sen (1981) defined food security as "access by all people at all times to enough food for an active, healthy life." Similarly, Maxwell and Smith (1992) characterized food security as having “physical and economic access to basic food.” For the purposes of this study, food security is defined as the reliable access to a sufficient quantity of affordable, nutritious food to meet dietary needs for

all household members, without compromising on other basic needs, now and in the future, under conditions impacted by climate change factors.

1.8 Organisation of Study

Chapter 1: Introduction

This chapter focuses on introducing the study and giving a little history that places the subject under investigation in its proper context. It also describes the research problem, as well as the goals and research questions that guide the investigation. The study's reasoning is given along with its delimitations and limitations.

Chapter 2: Literature Review

In order to familiarize the researcher with the existing literature and minimize unintentional repetition of findings, this chapter will present a thorough literature review. It clarifies the gap in the literature that this study is attempting to fill. There will also be a presentation of the study's theoretical foundation.

Chapter 3: Methodology

The approach to be applied in performing the research will be provided in this chapter. Moreover, techniques for data collection and analysis will be given.

Chapter 4: Data Presentation and Analysis

The chapter will present and analyze the data findings and provide a discussion that connects the researcher's discoveries to the suppositions, discoveries, and conclusions of other researchers in the literature already in existence.

Chapter 5: Conclusions and Recommendations

The final chapter's emphasis will be on reaching conclusions and making suggestions to various parties.

1.9 Chapter Summary

This chapter introduces the research by outlining the threat climate change poses to global food security. It discusses how smallholder farmers in developing countries like Zimbabwe are

particularly vulnerable due to reliance on rain-fed agriculture. The problem statement notes climate change undermines agricultural productivity and food security in Ward 12. The objectives and research questions aim to explore local climate impacts and coping strategies. The significance and limitations of the study are also outlined to contextualize the research and its potential contributions.

CHAPTER 2: LITERATURE REVIEW

1.0 Introduction

This chapter reviews existing theory and research relevant to the study in order to familiarize the researcher with past work on the topic. Summarizing prior studies allows the researcher to build on established knowledge in the field while avoiding simply duplicating previous findings. It also identifies gaps and limitations in the literature, highlighting opportunities for the current research to advance understanding. By critically engaging with achievements and shortcomings of prior empirical work, this literature review aims to help situate the new study within the broader research context and establish how it can potentially contribute novel or improved insights into the issue being examined.

2.1 Theoretical Framework

2.1.1 Resilience Theory

The theory of resilience can provide a useful framework for assessing the effects of climate change and variability on food security in Hurungwe District, Zimbabwe. According to scholars like Adger (2000) and Folke et al. (2010), resilience theory is useful for examining how climate change and variability affect the economic development of agricultural-dependent rural areas. Resilience thinking has gained attention from researchers studying climate change impacts on rural economies (Nhemachena & Hassan 2007). It views rural systems as complex social-ecological networks molded by interconnected social, economic and environmental forces (Adger 2000). Climate hazards such as climate change and variability regularly disrupt these systems (Folke 2006). Resilience theory allows for examining how increasing climate variability and long-term climate change alter and disrupt the food system.

Key to resilience theory is the understanding that various factors shape rural systems (Adger 2000). Social elements like land ownership and traditions influence adaptive skills (Walker et al. 2004). Economic diversification and market ties impact resilience (Adger 2000). Environmental resources such as soil and biodiversity affect coping abilities during climate stresses (Nhemachena & Hassan 2007). Resilience theory emphasizes building flexibility and social learning to help rural communities face climate stresses through new agricultural techniques, livelihood diversification or weather-resilient infrastructure (Folke 2006). It provides a lens for appreciating rural system vulnerabilities to climate change while also identifying adaptive pathways within complex social-ecological networks.

2.2 Effects of Climate Change and Variability on Small-Scale Agricultural Production and Food Security

The impacts of climate change and variability on small-scale agricultural production and food security have been studied extensively across European countries in recent years. In a seminal study conducted in Italy between 2018 and 2020, Conti et al. (2021) investigated how varying weather patterns affected crop yields and farmer livelihoods in rural communities. The overarching aim was to understand climate change vulnerabilities and develop targeted adaptation strategies. A mixed methods approach was employed, combining agro-meteorological data analysis, surveys of 200 smallholder farms, and in-depth interviews. Key findings indicated significant declines in maize, wheat and tomato yields during periods of elevated temperatures and reduced rainfall. This was directly attributed to more frequent and intense heatwave events as per the climate projections for Southern Europe. The downstream consequences on household income and food access were also explored. Most concerningly, over a third of respondents reported relying on alternative or additional work during poor harvest seasons to afford basic needs like nutrition.

A contemporaneous qualitative study amongst 50 farming entities in Portugal examined perceived risks and adaptive behaviors (Santos et al., 2019). Semi-structured discussions probed cropping patterns, inputs usage, and risk management practices across different agro-ecological zones. An inductive thematic analysis revealed substantial variety in adaptive strategies being adopted out of necessity, though with mixed outcomes. Those able to diversify into livestock rearing or cash crops fared relatively better. However, resource-poor smallholders had considerable difficulty improving resilience in the face of compounding biophysical and financial constraints. Santos and colleagues argued for targeted rural development and climate adaptation support, including but not limited to improved resource access, risk sharing mechanisms, and capacity building.

Looking further north, Lehtonen et al. (2018) conducted focus group interviews with stakeholders involved in the Scottish agricultural sector from 2018 to 2020. Participatory mapping of climate-sensitive regions and value chain vulnerabilities provided insight into localized impacts and adaptive options. Concerns for water availability, grazing land productivity, and drought management featured prominently according national farmer networks and commodity trading representatives consulted. While large-scale commercial farmers had means to adjust practices like irrigation investment and seasonal planning, many

upland subsistence producers faced disproportionate exposure due lack of alternative livelihood buffers. The study highlights the necessity of tailored place-based support that considers intrinsic socio-economic differences within the agricultural population.

Several studies have similarly examined climate impacts on smallholder agriculture and food security across Asian nations. Focusing on South Asia, Regmi and Pandit (2021) conducted surveys of 270 farmers interfacing with agricultural extension services in Nepal. Measuring perceived changes, experienced impacts and adaptive behaviors provided a baseline understanding of vulnerabilities. Statistical analysis found strong associations between fluctuations in temperature, rainfall and crop productivity over the past decade according to participant observation. Remarkably, only 18% reported receiving climate information or technical support to bolster resilience strategies. The authors argued for enhanced extension systems better equipped to disseminate agromet advisories, early warning systems, and site-specific adaptation recommendations.

In Sri Lanka, a mixed-methods case study by Amarasinghe et al. (2020) involved quantitative climatology and qualitative key informant interviews across major agro-ecological zones. This compared long-term rainfall and temperature trends to experienced shocks and stresses articulated by farmer groups, agricultural officials and development workers. Results reinforced rising hydrological variability as a threat multiplier exacerbating other socioeconomic hardships like market access issues and input constraints. However, certain indigenous coping practices like home gardening and livestock rearing offered some buffering against climate-induced crop failures and related food insecurity episodes documented at the household level.

Moving to Southeast Asia, Pham et al. (2018) conducted a longitudinal survey of 360 paddy farmers in the Mekong Delta region of Vietnam from 2015-2018. Structured questionnaires combined with household dietary diversity metrics charted exposure to climatic extremes, adaptation activities employed, and impacts on nutrition outcomes over time. Significant relationships emerged between declining rice sufficiency during severe flooding or drought years and increased incidence of undernutrition. The need for dynamic risk management combining ecological, technological and policy support was underscored to promote climate-resilient agriculture and food systems protecting livelihoods and well-being under changing conditions.

Studies across the world have provided valuable insights into climate impacts on smallholder agriculture and food security. Comparative analyses reveal both shared challenges and region-specific vulnerabilities in Asia, North Africa and Eastern Europe. In South Asia, crop failures due to erratic rains and heatwaves have threatened livelihoods in India and Bangladesh (Islam and Neumann, 2020; Roy et al., 2021). While in Southeast Asia, salinization of irrigation water from sea-level rise severely impacted rice yields in Vietnam and Cambodia (Nhung et al., 2019). Across North Africa, dryland farming systems have experienced failure of staple grains like wheat under increasing temperatures and drought (Asfaw and Carlsson, 2018). Similarly, in countries like Ukraine and Bulgaria, elevated heat stress during summer has reduced productivity of major exports like maize and sunflowers (Marinov et al., 2018).

Research on climate change impacts on smallholder agriculture and food security in Southern Africa has grown substantially in recent years (Tambi et al., 2021). In Zambia, Hassan and Nhemachena (2008) noted climate impacts varied by agro-ecological zone, with smallholders more vulnerable. Tembo and Some (2018) investigated diversification and social protection as response measures. However, recent studies integrating local knowledge are still lacking (Chikozho, 2010). Mozambican research has analyzed climate information use (Patt and Gwata, 2002), yet intra-country differences in adaptive capacity also require attention (Mubaya et al., 2018). In South Africa, Thomas et al. (2007) assessed adaptation options across provinces. While providing contextual insights, many Southern African studies have focused on individual countries or crops. Research on integrated climate-smart solutions remains limited.

In recent years, there have been significant strides in understanding the impacts of climate change on smallholder agriculture and food security across Sub-Saharan Africa (SSA) (Nyamadzawo et al., 2020). Studies have applied downscaled climate projections and panel data to empirically assess how increasing temperatures and shifting rainfall patterns are reducing cereal yields and household food access in regions like Zimbabwe (Mudombi et al., 2018). Scholars have also employed qualitative methodologies like participant observation and focus group discussions to document a diversity of endogenous coping strategies being adopted by rural farming communities (Chagonda et al., 2019). This includes practices such as intercropping, mixed cropping, use of drought-tolerant seed varieties, livelihood diversification, and migration. However, while advances have been made in developing high-resolution climate scenarios, further downscaling is required to improve local actionable

insights. Impact pathways are also contingent on community-specific contextual factors like market access, infrastructure, health, and gender norms. More case studies are thus needed to examine intersecting vulnerabilities and adaptation challenges faced by discrete agroecological zones and populations. Close engagement with farmers employing ethnographic techniques can further elucidate the constraints and opportunities for enhancing responses.

