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The Impacts Of Climate Change On Smallholder Farmers Case Study Of Mazowe District Ward 8, 10 And 12, Mashonaland Central Province, Zimbabwe

BY

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The undersigned certify that they have read the dissertation and recommend to the Bindura University of Science Education for acceptance of this dissertation entitled: **Impacts of Climate Change on Smallholder Farmers Case study of Mazowe District, Ward 8, 10 and 12**. This research is submitted to the department of Sustainable Development in partial fulfillment of Bachelor of Science Honors Degree in Development Studies.

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DECLARATION

I, RUGARE KANGAI, am a student pursuing a Bachelor of Science Honors Degree in Development Studies. I really declare that I understand that data fabrication is unethical and that plagiarism is a criminal offence of Development Studies research.

Impacts of Climate Change on Smallholder Farmers in the Case of Wards 8, 10, and 12 Mazowe District, Mashonaland Central of Zimbabwe is the title of my dissertation report. It is the product of my own work and is not plagiarised. I have complied with the requirements of research ethics necessary to pursue Development Studies research, and I authorise the University to use it for instructional purposes.

Date May 2024

Student's Name RUGARE KANGAI

Signature ……

DEDICATION

Special devote goes to my loving mother, Vaida Muhambiwa, my sister in law Rumbidzai Grace Kangai and my brother Reward Kangai for they had always inserted value in my life through all their struggles. I also dedicate this piece of work to my supervisor, Doctor Boora, family, friends, Mazowe Rural District Council and everyone else who made this study research a success.

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ABSTRACT

The purpose of this study is to assess the impact of climate change on smallholder farmers in Mazowe District, Wards 8, 10, and 12, Mashonaland Central, Zimbabwe. The questionnaire-based survey, key informant interviews, and focus group discussions included 100 participants. Ward councillors, extension officers, weather station officers, independent experts, NGO officers and farmers were randomly selected from the district's three rural wards as participants. The study combined quantitative and qualitative methods. A deliberate sampling of the district's wards was required for the use of the qualitative methodology. Using standardised questionnaires and in-person interviews, both qualitative and quantitative data were collected from the community under study. The research strategy for this study was influenced by the kinds of data that were collected, the research subjects, and the research resources. The great majority of the questions were open-ended because the data was gathered using questionnaires. Interviews were another method the researcher employed to gather data. The identical set of questions, presented in the same format and sequence, were sent to each respondent. Observation served as the third tool employed to obtain data. In order to assess how climate change is affecting smallholder farmers, the researcher travelled around the wards. The study's conclusions were focused on four main goals, the first of which was to identify the reasons for climate change's effects on Mazowe district's smallholder farmers. The second goal was to determine those effects. The third goal was to identify the difficulties smallholder farmers in Mazowe district experience in adjusting to the consequences of climate change. The final goal was to identify better ways to assist smallholder farmers in adjusting to these effects. The study's suggestions were for Zimbabwe's metrological services organisation to offer sufficient extension information services so that farmers could receive current information on rainfall patterns and make well-informed planting decisions. The government should hasten programmes that promote farmer training and access to financing and aid facilities, as well as assist farmers in acquiring livestock and other critical agricultural assets that can help raise net farm productivity. Government

should implement climate change adaptation strategies such as pfumvudza programme to sustain people's livelihood and support food security program.

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ACRONOMYS

IPPC	International Panel on Climate Change
GoZ	Government of Zimbabwe
CwDCCP	Copping with Drought and Climate Change Project
DFID	Development for International Development
SLF	Sustainable Livelihood Framework
FAO	Food and Agriculture Organisation
BMD	Bangladesh Metrological Department
ICCCAD	International Centre for Climate Change and Development
NGO	Non-Governmental Organisation
FGD	Focus Group Discussion

CHAPTER ONE

1.1 Introduction

Climate change remains a global problem. It threatens various economic growth areas, involving food security, farming, the environment, natural resources, health, manufacturing, and forestry. Climate change alters rainfall patterns, lengthens dry seasons, and raises temperatures, all of which lead to widespread droughts that affect crop yield. Climate change adaptation challenges have received increased attention in Zimbabwe over the last few years. This study aims to investigate how smallholder farmers in Mazowe District, Ward 8, 10 and 12, Mashonaland Central Province, Zimbabwe, are impacted by the changing climate. A summary of the project is given in this chapter, together with information on the study's objectives, setting, and issue statement.