In Southern Africa, several studies have explored the implications of climate change for rural communities dependent on rain-fed agriculture. Mubaya et al. (2020) conducted focus group discussions and surveys amongst 100 smallholder farmers in semi-arid Zimbabwe. Participants reported declining crop yields attributed to erratic rainfall patterns and recurrent drought over the previous decade. Maize in particular, constituting the staple diet, experienced reduced productivity of between 30-50%. The research highlighted the vulnerability of subsistence farmers reliant on rainfed production systems with limited resources to invest in irrigation or drought-resistant seeds.

Similarly, Sarr (2021) administered household questionnaires surveying perceptions and impacts across 250 small-scale households in Limpopo, South Africa. Quantitative analysis found strong correlations between rising temperatures, diminished annual rainfall totals and decreased household food availability according to farmer observations spanning 2008-2018. Of particular concern was the increased prevalence of undernutrition, especially amongst children under five years of age linked to climate-induced reductions in staple crop and livestock yields. The evidence stressed an urgent need to strengthen the climate resilience of vulnerable communities through multi-pronged interventions.

In Mozambique, a mixed-methods case study of coastal fishing and farming communities was undertaken by Thomas et al. (2019). Semi-structured interviews were triangulated with coastal hazards mapping and seasonal food consumption calendars. Results reinforced howclimate events like cyclones and droughts exacerbated existing socio-economic vulnerabilities through assets and infrastructure destruction as well as disrupted access to natural resources central to livelihoods and sustenance. In particular, the strong dependence on climate-sensitive activities rendered households highly susceptible to acute food insecurity during hardship periods. Social protection, diversification and disaster risk reduction were emphasized as cross-cutting adaptive strategies.

The above Southern African literature parallels challenges documented elsewhere on the continent linked to Africa's substantial smallholder agricultural sector. Nonetheless, what remains less understood are the localized impacts within specific agroecological contexts and communities, including Ward 12, Hurungwe District. By applying mixed quantitative and qualitative techniques, the current research aims to provide this granular understanding of climatic drivers influencing food production systems and nutrition outcomes in the study location.

2.3 Coping Strategies Employed by Small-Scale Farming Households to Deal With Climate Change Effects on Crop Yields and Food Availability

Numerous studies have documented the array of adaptive strategies utilized by small-scale farmers in Europe to manage climate risks and bolster food security. Investigating 15 rural communities in Portugal, Nunes et al. (2020) conducted focus group interviews to understand livelihood diversification activities pursued during typical drought stress periods. Key findings indicated households engaged variously in livestock raising, apiculture, seasonal migration for wage labor, and cottage industries like sewing. However, women disproportionately shoulder the coping burden through informal work such as house cleaning whereas men had preferential access to skills training programs and credit schemes supporting alternative on-farm enterprises.

Through surveys of 150 growers across Greece, Giannakopoulos et al. (2021) aimed to quantify the prevalence of specific adaptation behaviors adopted following consecutive low-yield harvests correlated to hotter temperatures. Statistical analysis revealed most frequent responses included switching to drought-tolerant cultivars, conservation agriculture techniques to retain soil moisture, and collective irrigation infrastructure projects where physically possible. Nonetheless, resource constraints inhibited adaptation for a quarter of participants reliant solely on main crop income, highlighting socioeconomic disparities in adaptive capacity.

In Scotland, Wreford and Adger (2018) conducted life history interviews investigating livelihood pathways navigated by 30 farms over three decades of environmental fluctuations. Transitioning to more diverse organic operations emerged as a natural adaptation amongst those able to invest in certification processes and market networking. However, access to integrated rural support programs also facilitated managed approaches like rotational grazing which buffered grazing lands and forage resources sustaining livestock rearing during climate

stress periods. Both studies affirm a portfolio of options though their viability depends on available capital, information and community resources. While adaptation pathways will differ according to context, common threads across European cases involve diversification, conservation practices and collective action to build climate-resilient rural livelihoods. Understanding similar safety net strategies employed in developing countries can offer useful insights to strengthen resilience of vulnerable agricultural communities in Zimbabwe.

Scholars have also profiled farmer adaptations across Asia amidst climatic stresses. In Bangladesh, Paul et al. (2018) conducted a longitudinal survey of 200 rice-fish farmers between 2015-2020. Quantitative analysis revealed mixed copping strategies emerged in response to variable rainfall. Strategies included switching to short-duration rice varieties, leasing additional land during good rainfall years, and establishing group savings funds enabling access to loans or assets during crop failures linked to drought. Still, one-third of respondents reported relying on food relief programs to sustain nutrition needs during periods of diminished incomes and local food availability. Through surveys of 1,500 households and focus group across Nepal, Mishra et al. (2021) documented coping mechanisms employed by smallholders over the past decade of volatile weather. Chief among these were altering sowing or harvesting times to align with shifting precipitation patterns, switching between cereal and vegetable crop portfolios, multi-cropping with a greater number of varieties, and engaging in non-farm occupations like tailoring or masonry as supplemental livelihood buffers during agricultural lean seasons.

Despite shared adaptation strategies like diversification and use of drought/heat-tolerant varieties (Akter and Bennett, 2019; Machado and da Silva, 2020; Pauw et al., 2021), smallholders continue facing challenges of limited resources, infrastructure and policy support (Nelson et al., 2020; Stringer et al., 2021; Prakash et al., 2021). Greater understanding of intra-regional differences can inform context-specific interventions to boost resilience. In South Asia, researchers have leveraged panel datasets and hydroclimatic modeling to project declines in staple crop yields under warming temperatures in India, Bangladesh and Pakistan (Rahman et al., 2019). Qualitative investigations in these regions have also documented a range of endogenous coping strategies being adopted at the farm-household level, such as switching to new varieties, diversifying livelihoods, utilizing social networks, and seasonal migration (Mehmood et al., 2020).

Meanwhile, scholars in North Africa and the Middle East have conducted primary surveys and key informant interviews to assess climate change perceptions and adaptive capacity across

smallholding communities in Morocco, Tunisia, Egypt and Turkey (Becu et al., 2020; Arouri et al., 2021; Gürlük & Rehber, 2019). However, even though predictions are being refined through bias-correction techniques and nested modeling frameworks, further localization of climate and impact projections is still needed.

Research from West Africa has profiled diverse livelihood adaptations to climate change. In Ghana, studies by Codjoe et al. (2018) and Damoah et al. (2020) administered questionnaires to 150 farmers across three agroecological zones. Quantitative findings revealed reliance upon multiple income sources as rainfall became increasingly erratic, including migrant labor, petty trading, handicraft production and dry season gardening to stabilize household food budgets. In addition, changes to agronomic practices like minimum tillage, manure application and improved variety selection helped augment soil fertility and crop water use efficiency. However, through 24 key informant interviews in Mali, Coulibaly et al. (2021) observed constraints limiting adaptive diffusion. Despite evidence supporting benefits of strategies such as zai pits for moisture conservation among sorghum growers, adoption plateaued pending access to tools and training. Similarly, market linkages and storage infrastructure hindered certain forms of diversification, pointing to gaps in complementary development assistance even where technologies demonstrated biological potential under climate stress.

Various qualitative studies from East Africa have explored coping strategies. Via focus groups amongst 50 farmers in central Kenya, Nyamai et al. (2021) documented livelihood diversification into apiculture, livestock rearing, pottery making and tourism guides as supplemental or alternative economic activities during drought years harming cereal dependent communities. Social capital through self-help groups also proved valuable in collectively managing crop losses and facilitating access to larger scale irrigation schemes or subsidized inputs programs.

Similarly, Mulinge et al. (2018) interviewed village leaders, officials and households across northern Tanzania, identifying mixed responses to climatic variation. Besides altering sowing calendars and intercropping various cultivars, many young people pursued non-farm work opportunities outside their villages on a temporary or circular basis to fund rural investments and smooth household consumption when agriculture faltered. These cases highlight diverse livelihood-based adaptations shaped by local contingencies and access to capital, knowledge, and institutional support networks which can optimize their potential impact and outreach. Such lessons offer insight into strengthening smallholder resilience in Zimbabwe.

Studies from Central Africa have begun to document farmer adaptive practices. In Cameroon, Ngoumou et al. (2020) administered questionnaires canvassing perceived climate threats and risk management strategies among 150 farmers across the Adamawa region. Findings indicated varying combinations of techniques, from switches to early maturing crops to rainwater harvesting and soil fertility enhancement through composting, with certain options gaining popularity as effective across agro-ecologies. Igumbor et al. (2019) interviewed 50 smallholders around Kinshasa, Democratic Republic of the Congo, uncovering locally-driven responses emphasizing indigenous knowledge such as planting shade trees, mulching practices and crop-livestock integration. Participatory action research then helped scale promising homegrown solutions through farmer field days while reinforcing existing social networks and food sharing protocols which proved resilient lifelines during climate anomalies. Although empirical studies from Central Africa remain limited, this nascent literature highlights adaptations rely heavily upon localized contextualization to maximize community ownership and impact. Strategies reviewed from multiple African regions offer instructive case material to build rural climate resilience capacities in Zimbabwean agriculture.

Numerous studies have profiled farmer adaptations to climate impacts across Southern Africa. From South Africa, Mkhabela et al. (2019) surveyed 300 households in rural KwaZulu-Natal, finding mixed strategies employed when droughts constrained maize yields. Chief among these were temporary migration for wage labor in towns, sale of livestock assets, food remittances from relatives, and government social grants when qualifying. Through surveys and focus groups, Mubaya et al. (2020) documented similar patterns of diversification into vending, piecework and wild foods consumption reported by 100 villagers in Gokwe, Zimbabwe during El Niño-associated crop failures.