1.2 Background for the study

Global issues like climate change have impeded growth. Because industrialised countries are more equipped to handle climate change issues than developing countries are, it has presented serious risks to sustainable development at both the macro and local levels, albeit more slowly than in developing countries. Europe has seen a series of climates, but the majority of the continent has had nice weather, with some notable unusual weather patterns. Climate change affects the entire continent, according to the Europe Environmental Agency's Climate Change Impacts and Vulnerability research (E.E.A 2012). Climate change has caused a 40% decline in Europe's Arctic sea ice since the 1960s. Climate change has resulted in a 40% reduction in Arctic sea ice in Europe since the 1960s (NASA). It has also raised temperatures in Arctic regions like Alaska and Canada, decreased rainfall in regions like Spain and increased rainfall in Northern Europe, and altered rainfall patterns, environmental activists pointing out that there is more precipitation in the north and less in the south. River flooding has also increased; the Danube River in Budapest and the Elbe River in Germany both rose 8.91 metres in 2013 over 2006 levels. Rising temperatures have sped up the water cycle (Sky News, 2013).

Aside from that, precipitation events in Europe are getting increasingly intense, increasing the risk of flooding and famines. The continual rise in temperatures best explains why Arctic

water warms quicker in most locations, and the melting of Arctic sea ice in the past few years demonstrates swift alterations in the climate. All of this demonstrates that, like the rest of the globe, Europe is not immune to the consequences of climate change.

To be clear, Africa as a whole is threatened by climate change, not just Europe. Increased food insecurity and famine, reduced agricultural production from rain-fed crops, elevated water stress, and the IPCC predicts the growth of dry and parts of Sub-Saharan Africa that are semi-arid. According to the IPCC, Sub-Saharan Africa will see an increase in food insecurity and hunger, reduced yields from rain-fed farming, heightened water stress, and increasing semi-arid and dry land expansion. Climate change is already having an impact in Zimbabwe, according to meteorological data. This includes more erratic rainfall in addition to a rise in, a regularity and intensity of weather-related disasters, such as droughts and floods d tropical cyclones.

Furthermore, climate change is anticipated to raise temperatures by two degrees Celsius by 2080, leading to more severe weather and climatic extremes (Gogo, 2013), while Zimbabwe's rainfall varies seasonally. The onset of rainfall has shifted significantly, with the season beginning as late as January, causing farmers to get quite agitated. During previous seasons, the country and region have gotten inadequate precipitation due to fluctuating weather patterns, resulting in a food deficit. Seasons in Zimbabwe have changed, as have rainfall patterns, with substantial implications for smallholder farmers who rely on rainfall for agricultural productivity.

According to the Government of Zimbabwe, the Zimbabwe economy and livelihoods are under stress as a result of a variety of socioeconomic, environmental, and political reasons. Climate change amplifies the effects of these various pressures on people's health and livelihoods. According to studies, climate change has caused changes in agro-ecological zones, such as Chinhoyi and Chivero migrating from region 11 to region 111; also, natural region 111 has shifted to the north, natural region 11 has moved farther east, and natural region 1 has diminished in size (Government of Zimbabwe, 2014). These changes have significant ramifications for people's livelihood plans, especially in agriculture.

The agricultural sector of smallholder farmers in Mazowe is nearly paralysed as crops wilt owing to severe heat, and animal output has been hampered since pastures have become

scarce in the area (Madhuku, 2011). According to the Coping with Drought and Climate Change Project (CwDCCP), 2012, most communities are growing more reliant on donor hand outs as farms no longer produce enough to support farmers until the following season.

1.3 Problem statement

According to Henry and Lipper (2019), climate change affects smallholder farmers by limiting their availability to agricultural inputs like seeds, fertilisers, and irrigation systems. This viewpoint highlights the lack of access to resources and infrastructure, which lowers smallholder farmers' productivity and profitability. Morton (2014) underlined climate change's effects on crop yields, food security, and smallholder farmers' livelihoods. Holland and Harvey (2020) investigated how access to loans, market linkages, land tenure systems, and gender dynamics influence farming activities and outcomes for smallholder farmers. I decided to conduct study on how climate change impacts small farmers since, despite the researchers' best efforts, they did not sufficiently investigate how smallholder farmers might be impacted by climate change in Mazowe District. For instance, one noted the need for more localised data or context-specific insights to drive policy interventions or development programmes aimed at smallholder farmers in Mazowe District Ward 12.

1.4 Aim of the Study

The research seeks to investigate how climate change affects smallholder farmers in Mazowe District. By evaluating the specific obstacles faced by smallholder farmers, the study hopes to discover viable adaptation techniques and interventions that can help alleviate these effects. The project's goal is to ascertain how Mazowe District's climate change has an influence on smallholder farmers. In order to support smallholder farmers in Mazowe District Wards 8, 10, and 12, the project intends to offer evidence-based recommendations for boosting resilience and putting sustainable agricultural methods into practice given the effects of climate change

1.5 Research Objectives

The study sought:

1. To examine the causes of climate change in Mazowe District, ward 8, 10 and 12, Mashonaland Central of Zimbabwe.

2. To analyse the effects of climate change on smallholder farmers in Mazowe district.
3. To examine the challenges faced by smallholder farmers to adapt to the effects of climate change.
4. To suggest improved strategies to help smallholder farmers adapt to the effects of climate change in Mazowe district.

1.6 Research Questions

1. What are the causes of climate change in Mazowe District, Mashonaland Central of Zimbabwe?
2. What are the effects of climate change on smallholder farmers in Mazowe District Ward 8, 10 and 12?
3. What are the challenges faced by smallholder farmers to adapt to the effects of climate changes in Mazowe District?
4. What are the improved strategies to help smallholder farmers adapt to the effects of climate change in Mazowe district?

1.7 Assumption of the Study

The researcher assumed that:

1) Climate change has considerable impact on smallholder farmers.

2) Smallholder farmers will provide valuable information for my research.

1.8 Significance of the study

This study's main objective is to examine how smallholder farmers are adjusting to the consequences of climate change, which addresses one of the most significant issues in agricultural research and climate change.

1.8.1 Policy makers

The study's findings can inform policy at all levels, including local, national, and global.
Using this data, policymakers can create programmes that help farmers who are smallholders adjust to the consequences of climate change. By drawing attention to the particular problems faced by smallholder farmers in Mazowe Wards 8, 10, and 12, it has the potential to have an impact on the worldwide conversation about mitigating and adapting to climate change.

1.8.2 Researchers

The study's findings will help academics develop sustainable agriculture strategies that are resilient to climate change. This understanding can help to shape long-term development strategies that prioritise environmental sustainability.

1.8.3 Residents of Mazowe District Ward 8, 10 and 12

The research will help Mazowe District Ward 8, 10, and 12 residents understand how climate change will affect them. The study's findings will also help smallholder farmers in various places discover efficient ways to methods with the effects of climate change, as they supplement existing knowledge.

1.8.4 Government

Based on the findings, the Zimbabwean government and policymakers will be able to propose and implement appropriate economic stabilisation measures. The findings will also assist the government make judgements about successful adaptation methods. Furthermore, the research falls under the purview of disaster management, and it will benefit a variety of stakeholders if the findings and recommendations are examined and included into their future growth and drought control strategies.

1.9 Study Area

1.9.1 Location and Study Site Description

This study was carried out at Mazowe District's Ward 8, 10 and 12, which is located in Chiweshe. Figure 1.0 depicts the study area's location, which includes Wards 8, 10, and 12.