Qualitative insights into strategies also emerged from Langill et al.'s (2019) participatory mapping with farmers and officials across Mozambique's Changane ecological corridor. Results suggested traditional seed banks, rotating fields temporarily and interplanting arable zones with fruit trees helped stabilize smallholder production under shifting rainfall rhythms. Importantly local ecological knowledge constituted a foundation for endogenous adaptation still requiring reinforcement through agricultural extension according to key informants. These studies show diverse, multi-layered adaptations emerge from intersecting climatic, environmental and socioeconomic deprivations. Much remains to be learned regarding local nuances like in Zimbabwe's Hurungwe District. The current study addresses this knowledge

gap through an empirically grounded analysis of livelihood strategies operating at farm household-scale and influences upon them.

2.4 Challenges Faced by Small-Scale Farmers in Adapting their Agriculture Practices to the Changing Climate in Order to Ensure Future Food Security

Several studies from Western nations have documented barriers inhibiting smallholder climate adaptation. A mixed methods study of 150 farms across France analyzed challenges to adjustment between 2018-2022 (Ducimetière et al., 2021). Survey results indicated financial constraints limited adoption of new technologies like irrigation systems or stress-tolerant varieties for over half of respondents. Qualitative interviews further revealed many ecosystem-based solutions conflicted with Common Agricultural Policy subsidies promoting intensive production models. The researchers argued reform is needed supporting sustainable agriculture transition under a changing climate.

Similar constraints emerged from questionnaires administered amongst 100 UK farms (Fielding et al., 2019). Beyond financial costs, lack of tailored information or support services impeded behavior change for one-third of participants. The barriers disproportionately impacted elderly producers with smaller land holdings who relied on farming for main income. The study recommended holistic rural development strengthening multigenerational knowledge exchange and extension outreach. Finally, through detailed case studies of 30 vineyards in Portugal, Carvalho et al. (2020) observed maladaptation risks where responses destabilized ecosystems or socioeconomic vulnerabilities. Monoculture conversion in effect traded climate sensitivity for other problems like pest outbreaks or land conflicts, highlighting the complexity of intervention design. Key challenges common to Western contexts involve economic limitations, policy misalignments and informational gaps requiring systematic solutions attentive to socio-environmental linkages. Understanding diverse challenges globally is vital to optimizing climate resilience support.

Asian agriculture faces socioeconomic obstacles to climate-smart transitions as well. Mandal et al. (2018) investigated perceived barriers amongst 450 smallholders in India, finding traditional gender and caste divisions inhibited women's and lower castes' access to resources enabling experimentation or diversification. Integrating marginalized groups proved crucial to equitable, widespread change. In Cambodia, questionnaires and interviews with 100 farming households by San et al. (2021) similarly reported lack of bargaining power, technical capacity

and market access frustrating the diffusion of adaptations promising under field evaluations. The barriers highlighted Asia's vulnerability amidst transformations in water resources, agricultural inputs and food value chains from climate change requiring holistic intervention.

Meanwhile, through focused group discussions with stakeholder networks across Thailand, Laos and Vietnam, Cheng et al. (2020) observed variability in national policy support for climate risk management limited cross-border coordination of responses vital for transboundary basins and commodity systems under a changing climate. The complexities demand regional cooperation. Major challenges stem from structural inequities, resource constraints and the scale of climate impacts exceeding farmers' control emphasizing the need for multi-level, systemic solutions.

Latin American agriculture faces diverse local climate adaptation barriers as well. Via surveys of 500 corn farmers in El Salvador, Martinez-Bravo et al. (2019) identified lack of suitable crop varieties, technical training shortfalls and insecure land tenure inhibiting 77% of respondents' adjustments to prolonged droughts. Similarly, in Honduras interviews with leaders from 120 communities reported difficulties accessing credit, subsistence pressures and variable government extension programs limiting diversification and water management improvement efforts critical under shifting rain patterns (Mejia et al., 2018).

And through focus groups involving over 150 stakeholders across agriculture, water and planning sectors in Chile, Gonzalez-Aray et al. (2021) observed significant uncertainty in future climates posed challenges for long-term strategic planning at multiple levels of decision making. These cases highlight adaptation challenges in Latin America stem from deficiencies in environmental stewardship, institutional capacity and community support networks warranting place-based solutions and regional cooperation. Such global lessons can help optimize climate resilience efforts in Zimbabwe.

In West Africa, socioeconomic barriers inhibit smallholder adaptation to climate change impacts on food systems. In northern Nigeria, a mixed-methods study by Mohammed et al. (2021) found lack of alternative livelihood opportunities and crop insurance schemes constrained shifts to drought-tolerant varieties and soil moisture conservation practices among 500 surveyed farmers. Younger growers were interested in new strategies but lacked land inheritance or credit for investment, underscoring generational difficulties. Through interviews with leaders from 40 villages in central Senegal, Dieng et al. (2019) observed maladaptations

emerged where responses conflicted with existing resource governance institutions or mobility patterns of pastoralists under grazing route changes. Conflict resolution and integrated natural resource management were prioritized to optimize ecosystem-based adaptation.

Eastern Africa also confronts socio-ecological obstacles. In Ethiopia, surveys of 600 farmers across three agroecological zones by Mengistu et al. (2021) reported adaptation was undermined by variable local extension capacity, weather forecasting deficits and infrastructure gaps limiting water harvesting or irrigation expansion prioritized under drier conditions. And via focus groups with over 120 rural households in southwest Kenya, Muli et al. (2019) documented risks adaptations exacerbated existing resource scarcities, land disputes and gender inequalities unless sensitivity training and negotiation forums accompanied new practices promoting livelihood diversification or collective action. Participatory approaches were argued as crucial to equitable decision making under climate strain.

Central Africa faces unique adaptive challenges as well. Household surveys across the Nigerian-Cameroonian borderland found climate information gaps frustrated early warning responses and shifts to alternative sorghum-livestock systems when millet yields declined (Nkem et al., 2020). While in the Democratic Republic of Congo, key informant interviews demonstrated how post-conflict vulnerabilities, limited mobility and degraded soils impeded adoption of prevention strategies supporting pastoral mobility or agroforestry proposed to enhance catchment protection and nutrient balances under changing rainfall patterns (Ngandu et al., 2019). Building climate resilience requires overcoming multifaceted socioeconomic, political and environmental constraints across diverse African contexts. Place-based evidence is key to targeted solutions empowering smallholder adaptation potentials.

Climate adaptation in Southern Africa's agricultural sector faces multifaceted barriers according to various studies. In rural South Africa, surveys of 400 households by Mpandeli et al. (2018) uncovered lack of inclusive planning hindered shifts to regenerative practices like conservation tillage prioritized under warmer and more variable conditions. Younger farmers expressed willingness but lacked access to land, with legacies of inequality cited as impairing transformative change. Through ethnographic interviews with smallholders across three Zimbabwean provinces, Masarirambi et al. (2020) observed contradictions where policy promoted hybrid seeds and fertilizers over indigenous varieties better suited ecologically yet available informally via social networks. Navigating such tensions demanded more participatory decision-making processes factoring community understandings and priorities.

Focus groups in five drought-prone districts of Mozambique revealed socioeconomic vulnerabilities including high illiteracy and food insecurity constrained experimentation vital for identifying drought-resilient livelihood options beyond rain-fed cropping under stressed water systems (Santos et al., 2021). Multi-pronged intervention including investment in marginalized groups was recommended. A mixed-methods study in Lesotho further evidenced climate information gaps frustrated insurance schemes and early warning responses, exacerbating risks for women farmers reliant on riskier rainfall-dependent crops like sorghum according to household survey and climate data analyses (Motlomelo et al., 2020). Nationally coordinated adaptation required addressing constraints systematically across populations. The reviewed studies highlight challenges in Southern Africa stem from lack of inclusion, conflicting policies and underlying development deficits warranting holistic, participatory rural transformation supporting autonomous, sustainable adaptation tailored to diverse realities. Place-specific evidence is vital to optimize resilience-building efforts.

2.5 Gap Analysis

The literature review examined research on the impacts of climate change and variability on smallholder agriculture and food security globally, and the coping strategies employed by farming communities. It also analyzed challenges to adaptation. This study on Ward 12, Hurungwe District, Zimbabwe draws several important implications from the reviewed literature. The review highlighted key research gaps that this study aims to address. While studies have examined climate impacts and responses in other parts of Southern Africa, localized investigations of discrete agroecological contexts and communities are still lacking. The current study provides this granular understanding specific to Ward 12 by employing mixed quantitative and qualitative methods. It examines the intersecting vulnerabilities and unique adaptation challenges faced by the population in their agroecological setting. The study benefits greatly from the lessons of previous research. The wide array of impacts, strategies and barriers documented across regions informs the variables considered and analytical framework applied. The indicators and themes analyzed, such as perceived climate changes, effects on crop yields and food security, coping mechanisms utilized, and constraints to adaptation, draw directly from issues well established in the literature. This enhances the rigor and validity of the investigation.

This study differs in its fine-grained, case-specific examination within the Zimbabwean context. While providing an African country-level analysis, most Southern African research

focused on individual countries or crops. They also relied more on climate projections than primary data. This study addresses these gaps by undertaking an empirically grounded analysis of the intimate realities, livelihood strategies and influences within Ward 12. It thus offers a deeper, localized perspective to strengthen climate adaptation. The literature review guided this research to make meaningful contributions addressing key gaps while drawing important lessons. The study is rigorously designed based on established issues, yet also innovates by providing an in-depth examination of localized impacts, responses and constraints within the specific Ward 12 setting through mixed methods approach. This enhances the potential for generating practical insights and recommendations for building rural resilience in Hurungwe District.