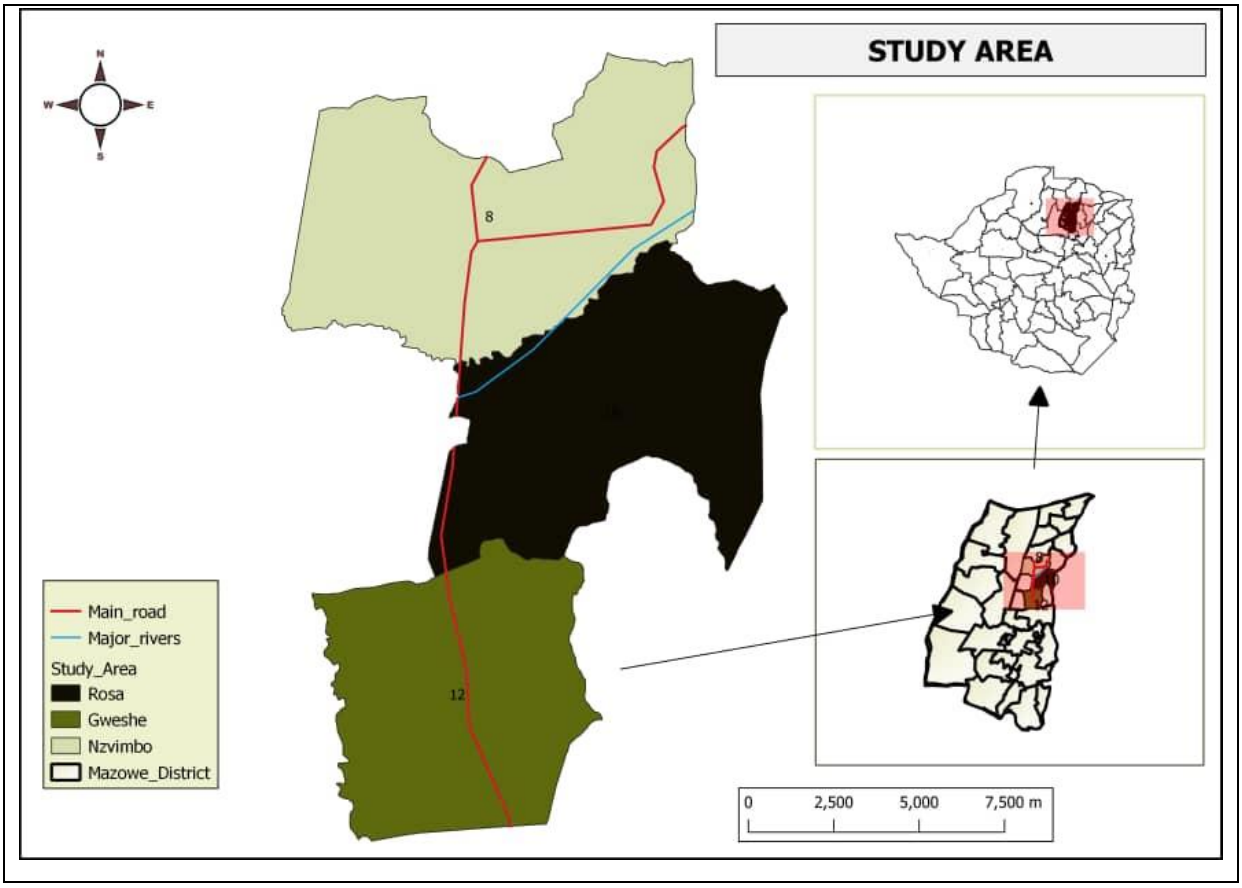

Figure 1.0: Location of the research area (created by the author).

The study areas are the rural areas in Zimbabwe's Mazowe District. Mazowe District is in Mashonaland Central Province, in the country's north. Bindura, located about 50 kilometres southeast of the study area, serves as the district's administrative centre. It is distinguished by its largely agricultural terrain, which includes enormous areas of farmland and rural villages. The region is recognised for its fertile soil, which support a wide range of agricultural activities like as grain cultivation and livestock breeding Maize, tobacco, cotton, and vegetables are among the most often, `grown crops in the area, contributing to the local economy and food production.