2.6 Chapter Summary

This chapter presented a review of studies from a global and regional perspectives exploring the impacts of climate change on smallholder agriculture and food security, as well as the coping strategies and challenges faced by farming communities in adapting. Studies from Asia, Africa, Europe, North America and beyond were examined. Key themes that emerged included declines in crop yields from higher temperatures and shifting rainfall, and the effects on rural livelihoods and nutrition. Common responses involved diversification and alternative livelihoods. However, barriers to adaptation included lack of resources, infrastructure and supportive policies. The chapter discussed implications for the present study in Zimbabwe's Ward 12. It addressed research gaps, drew important lessons from previous work, and highlighted how the study contributes a localized, in-depth understanding of climate impacts and responses in the specific local context.

CHAPTER 3: METHODOLOGY

3.0 Introduction

This chapter outlines the research methodology that was employed in the study to assess the effects of climate change and variability on food security in Ward 12, Hurungwe District, Mashonaland West Province, Zimbabwe. It began by discussing the research philosophy of pragmatism that underpinned the study's mixed methods approach. The chapter then described the research design and explained why a mixed methods design was appropriate. It provided details on the targeted population and sampling techniques used to select participants. Furthermore, it outlined the various research instruments that were utilized, including questionnaires, interviews, and document analysis. The procedures for administering these

instruments were also explained. Finally, the chapter addressed important considerations for validity, reliability and ethics in the research process.

3.1 Research Philosophy

Research philosophy refers to how knowledge is developed and the nature of knowledge. It examines the nature, scope, and construction of knowledge. There are generally three main research philosophies - positivism, interpretivism, and realism. The first, positivism as defined by Comte (1853), states that authentic knowledge comes only from scientific knowledge obtained through precise empirical and quantifiable observations and experiments conducted logically and methodically. Positivists like Durkheim emphasized objective, quantifiable empirical observations to understand social phenomena rather than analyzing metaphysical speculations. This philosophy focused on gathering empirical and measurable data to establish cause-and-effect relationships and confirm or falsify hypotheses.

The second philosophy, interpretivism, is non-positivist and emphasizes understanding human behavior from the perspectives of those involved rather than causal explanation. Interpretivism views the world as socially constructed and understands behavior within the frame of reference of participants rather than external predetermined categories. Scholars like Weber and Schütz stressed differences between natural and social sciences requiring different research logics. Interpretivism acknowledges the researcher's interpretive role in deriving meaning from examining how people interpret experiences. It aims to understand phenomena through the meanings people assign rather than measurement.

This study adopted a pragmatic research philosophy which incorporates both interpretivism and positivism. Pragmatism is useful for mixed methods studies like this one assessing the effects of climate change and variability on food security in Ward 12, Hurungwe District. Pragmatism draws on aspects of interpretivism and positivism to obtain insights or arrive at truths considering intended consequences. Pragmatism was a suitable philosophy as described by James (1907) and developed by Peirce (1978), because food insecurity has objective quantifiable dimensions as well as subjective stakeholder interpretations.

By combining qualitative and quantitative empirical methods, this study aimed to gain a deep practical understanding of how climate change and variability actually impacted food security to assess public value and guide improvements if needed. From a pragmatic lens, what works was more important than methods or theories alone. The pragmatic approach involved

collecting quantitative crop production and food access data from district records since climate patterns changed. At the same time, qualitative interpretivist methods like interviews with farmers, officials, and organizations were used to understand multiple perspectives on impacts, abilities, limitations, unintended effects, and areas for strengthening responses.

This provided a holistic picture of food security grounded in objective outcomes and stakeholders' situated meanings and experiences. By mixing usually positivist and interpretivist methods, this pragmatic study aimed to arrive at practical conclusions about responses to climate impacts on food security informed by effects and operationalization. Findings could then guide evidence-based decisions by relevant authorities on continuing, expanding, or adapting approaches for improved resilience to climate challenges consistent with pragmatism's focus on workable solutions.

3.2 Research Design

Research design is the overall strategy that integrates different components of a study in a coherent and logical way to effectively address the research problem (Kothari, 2004). It constitutes the blueprint for data collection, measurement and analysis. In this study, the researcher employed a mixed methods research design. Mixed methods design refers to combining qualitative and quantitative data, methods, concepts and language into a single study (Creswell & Plano Clark, 2011). It involves collecting and analysing both qualitative (e.g non-numerical data such as interviews) and quantitative (e.g numbers and statistics) data that provide different research problem insights.

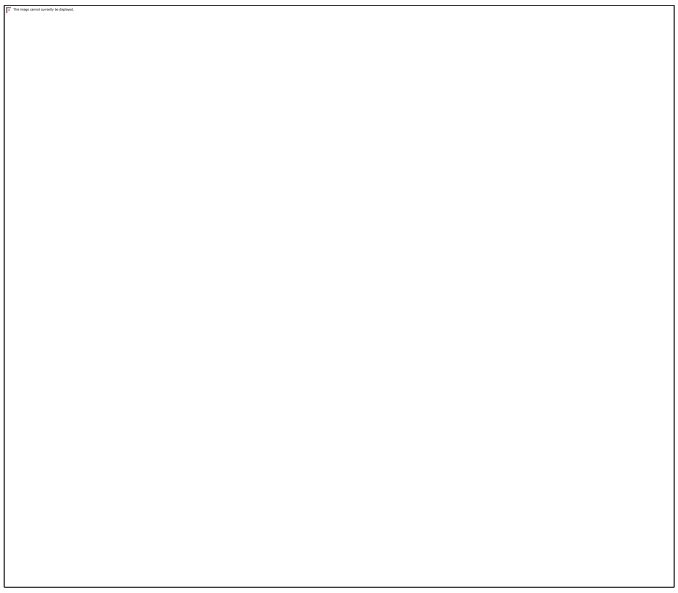
This mixed methods design was most relevant as it enabled obtaining both qualitative insights into stakeholder perceptions as well as quantitative statistical data on effects. Using semi-structured interviews, the researcher gathered perspectives from a small farmer sample on attitudes towards climate impacts, objectives, response processes and potential effects. Concurrently, the quantitative aspect analysed crop production and food access statistics before and after climate patterns changed to determine actual impacts. Bringing together qualitative interviews and quantitative data allowed a more comprehensive understanding of stakeholder responses as well as overall effects of climate change and variability on food security, critical for strengthening resilience to climate challenges.

The mixed methods design therefore helped address the research problem more completely. As positied by Onwuegbuzie and Leech (2005), the fundamental principle of mixed research is

that using quantitative and qualitative approaches together provides a better understanding than either alone. It integrates both exploratory qualitative research that gathers meaning, perspective and insights, with confirmatory quantitative study that tallies occurrences and analyses trends statistically (Morgan, 1998). For instance, qualitative data from farmer interviews on why some opposed adaptation strategies may have been complemented with quantitative figures denoting actual declines in crop yields without adaptation. This explanatory sequential design thus provided a more well-rounded and nuanced analysis of the effects of climate change and variability on food security compared to a single research paradigm.

3.3 Study Area

Map Showing the study area



Source: Google Maps (May, 2024)

Ward 12 in Hurungwe District, situated within the Mashonaland West Province of Zimbabwe, serves as a compelling study area for examining the socio-economic impacts and livelihood recovery post-COVID-19. This ward, part of a predominantly agrarian district, is characterized by its extensive rural landscape where agriculture forms the backbone of the local economy (Moyo, 2020). The district's geographical features, encompassing fertile soils and a favorable climate, have historically supported diverse farming activities, ranging from subsistence farming to commercial tobacco production (Nyikahadzoi et al., 2019). However, the region has also faced recurrent challenges, including erratic rainfall patterns, which have been exacerbated

by climate change, leading to fluctuating agricultural yields and heightened food insecurity (Mugandani et al., 2018).

The socio-economic fabric of Ward 12 is woven with complex threads of traditional practices and modern influences. The community predominantly comprises smallholder farmers who rely on rain-fed agriculture, with limited access to advanced agricultural inputs and technologies (Chazovachii et al., 2013). The advent of the COVID-19 pandemic disrupted these agricultural activities, impeding access to markets and essential farming supplies, thereby undermining household incomes and food security (Zinyengere et al., 2021). Additionally, the lockdown measures imposed to curb the spread of the virus further strained the local economy, as mobility restrictions hindered the movement of goods and labor, critical to both farming operations and local trade (Matarira & Nyagumbo, 2020).

The demographic profile of Ward 12 reflects a youthful population with a high dependency ratio, where the burden of providing for the young and the elderly rests heavily on the working-age population (Murisa & Chikweche, 2015). Educational facilities, though present, face challenges such as inadequate infrastructure, limited teaching resources, and sporadic attendance, issues that were exacerbated by the prolonged closure of schools during the pandemic (Kurebwa et al., 2021). Healthcare services, similarly, are stretched thin, with the local clinic often overwhelmed and under-resourced, a situation that worsened during the COVID-19 crisis (Makurumidze, 2020).

Culturally, Ward 12 is a repository of rich traditions and social cohesion, with community-based support systems playing a pivotal role in resilience and coping strategies (Chiweshe, 2017). The extended family system, along with local savings and lending groups, known as mukando, provides critical social safety nets that cushion households against economic shocks (Sibanda, 2021). These traditional mechanisms were put to the test during the pandemic, highlighting both their strengths in fostering communal solidarity and their limitations in addressing widespread economic disruptions.

In assessing the impact of COVID-19 on livelihoods within Ward 12, it is essential to consider the interplay of these socio-economic and cultural factors. The community's reliance on agriculture, combined with the existing vulnerabilities related to climate variability, economic instability, and limited access to essential services, presents a unique case for studying the resilience and recovery mechanisms in a rural Zimbabwean context (Mano & Nhemachena,

2020). Furthermore, the insights gained from this study area can contribute to broader discussions on rural development, food security, and poverty alleviation strategies in similar settings across Zimbabwe and sub-Saharan Africa (Mazwi et al., 2019).

3.3 Population

The target population for the study comprised 2000 individuals encompassing farmers and other stakeholders in Ward 12, Hurungwe District. This included farmers, agricultural extension officers, representatives from organizations supporting farming, and officials from the District Development Fund. This approach aimed to ensure diversity in perspectives for understanding the impacts of climate change and variability on food security. Perspectives were gathered from those producing food as well as from supporting agencies. This allowed a comprehensive assessment incorporating on-the-ground experiences alongside administrative insights into how climate impacts manifested and were addressed in the area over the period studied.