The climate in the study region and nearby Mazowe District is subtropical, with separate rainy and dry seasons. The climate in the study region and nearby Mazowe District is subtropical, with separate rainy and dry seasons. The area receives a modest quantity of rainfall, approximately 800 to 1,000 millimetres (mm) per year, which is critical for agriculture. The minimum temperatures range from around 10 to 15 degrees Celsius during

the cooler months. During the warmer months, the minimum temperatures can range from around 15 to 20 degrees Celsius or higher. This area is home to a diverse community, primarily consisting of the Shona people, who are the majority ethnic group in Zimbabwe. The residents engage in small-scale farming, subsistence agriculture, and some engage in informal trading and other small businesses.

1.9.2 Delimitation of the study

The investigation was conducted in Mazowe, a drought-prone area. In Zimbabwe's Mashonaland Central Province, the district of Mazowe is home to about 203 936 people. It will also employ Nzvimbo, Gweshe, and Rosa Hamlets as a case study, as they are located in Wards 8, 10, and 12 under Chief Chiweshe and serve 100 homes. The study also spans the years 2023-2024 in order to better understand the adaptive strategies used by residents in Mazowe district's Ward 8, 10 and 12.

1.10 Limitations

The researcher encounters a variety of problems, including:

1.10.1 Financial challenges

The researcher had financial difficulties while conducting the study. The researcher asked funds to fly to Mazowe, conduct interviews, and purchase questionnaire stationery. Money was also required to acquire housing, as the researcher did not have any. The researcher asked friends and family for financial support in order to get past this obstacle.

1.10.2 Time Consuming

The project required a lot of time because the researchers had to devote their full focus to organising and preparing questionnaires, as well as conducting comprehensive interviews. Nonetheless, the researcher had to remain patient to obtain appropriate data.

1.10.3 Cooperation from the people

Individuals' lack of participation presents a challenge for the student. Some persons refused to participate by withholding the information. The researcher had to negotiate with participants to provide assistance at their most convenient times.

1.11 Definition of key words

1.11.1 Climate

Climate describes the atmosphere's long-term behaviour in a particular place. It displays the long-term reactions of the atmosphere. Climate change is influenced by a number of variables, including average temperatures, precipitation, and the kind, the regularity, length, and severity of meteorological phenomena such as heat waves, cold snaps, tempests, flooding, and dry spells (Nhandara, Shumba, Mutsvagwa, 2013).

1.11.2 Climate Change

When major changes in climate variables like temperature, wind, and rainfall persist for several years or decades, they are referred to as climate change. According to the Grains Research and Development Corporation (2008–2013), change takes time. The phrase is commonly employed to depict the gradual alterations in climate statistics. Both natural and man-made factors are the primary sources of climate change.

1.11.3 Small holder farmers

78% of farmers in the nation are classified as small-holder farmers, they are defined as homes that look after or possess less than two hectares of land and are classified as marginal and sub-marginal. (WIEGO, 2013). Smallholder farmers are rural cultivators who primarily employ family members and whose farm is their only source of income. They are primarily found in developing nations (Morton, 2007).

1.11.4 Weather

"Weather" describes the state of the atmosphere where it is at any given time. According to David Waugh (p. 188), it is described as the local atmospheric state throughout a brief period of time, spanning from minutes to months. Temperature, precipitation, clouds, and wind are among the most prevalent meteorological features.

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1.12 The study's organisation

Six chapters make up the research, and they are presented in the following chronological order:

CHAPTER ONE: Introduction and Background - This examines the research's aim, research objectives, research questions, study assumptions, study significance, study location, delimitation, restrictions, and key term definitions.

CHAPTER TWO: Literature Review - This chapter looks at research on how climate change is affecting smallholder farmers. It also assesses pertinent literature and takes into account the findings of earlier studies regarding the consequences of changing in climate for small-scale farmers.

CHAPTER THREE: Research Methodology- The investigator talks about their research methodology. The research techniques used in the study to gather pertinent data are covered in this chapter. It also covers the population sample, target demography, design, sampling procedures, and research technique.

CHAPTER FOUR: Data Analysis, Presentation and Discussion - The results of the investigation are presented and interpreted in this chapter. This chapter summarises the data analysis, findings, and result interpretation.

CHAPTER FIVE: Summary, Conclusion and Recommendations - The researcher presents the research findings, incorporating them into earlier studies and the theoretical framework. This chapter draws conclusions from research findings. It also summarizes the research findings.

1.13. Chapter Summary

This section acted as a summary of the study, providing direction for all of the chapters written in this research. The chapter primarily focused on the study's history, problem statement, research aims, research questions and assumptions, study importance, study location, delimitation, limitations, definition of key terminology, and dissertation outline. The study looked at how smallholder farmers in Mazowe, Zimbabwe's Mashonaland Central Province, Wards 8, 10, and 12, were affected by climate change. Chapter one highlights the study's key findings.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction.

The chapter before this one covered the problem statement, the goals of the research and the history of the study. A review of the literature that is pertinent to the goals of the study is given in this chapter. As a result, the chapter contains real facts from a variety of experts regarding how smallholder farmers are affected by climate change, along with a conceptual framework and mitigation strategies.

2.2 Conceptual framework

A conceptual framework is presented in this section of the study to show the relationship between variables and how the study intend to explore the variables. In this study, the literature review begins by using the sustainable livelihood framework (SLF) to understand smallholder farmers' livelihoods and how they will be impacted by climate change, as well as how they can adjust their livelihoods to develop livelihood strategies. Figure 2.1 depicts the conceptual foundation for this investigation.

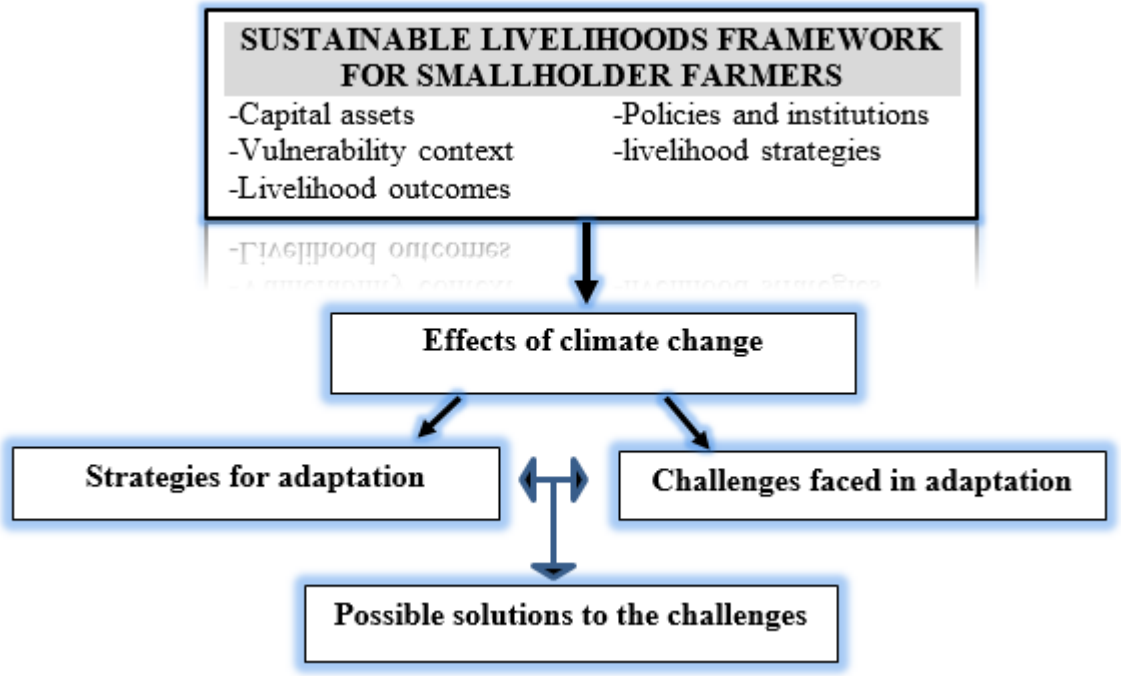


Figure 2.1: Conceptual framework (Source: Author)

As demonstrated in Figure 2.1, the study used the sustainable livelihood framework technique to gain a comprehensive understanding of the conditions affecting smallholder farmers' livelihoods in Mazowe District. The nexus between the objectives is also investigated by reviewing relevant literature on each of the variables.