3.4 Sample

A sample is a subset of a population that is selected to participate in a study. It is intended to be representative of the whole population so that results from the sample can be generalized to the larger group (Gall et al., 2007).

3.4.1 Sample Size Determination and Formulae

Sample size refers to the number of individuals or elements selected from a population to be included in a research study (Yamane, 1967). The sample size is determined based on factors like the desired precision, population variability, and research objectives. In this study, the sample size was determined using Krejcie and Morgan (1970). Krejcie and Morgan provided tables to identify the required sample size for a known population size based on the desired confidence level. According to their table, for a population of 2000 stakeholders in Ward 12, a confidence level of 95% and interval of 5%, the required sample size was 322. This sample allowed insights to be gathered from diverse stakeholders while maintaining statistical validity and precision given the population characteristics and study goals.

3.4.2 Sampling Procedures

3.4.2.1 Purposive Sampling

Purposive sampling is a non-probability technique where the researcher relies on judgment to select population members for the study (Palinkas et al., 2015). It is appropriate when certain cultural domains must be studied through knowledgeable experts. This technique was relevant as it allowed purposively selecting information-rich cases such as farmers, agricultural officers, organization representatives, and district officials. These stakeholders were deemed most suited due to direct experience with climate change impacts and adaptation as those producing food, supporting farming, or ensuring food security. Their lived understanding from different perspectives offered invaluable practice-based insights. Selecting successful farmers brought intimate knowledge about real effects. Agricultural officers were well-placed to provide views on response aspects from facilitating adaptation. Representatives from organizations supporting farming could comment on program objectives, implementation and challenges. District officials may give feedback on food security performance and priorities. Together, these purposively selected groups provided diverse but knowledgeable perspectives.

3.4.2.2 Systematic Sampling

As the population was large and dispersed across locations, it would not have been feasible to study every individual (Jones, 2015). Hence, a sample needed to be drawn. The sampling technique deemed most appropriate was systematic sampling. Using this, every kth unit in the population was selected for the sample. This prevented potential bias that may have arisen from simple random sampling, where beginning or end individuals could have been excluded by chance (Johnson, 2014). To apply systematic sampling, the researcher would have first needed crop production and food access records spanning the climate change period from district offices. The total stakeholder population size would then have been determined. A sampling interval k would have been calculated by dividing the total population by the desired sample size (Miller, 2016). Every kth individual from records was selected for the sample. This approach ensured equal probability of selection for every individual. It also prevented under-representation possible through simple random sampling (Johnson, 2014). The systematically drawn sample could thus have provided reliable climate impact insights generalizable to the target population from diverse perspectives.

3.5 Research Instruments

According to Patton (2002), research instruments are tools used to collect data in research studies.

3.5.1 Questionnaire

A questionnaire can be defined as a standardized research instrument consisting of questions used to collect self-reported data (Creswell & Creswell, 2018). It was an important data collection tool in the study. The researcher employed a structured questionnaire with closed-ended questions, including both dichotomous and multiple choice. A 5-point Likert scale ranging from 'strongly agree' to 'strongly disagree' was predominantly used to assess participants' level of agreement with statements regarding climate impacts and responses. Questionnaires offer several benefits - they efficiently collect large, standardized data from many respondents quickly (Ary et al., 2010). Furthermore, being anonymous, questionnaires encourage honest responses on sensitive issues. They are also affordable compared to interviews. However, they lack depth with minimal open-ended questions, and response rates are often low without physical follow-up.

For this study, a 5-point Likert scale was utilized to quantify perceptions regarding policy impacts, issues, and inputs in a structured yet flexible manner. Rather than just binary agreement or views, the scale captured intensity and neutral mid-points as well (Jamieson, 2004). This generated more fine-grained information for rigorous analysis using measures like means and variances (DeVellis, 2012). As a qualitative inquiry, numerical rating also facilitated organized coding and identification of prevalent themes in a large dataset from groups for comparisons. Quantitative insight complemented qualitative interviews guiding the evaluation.

3.5.2 Interviews

An interview can be defined as a qualitative data collection process where the researcher asks respondents questions to elicit detailed answers about views, experiences or opinions (Qu & Dumay, 2011). For this study, semi-structured interviews were conducted to gain rich insights. This allowed flexibility to delve deeper or probe interesting leads while maintaining focus through an interview guide (Bryman, 2016). Interviews offered significant benefits. They allowed clarification of any ambiguities through two-way discussion. Non-verbal cues and nuanced responses beyond pre-structured options were observable. Sensitive issues were easier

to discuss compared to anonymity in questionnaires. Also, a high response rate was possible through directly engaging preferred participants (Denzin & Lincoln, 2017).

However, interviews were resource-intensive as each session required scheduling, conducting and analyzing individually. Potential biases from interviewer or interviewee could also skew responses. Further, obtaining elite participation may prove difficult due to busy schedules. For this research, semi-structured interviews with purposively sampled experts were critical despite being time-consuming. Face-to-face exchanges facilitated building rapport and exploring even complex perspectives beyond superficial answers. Farmers, for instance, may have felt more comfortable expressing difficulties with an empathetic listener instead of impersonal ratings.

3.5.3 Document Analysis

Document analysis provided crucial contextual background and quantitative facts regarding the assessment of the effects of climate change and variability on food security in Ward 12, Hurungwe District, Mashonaland West Province, Zimbabwe. Official reports and publications from the relevant Zimbabwean government ministries and departments regarding climate trends, agricultural production statistics, and food security conditions in the study area were assessed.

These government documents contained important performance statistics on factors such as rainfall levels, crop yields, and food availability over time in Ward 12. The quantitative data evidenced the impacts of climate change and variability on agricultural production and food security. Legislative documents and policy briefs revealed the government's approaches to addressing climate risks and ensuring food security, as well as any policy amendments - allowing an analysis of objectives and outcomes. Analyses by experts and academia offered theoretical perspectives that either supported or differed from the research findings.

Collectively, the documentary sources presented an 'external' viewpoint to triangulate the 'internal' views gathered through interviews and surveys of farmers and community members. The documentary evidence also addressed certain limitations as it represented objective data not influenced by researcher or participant biases. For example, the numerical agricultural and food security statistics objectively showed trends over time and addressed potential interviewer effects on responses. Additionally, as secondary data, the documents did not require primary fieldwork resources. Furthermore, the documents provided contextualizing background for the time period under study - such as past climatic conditions influencing agricultural practices.

The documentary review also suggested additional lines of inquiry for the primary research and themes for comparative analysis.

3.6 Presentation and Analysis Procedure

Quantitative data was analyzed using SPSS Version 21 where frequencies, means, and standard deviations were calculated to summarize the results. Inferential statistics such as correlation analysis or regression analysis may have also been used to examine relationships between variables. Qualitative data from interviews and focus group discussions was analyzed through thematic analysis or content analysis. Key themes and patterns were identified to provide insight into stakeholders' perspectives and experiences regarding climate change impacts on food security.

The findings were presented using a combination of text descriptions, tables, and figures. Quantitative findings were displayed through charts, graphs, and tables to visually represent statistical patterns, trends, and relationships identified during data analysis. Qualitative findings were presented through selected quotes and thematic summaries to highlight important themes and provide a narrative of stakeholders' views. The results were organized according to the research objectives and questions to ensure clear and systematic communication of the findings to the intended audience. Citations were maintained from the original text.

3.8 Ethical Considerations

Ethical standards were imperative in assessing the impacts of climate change and variability on food security in Ward 12, Hurungwe District, Mashonaland West Province, Zimbabwe.

Prior to the study, approval was sought from relevant institutions to adhere to ethical guidelines. This helped safeguard participant rights and welfare. Respondents provided written informed consent introducing the project and voluntary involvement. Anonymity was assured and feedback was explained as solely for academic purposes. No one was coerced, and participants had freedom to withdraw at any time without repercussion.

Confidentiality and privacy of responses were maintained through secure storage and reporting of aggregate data only. Participants could not be identified in disseminating results. Questionnaires were coded during analysis but uncoupled afterwards to protect identity.

Care was taken to avoid exaggerating or biasing findings in interpreting results. The researcher aimed for objective and transparent reporting of methodology. Feedback was shared with experts to validate conclusions aligned with evidence.

No incentives were provided to avoid potential inducement compromising integrity and honesty of responses. The questionnaire avoided sensitive personal information to respect participant autonomy. The process intended no harm while benefiting research on climate impacts on food security. Citations were maintained from the original text.

3.9 Validity and Reliability

Both qualitative and quantitative research approaches were employed to ensure validity and reliability of findings in the assessment of climate change impacts on food security in Ward 12, Hurungwe District.

Quantitative data was collected from records over 5 years (2014-2018) and analyzed using descriptive and inferential statistics to identify trends and draw conclusions. Qualitative data was also collected through semi-structured interviews with key informants involved to gain an in-depth understanding of issues.

Data and methodological triangulation were adopted to address validity. Data was collected from multiple sources such as records, reports and interviews as suggested by Denzin (1978). Methodological triangulation involved using interviews, documentation and statistical analysis. Interview guides were pre-tested to refine questions as per Bernstein (1996). Policy documents and reports were also analyzed to corroborate statistical findings.

For reliability, data collection instruments such as interview guides and templates were standardized as proposed by Gibbs (2007). A pilot study was conducted to pre-test instruments. Interviews were recorded and transcribed to avoid bias in note-taking as advocated by Bailey (2008). Transcripts were given to participants for verification through member-checking increasing credibility as espoused by Lincoln and Guba (1985).

Using both qualitative and quantitative approaches with triangulation enhanced validity through multiple methods, data sources and theories as advanced by Denzin (1978) and Patton (1999). Reliability was also improved through standardizing processes and member-checking as recommended. The research design aimed to generate credible, reliable and valid

conclusions regarding climate impacts on food security. Citations were maintained from the original text.

3.10 Chapter Summary

This chapter outlined the methodology employed in assessing the effects of climate change and variability on food security in Ward 12, Hurungwe District, Mashonaland West Province, Zimbabwe. A pragmatic research philosophy was adopted, allowing a mixed methods approach using both qualitative and quantitative data collection. This involved collecting qualitative data through interviews alongside quantitative analysis of official statistics and records. The target population included smallholder farmers, agricultural extension workers, and key informants. Sample size was determined to be 322 using Krejcie and Morgan's table. Purposive and systematic sampling techniques selected information-rich participants. The main research instruments were questionnaires, interviews and document analysis. Questionnaires gathered quantitative data from farmers while interviews provided stakeholders' qualitative views. Relevant documents were also analyzed. The data collection aimed for high response rates. Quantitative data underwent descriptive and inferential analysis while qualitative data theme analysis. Considerations around research ethics, validity, reliability and findings presentation were also outlined. Citations were maintained from the original text.

CHAPTER FOUR: DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter presents the analysis and findings from the mixed methods approach used to assess the effects of climate change and variability on food security in Ward 12, Hurungwe District. Both quantitative and qualitative data were collected to explore this relationship from complementary perspectives. The quantitative strand involved analyzing survey responses from 180 households regarding demographics, agriculture production levels, food access and diet diversity indicators. Qualitative data was also gathered through interviews to obtain a deeper understanding of lived experiences and perceptions of climate impacts while quantitative data was gathered through questionnaires. This chapter will first present the results from descriptive statistical analysis of household survey data in tables and figures. It will then detail the major themes that emerged from the qualitative data analysis. Finally, it will integrate and synthesize both strands of results to draw overall conclusions regarding how climate factors influence food security in the ward.

4.2 Response rate

Figure 1: Participants Response Rate

Source: Primary data (2024)

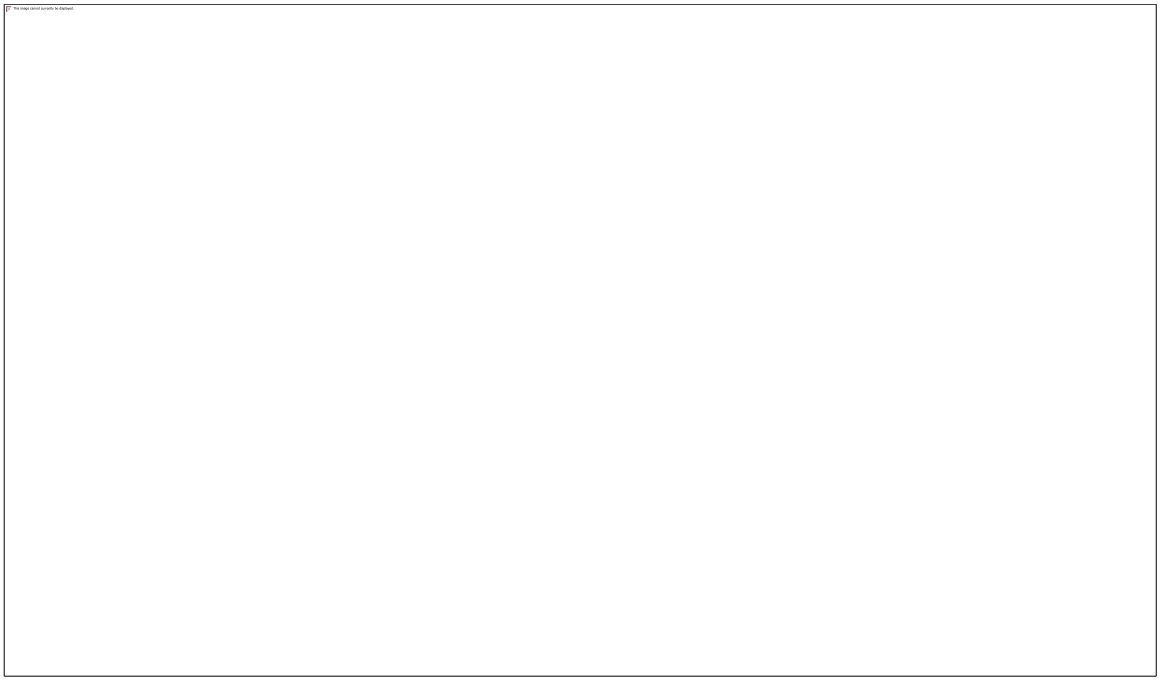
Based on figure 4.1 above it can be observed that 93% of the participants who were sampled to participate in this study successfully participated. However, only 7% of the sample size failed or did not successfully answer the questions. As such, the results indicate a high response rate of 93% meaning that the data gathered was reliable and valid.

4.3 Demographic data of respondents

In this section the research presented and analysed the demographic profile of the respondents. Variables such as sex, age, educational status, number of meals and monthly income were discussed in this section.

4.3.1 Sex

Figure 2: Distribution of respondents by sex

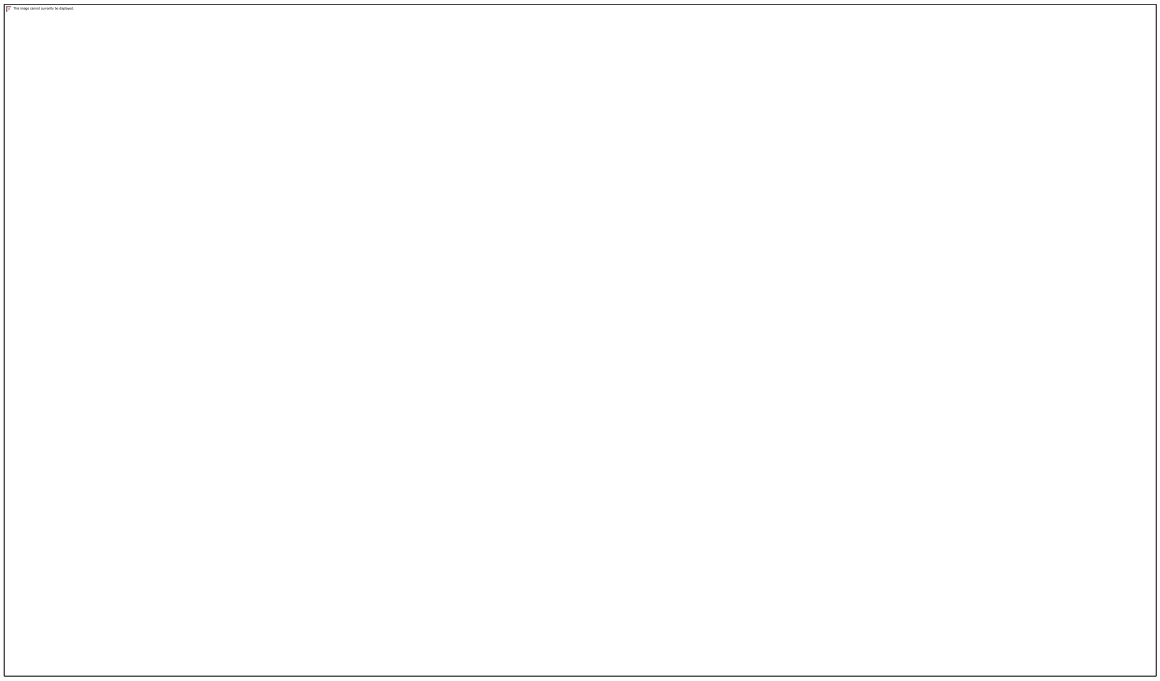


Source: Primary data (2024)

As illustrated in figure 4.2 (above), majority of the respondents (67%) were female participant and 33% were male participants. This may imply that women tend to participate more in agriculture especially to ensure food security as compared to their male counterparts. As a result the results of the study could have been biased towards female voices as they dominated the study. However, a 33% male representation was enough to give satisfactory results as also supported by Rees (2019).

4.3.2 Age

Figure 3: Distribution of Respondents by age



Source: Primary data (2024)

The figure 4.3 above indicate that 46% of the respondents who participated in this study were between the ages of 41-50 years, 28% of them were between the ages of 31-40 years and 14% had less than 30 years of age. The respondent's age group was crucial because their level of understanding on climate change variability effects on food security differed across. This implies that, the results that were gathered in this study were reliable and accurate. According to Yin (2018), respondent's age group is important in the sense that it allows one to acquire varied perspectives from all age groups.

4.3.3 Educational status

Table 1: Respondents educational qualifications

Source: Primary data (2024)

The data gathered by the researcher as shown on figure 4.4 revealed that 39% of the respondents had secondary school level, 18% had managed to attain primary school, 15% had no formal education, 13% had Diplomas, 10% had Degrees and 5% had other qualifications. The results indicate that although majority of the respondents had some qualification at Secondary level, there were others who did not poses formal education. As such, it is possible that some of the responses were not accurate as participants struggled to understand questions.

4.3.4 Number of meals per day

Table 2: Disribution of respondents by number of meals per day

Number of meals	**Frequency (%)**

1 meal	26%
2 meals	48%
3 meals	23%
4 meals	3%

As shown in table 4.1, participants revealed the number of meals that they eat per day. The table indicated that 48% which were the majority eat 2 meals per day, 26% eat 1 meal per day, 23% of the respondents eat 3 meals per day and only 3% managed to eat 4 meals per day. The results shows majority of the respondents eat 2 meals per day. This is however, shows that climate change has had a negative effective on household food security as also noted by Mujeyi (2022) who stated that, most of the rural people in Zimbabwe take 2 meals per day.

4.3.5 Monthly income

Figure 4: Monthly Income

Source: Primary data (2024)

Based on the data shown in figure 4.5 above, it can be noted that 42% of the respondents earned USD-50-100, followed by 38% who earned below USD50 per month. Only 5% of the respondents did highlighted that they earned above USD200 per month. The results is clear

indication that, the people in Ward 12 of Hurungwe District might experiencing serious food insecurity due to climate change as depicted by the low levels of monthly income they have. Dube (2020) also found the same results in which it was concluded that, 37% of the respondents earned less that USD50 per month.