2.3 Sustainable Livelihood Framework for smallholder farmers

The Sustainable Livelihoods Framework (SLF), as emphasised by the Department for International Development (DFID, 1999), provides a theoretical foundation and analytical structure for investigating the small-scale agricultural activities identified in this study, as well as their impact on the livelihood options of participating rural farmers. A livelihood is "the capabilities, assets (including both material and social resources), and activities required for a means of living" by Lemke, Yousefi, Eisermann, and Bellows (2012). When a means of subsistence maintains or increases its capacity and assets, is resilient to stressors and shocks, and does not deplete the base of natural resources, it is said to be sustainable. "In this scenario, the framework would be used to assess the impact of climate change on rural smallholder farmers' livelihoods. Figure 2.2 depicts A Framework for Sustainable Livelihood.

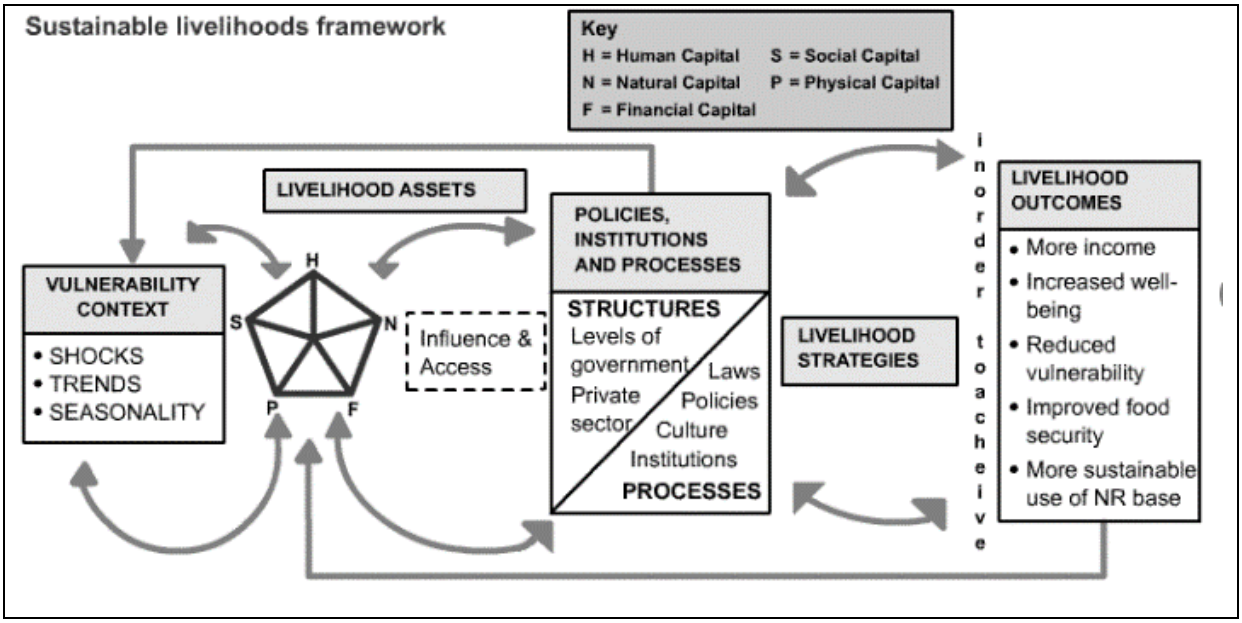


Figure 2.2: A framework for sustainable livelihoods (Source: Erenstein, Hellin & Chandna, 2007)

As shown in figure 2.2, the SLF helps in understanding how different components of the socio-economic activities of a particular community link together to produce livelihood outcomes and the influence of the vulnerability context on safeguarding sustainable livelihoods. For smallholder farmers in this study, the vulnerability context is particularly related to the changing climate systems.