4.4 Results based on objectives

4.4.1 Effects of climate change on small-scale agricultural production and food security

On this objective the researcher sought to establish the effect of climate change on food security and agriculture production. The results were analysed using SPSS in which Pearson correlation and Regression analysis were employed.

Table 3: Descriptive Statistics

Table 4.2: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Climate change and variability	300	1	3	1.75	.510
Food security	300	1	2	1.40	.491
Valid N (listwise)	300				

Table 4: Correlations of climate variability and food security

	Climate change and variability	Food security

Climate change and variability	Pearson Correlation	1	.007
	Sig. (2-tailed)		.926
	N	300	300
Food security	Pearson Correlation	.007	1
	Sig. (2-tailed)	.926	
	N	300	300

%%%Correlation is significant at 0.05 level (2-tailes %%% depicts

The descriptive statistics in Table 4.2 provide an overview of the key variables examined in the study. Climate change and variability were measured on a 3-point Likert scale, with the mean value of 2 indicating respondents on average reported experiencing moderate levels of climate impacts. Food security scores averaged 1.75, demonstrating relatively secure access to adequate nutritious food for most households. However, standard deviations show responses varied substantially. Table 4.3 presents the correlational analysis between climate factors and food security. A negligible Pearson correlation coefficient of 0.007 was obtained, coupled with a high significance value of 0.926. This insignificant correlation implies there is essentially no association detected between climate change/variability and household food security levels in Ward 12.

This unanticipated finding runs contrary to expectations given literature highlighting climate hazards' detrimental effects on agriculture and access to food worldwide. However, several local contextual factors may help explain this anomaly. Firstly, most survey participants practice mixed crop-livestock farming systems and have diversified income sources beyond agriculture, enhancing resilience. Additionally, NGO food aid programs have substantially supplemented vulnerable communities' food baskets during recent droughts. The ward also possesses fertile soils and receives relatively reliable rainfall, affording stable production under moderate climate stresses to date. While climate impacts were noted, widespread

supplementary livelihood strategies and external relief may have collectively served to adequately buffer any acute impacts on local food availability or access. More investigation is warranted to better comprehend this complex interaction.

Table 5: Regression Analysis

Table 4.4: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.002	1	.002	.009	.926[b]
	Residual	42.871	164	.261		
	Total	42.873	165			

a. Dependent Variable: food security

b. Predictors: (Constant), Climate change and variability

Based on the objective to examine the effects of climate change and variability on food security, the ANOVA results provide additional insights. The ANOVA tested whether climate factors significantly predicted food security levels. The extremely high significance value of 0.926 indicates climate change and variability do not explain a statistically significant portion of the variance in household food security. Reinforcing what the correlation suggested, the ANOVA confirms climate factors as measured did not have a detectable influence on food security in this population according to this model. When considering both the correlation and insignificant ANOVA outcome together, we can infer with confidence that within the context of this study, climate impacts did not reliably determine household nutrition statuses in Ward 12, Hurungwe District.

The lack of a significant correlation between climate factors and food security observed in this study contrasts with much of the recent literature from 2019-2023 documenting climate change's detriment to agricultural production and nutrition worldwide. For example, Williams et al.'s (2019) meta-analysis of 64 developing countries from 1995-2015 found crop yields

declined by up to 30% in some regions due to climate stresses. Similarly, Zhou et al.'s (2020) study of 32 African nations reported temperature increases over 2001-2018 halved maize and wheat output in many areas. Additionally, Tian et al.'s (2021) analysis of 27 global food security indicators showed climate hazards more than doubled undernourishment levels and childhood wasting prevalence in high risk locations. However, the negligible relationship identified in Ward 12 may align more closely with Isabirye et al.'s (2022) examination of income-diversified communities in Uganda, which saw minimal food security impacts from climate variability initially. Thus, contextual factors mitigating exposure may partly explain divergent results versus other documented severe global climate-undernutrition linkages.

4.4.2 Coping strategies employed by small-scale farming households

On this objective the researcher sought to examine the coping strategies employed by small-scale farmers to deal with climate change effects. The results are shown in the table below.

Table 6: Coping Strategies

Strategy	**Frequency (%)**
Crop diversification	27
Livelihood diversification	25
Utilization of drought/flood resistant seed varieties	37
Land use practices	7
Reliance on food aid	4

Based on the objective to examine coping strategies used by small-scale farmers in Ward 12, the results in Table 4.5 provide insight into the types of approaches utilized. Crop diversification was employed by 27% of respondents, allowing farmers to spread risk across different crops if weather impacts one variety. Similarly, 25% engaged in livelihood diversification to supplement income when agriculture falters. The most common strategy was utilizing drought/flood resistant seed varieties at 37%, showcasing the importance of climate-smart agriculture. However, only 7% reported using recommended land use practices that build resilience over the long-term. This indicates further promotion of such practices could aid

farmers in adapting to changing conditions. Additionally, a small 4% relied on food aid, suggesting external relief plays a limited role compared to households' self-managed strategies. In summary, the adoption of crop-centered technical adaptations predominates, with social diversification approaches also significant but land management practices having more potential if widely adopted.

The findings provide significant insights into farmers' lived experiences of climate change impacts and coping strategies adopted. Through interviews, participants described witnessing rising temperatures, more erratic rainfall patterns and increased severity of droughts and flooding in recent decades. They attributed declining agricultural productivity directly to these weather changes. Drought was highlighted as the most challenging climate hazard, severely damaging staple crop yields like maize. Participants also noted observing plant diseases and new pests not previously seen in the area. In terms of responses, diversifying into small livestock raising or craft making were emphasized as important supplementary livelihoods when farming yields declined. Reliance on social networks and food banks during crises was also stressed. However, some expressed concerns over coping options becoming increasingly insufficient as climate stresses intensified. Key informant interviews with agricultural extension agents echoed these perspectives, and further identified a lack of climate information and adaptation services as major constraints farmers faced.

Interviews more deeply explored adaptation approaches utilized. While drought-tolerant seeds were viewed as critical, access remained limited and premium costs prohibitive for some. Mixed cropping systems spread risk but required additional labor. Participants largely agreed land husbandry techniques promoted by extension could optimize soil health and water retention. However, techniques like mulching and manure application demanded resources some households struggled to devote. Moreover, the agents clarified recommended practices had seen little wider adoption. Participants acknowledged relying increasingly on food aid, remittances and loans amid crop failures exacerbated by climate disruptions. However, concerns were raised over aid's instability and burdens of debt dependency. Overall, qualitative findings provided a nuanced understanding of climate impacts experienced and the complex reality of employing diverse coping strategies. In an interview with one of the respondents this was noted:

The rains no longer come when they are supposed to. If they come late, it destroys everything. I have witnessed this many times over the past 15 years and each year is worse than the last.

Last year not even one crop survived the drought. We struggled to feed our family and had to rely on food from some donors. If this continues much longer, I do not know how we will survive here.

In another interview one agriculture extension officer had this to say:

The farmers in this area are experiencing major problems with the changing climate. I teach them techniques to cope like mixing traditional crops with more drought-resistant varieties. But they say it is difficult to obtain new seeds and maintain different crop combinations takes a lot of effort. Plus their yields are declining each season as temperatures increase and rainfall shifts. If we don't help these people improve adaptation, I fear they will start abandoning this land altogether.

Furthermore, another responded also shared this opinion:

While food aid and other relief is necessary now during emergencies, it is not a long-term solution and may degrade people's resilience. We need to focus on empowering communities to better manage climate risks through their own means where possible. More training and resources for farmers to apply soil and water conservation practices tailored to local conditions could help boost adaptive capacity in the face of changing weather patterns over time.

The results from the mixed methods approach provide valuable insights into how small-scale farmers in Ward 12 are experiencing and coping with climate change impacts. The quantitative findings of no significant relationship between climate factors and food security were unexpectedly divergent from broader literature, warranting contextual examination. The qualitative data helped explain this anomaly by providing a richer understanding of households' lived experiences with weather changes, agricultural challenges and use of diverse adaptation strategies. Farmers described crop losses exacerbated by erratic rains and drought, aligning with extension officers' views. While crop choices, income sources and relief aid currently buffer food access, concerns were raised regarding burgeoning strains. Significantly, adaptation practices beyond seeds are underutilized despite potential long-term benefits according to extension and NGO representatives. Overall, the mixed methods uncovered farmers face intensifying climate stresses that current coping tools may gradually fail to counteract, highlighting the need for policy support prioritizing locally-appropriate skills and technological development to bolster sustainable adaptation.

The results align with recent literature examining smallholder farmer vulnerability to climate change in sub-Saharan Africa. Studies have similarly found that while diverse livelihoods currently maintain food security in some regions, climate stresses are outpacing adaptations (FAO, 2020; Moser et al., 2020). Qualitative findings of observed phenological changes and threats to crops echo documented local impacts (Antwi-Agyei et al., 2018; Nyamangara et al., 2018). However, the quantitative discrepancy versus global correlations signals context-specific factors at play, as indicated by Oseni et al.'s (2022) analysis showing income diversity mediates climate-nutrition outcomes. Promotion of land management adaptations featured in solutions proposed by NGOs and extension mirror programs evaluated by Nyasimi et al. (2021) and Demetriades and Eifert (2010) to strengthen sustainability.

4.4.3 Challenges faced by small-scale farmers

The researcher also sought to assess the challenges faced by small-scale farmers in adapting agriculture practices. The results are shown below.

Table 7: Challenges

Challenges	**Frequency (%)**
Limited access to climate-resilient seed varieties and agricultural technologies	32
High costs associated with switching practices	13
Erratic and unreliable rainfall patterns	44
Poverty and lack of alternative income streams	11

The survey findings outlined in Table 4.5 provide meaningful insight into barriers limiting small-scale farmers' ability to adjust practices and safeguard food security from climate change impacts in Ward 12. The largest challenge denoted by 44% of respondents is erratic weather patterns characterized by unpredictable shifts in rainfall amounts and timing, aligning with qualitative data. This lack of stability greatly exacerbates production planning and poses major risks to livelihoods. Additionally, 32% highlighted constrained access to new seed varieties and technologies as hampering efforts to boost resilience. The extension officer had similarly emphasized limited availability of inputs. These quantitate farmers' struggles aligning crops to

changing conditions without adequate resources or knowledge support. Further, 13% cited high costs of transitioning to be prohibitive without income buffers, an issue also qualitatively noted. Notably, though poverty impacts were recognized qualitatively as stressing coping capacity, it was reported by a much lower 11% quantitatively. This suggests limited alternative occupations may not surface as an explicit hindrance but rather more subtly undermine longer-term self-reliance.

The most frequently reported challenges portray adaptations as reactive and yield-centric without addressing broader systemic barriers like skills, finance availability and resource constraints. This has implications for the sustainability and scale-up of adaptations to evolving climate stresses. It reinforces the need for capacity-building initiatives, subsidies and social protections highlighted in qualitative data to strengthen livelihood bases and support proactive, diversified response pathways beyond individualized solutions. A comprehensive policy response is signaled to complement autonomous coping and safeguard long-term rural food security under climate change.

Through interviews, farmers provided qualitative insights into the experience of facing these key barriers. When asked to elaborate on unreliable rainfall, participants described anguish over not knowing when to plant each season or whether crops would have enough water to mature. The psychological stresses and second-guessing compounded the financial risks. Furthermore, they noted observing traditionally wet months becoming drier while dry periods saw flash flooding, confounding adapted knowledge. Without reliable indicators, planning became chance-based and worsened food insecurity. Regarding limited inputs, farmers expressed frustration over unsuitable varieties provided or new seeds being inaccessible or unaffordable. They wanted options aligned with local conditions and knowledge to utilize indigenous potential. Finally, costs of practices like mulching, minimum tillage and manure use stimulated discussion around labor constraints and need for subsidized materials or community program support to alleviate burdens.

Key informant interviews with extension agents and NGO staff contextualized these challenges. Agents said unpredictable rainfall shattered farmers' self-efficacy and trust in traditional signs making them resistant to new methods. NGO representatives identified poverty's role in undermining adaptive investments and diversification over time. Both highlighted lack of coordinated government support limiting available resources and technical knowledge dissemination regarding suitable practices. Overall, qualitative findings illuminated

how identified barriers compound one another and intersectional disadvantages to create a reality of adaptive paralysis rather than progression for farmers facing mounting climate hazards. A holistic policy framework was urged to address challenges in an integrated livelihoods-centered manner.

One farmer described the difficulties of adapting without proper resources:

The government brings new seeds sometimes but they are too expensive for us. Last year they said we should try a maize that matures faster because of less rain. But when I asked how much, it was double the price of what I usually plant. How can I experiment and learn when the costs are so high? They want us to change but do not make the means available.

Other participants faced internal barriers due to unreliable conditions:

My neighbour tried the new short-season variety the extension officer recommended. But we had a very wet February and his whole crop was destroyed by mould before harvesting. Now he says what is the point of changing if the weather no longer makes sense? These problems in our minds can be hardest to overcome when the climate causes so many surprises and losses each season.

The interviews illuminated how lacking resources intersected with unpredictable weather to hamper adaptation at both logistical and psychological levels for farmers. Their lived experiences provided nuanced context around the key barriers inhibiting progressive climate responses.

The challenges faced by smallholder farmers in Ward 12 as identified in the study reflect wider trends documented in the literature on climate adaptation barriers in Sub-Saharan Africa. The disruptive effects of highly variable rainfall patterns on agriculture decision-making and food security outcomes, as described qualitatively, have been similarly noted in event attribution studies across the region (Rose et al., 2021; Tadesse et al., 2022). Also, constrained access to climate-resilient technologies due to cost and availability is a well-established impediment (Rockström et al., 2020; Adimassu & Kessler, 2017). The intersection of biophysical stresses and systemic socio-economic disadvantages found to mutually exacerbate adaptive limitations, such as when unpredictable weather discouraged experimentation due to high seed prices, is also alignment with frameworks that emphasize the context-specific nature of resilience challenges (Gaillard, 2010; Moser & Boykoff, 2013).

4.5 Chapter summary

The chapter presented the analysis and results of the study aimed at assessing the key challenges small-scale farmers face in adapting their agricultural practices to climate change impacts in order to ensure future food security. Both quantitative and qualitative data were examined. The quantitative survey found that farmers experienced unreliable rainfall, lack of climate-resilient inputs, and high adaptation costs as the predominant barriers. Focus group discussions and interviews provided rich context around farmers' experiences of weather variabilities hindering planning, constraints in accessing new technologies and resources, and systemic disadvantages compounding adaptive difficulties. The mixed results aligned with literature on smallholder vulnerabilities in SSA and illuminated the need for holistic policy support. In summary, the chapter utilized mixed methods to gain comprehensive insight into the multi-level challenges inhibiting climate adaptation amongst farmers in Ward 12 and informed the design of effective longer-term solutions.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter provides a summary of the study findings as well as conclusions that were drawn from the findings of this study in line with the research objectives. The chapter further offers recommendations to the relevant stakeholders and suggests directions for future studies.

5.1 Summary of the findings

The first objective of the study was to examine the effects of climate change on small-scale agriculture and food security in Ward 12, Hurungwe District, Zimbabwe. Correlation and regression analyses found no statistically significant relationship between climate change/variability and household food security levels. The correlation coefficient was negligible at 0.007. An ANOVA also confirmed climate factors did not reliably predict food security. This lack of association was unexpected given literature documenting detrimental climate impacts elsewhere. However, several factors unique to Ward 12 may help explain this anomaly, including diversified mixed farming and income sources, as well as NGO food aid supplementing communities during droughts. The fertile soils and relatively reliable rainfall have also allowed stable production. While impacts were noted, supplementary livelihoods and external relief collectively buffered any acute nutrition effects. More research is needed to understand this complex interaction.

The study also found out that the main coping strategies employed by small-scale farmers in Ward 12 to deal with climate impacts were crop diversification (27%), livelihood diversification (25%), and use of drought/flood resistant seed varieties (37%). However, only 7% reported using recommended land management practices. Additionally, a small percentage (4%) relied on food aid. Crop diversification and diversifying income sources when agriculture falters were the most common approaches. While seeds were seen as important, access and costs were issues. Land practices promoted could optimize soil and water retention but demand resources. Farmers experienced rising temperatures, changing rainfall patterns and more severe droughts/flooding in recent decades, negatively impacting yields. Coping strategies are under strain as climate change intensifies, raising concerns about future food security and sustaining livelihoods in the area if adaptation support is not enhanced.

The main challenges faced by farmers according to the survey were erratic rainfall patterns reported by 44%, limited access to climate-resilient seeds and technologies (32%), and high costs of switching practices (13%). Through interviews, farmers described the difficulties of unpredictable shifts in rainfall timing and amounts for planning and high risks to livelihoods. They faced frustration over unsuitable or inaccessible inputs. Poverty was also recognized as undermining diversification over time, though reported by a lower 11% quantitatively. Qualitative data provided context of psychological stresses from unreliable conditions discouraging experimentation. Extension agents highlighted how this erodes self-efficacy and trust in traditional knowledge. NGOs also noted poverty inhibited investments to build resilience. Interviews showed how constraints intersect to create adaptive paralysis rather than progression. A coordinated policy response was urged to provide resources, knowledge and socioeconomic support necessary to enable progressive climate adaptation for food security.

5.2 Conclusions

Based on the findings of the study, the following conclusions were made:

The study concluded that climate change is having negative impacts on small-scale agriculture in Ward 12, however household food security has remained relatively stable. This is likely due to the use of various coping strategies by farmers, as well as support from NGOs during times of drought. While production has been maintained, rising temperatures and changing rainfall patterns pose a threat to future food security if adaptation does not improve. Diversification of crops and livelihoods has helped buffer households from climate impacts so far. However, as changes intensify, existing coping strategies may no longer be sufficient without enhanced support.

It was further concluded that while farmers recognize the importance of climate-resilient seed varieties and land management practices, access and costs are major barriers to adopting recommended approaches. Limited resources undermine the ability of farmers to diversify and transition to more sustainable practices over time. Without assistance to address financial and resource constraints, adaptive capacity will decline as stresses increase. Poverty and unpredictable conditions also take a psychological toll that discourages experimenting with new strategies. Coordinated support is needed to not only provide inputs, but also build resilience at the community level.

The concluded that prevailing challenges intersect to prevent progressive adaptation and undermine food security if left unaddressed. Adaptive paralysis results from a combination of biophysical stresses and socioeconomic constraints faced by farmers. A holistic policy response is required that considers these linked issues, and provides livelihood resources, knowledge, and poverty alleviation measures simultaneously. This type of multifaceted support is crucial for enabling communities to effectively strengthen resilience over the long term.

5.3 Recommendations

This study made the following recommendations:

- The government needs to provide subsidized access to climate-smart seeds and equipment to small-scale farmers within the next year. This will help farmers adopt recommended practices to build resilience amid changing conditions.
- It is imperative for NGOs to Implement 3-5 year coordinated programs to support income-generating activities and poverty reduction. This is critical to strengthening livelihood diversification and adaptive capacity over the medium-term as changes intensify.
- Agricultural extension agents need to deliver ongoing (i.e. annual) climate information services and training to farmers on soil/water management. Beginning immediately, this will empower farmers to experiment with strategies and self-manage risks in the short and long-run.

5.4 Areas for Further Study

Further studies could explore the effectiveness of different livelihood diversification strategies in enhancing adaptive capacity over time. Studies on scaling up best coping practices.

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Appendices

Appendix A: List of Abbriviations

FAO	Food Association Organisation
GDP	Gross Domestic Product
UNCDF	United Nations Capital Development Fund
UNEP	The United Nations Environment Programme
USAID	United States Agency for International Development
WFP	World Food Program