Scoones (2009), explains the roots and history of the SLF and settles that it did not emerge from nowhere in the 1990s, but rather that it shares insights with past methodologies like village studies, political ecology and resilience studies. A livelihood is deemed sustainable if it can endure and recover from stressors and shocks while maintaining or developing its capabilities and assets without depleting natural resources. In this case, the framework would be used to evaluate how climate change affects the lives of rural smallholder farmers. Figure 2.2 displays the Sustainable Livelihoods Framework.

According to Lemke et al. (2012), at the family and community levels, livelihood assets (a mix of physical, natural, financial, social, and human capital) are critical for households and individuals implementing procedures (livelihood strategies) to achieve desired results. Livelihood outcomes affect livelihood assets. Institutional and policy structures and procedures at the national and provincial levels have an impact on the ability to mobilise and orchestrate livelihood assets and strategies, directly altering people' and groups' vulnerability settings.

The Vulnerability Context in the SLF refers to the seasonality, patterns, and shocks that disturb people's lives, particularly those of smallholder farmers. These elements are basically beyond local control, particularly in the short and medium term (Zhao, Fan, Liang, & Zhang, 2019). As a result, it is critical to develop indirect techniques for mitigating the negative effects of the Vulnerability Context while also strengthening resilience and overall livelihood security. This is especially relevant for the impoverished, who regularly sell assets in response to bad seasons and unexpected events (Pearson & Newman, 2019). However, the impoverished typically lack marketable assets. Their lack of assets also suggests that they are often less able to capitalise on positive trends than their wealthier peers.

Policies, institutions, and procedures are critical because they function at all levels, from local to global, and in all domains, from private to public, including smallholder agricultural systems (Lencucha, Pal, Appau, Thow, & Drope, 2020). They effectively manage access (to multiple types of capital, livelihood strategies, decision-making bodies, and sources of influence), exchange prices between different types of capital, and returns on any specific livelihood strategy (DFID 2000). Policies, institutions, and procedures have a direct impact on whether communities achieve a sense of inclusion and well-being, and because culture is involved, they also account for other 'unexplained' disparities in 'how things are done' between cultures (DFID, 2000). Policies, institutions, and processes can influence asset access and decision-making.

Livelihood schemes are decisions made by smallholder farmers to generate income, security, well-being, and other beneficial results. The benefits of diverse ways to generating income, boosting well-being, reducing vulnerability, and sustaining resources varied at the individual, household, and regional levels (Ahammad, Stacey & Sunderland, 2021). Higher income, improved well-being, increased food security, reduced vulnerability, and the utilisation of natural resources sustainably are all examples of livelihood advantages.

Tang, Bennett, Xu, and Li (2013) discovered that livelihood outcomes had a feedback effect on vulnerability situations and livelihood assets. Although the SLF does not specify how to assess the attributes, it remains an important tool for understanding the linkages between vulnerability, assets, institutional influences, and livelihood possibilities. The approach used in this study aims to assist understand the effects of climate change on smallholder farmers and their livelihood adaptation alternatives.

2.4 Major causes of climate change in smallholder farming societies worldwide

Climate change is significantly affecting agricultural practices and lives in smallholder farming communities around the world, particularly in the Netherlands and Pakistan. These causes are identified based on the observations and experiences of smallholder farmers in these regions.

In Netherlands, smallholder farmers have indeed been experiencing shifts in weather patterns, including increased rainfall intensity, longer dry periods, and changes in temperature (IPCC, 2014). These modifications may have a substantial impact on their farming methods and overall production. One example of the impact of increased rainfall intensity can be seen in the province of Limburg in the Netherlands. In recent years, heavy rainfall events have become more frequent, leading to increased soil erosion and waterlogging in agricultural fields (Dankers & Schuurmans, 2016). This excess water can hinder planting activities and cause water stress in crops, affecting their growth and yield.

The Netherlands, with its low-lying coastal areas, faces increased vulnerability to rising sea levels, which directly impacts smallholder farmers in these regions. The risks associated with flooding, soil salinization, and coastal erosion pose significant challenges to agricultural practices and livelihoods (Kabat et al., 2015). The province of Zeeland provides one example of how increasing sea levels affect smallholder farmers. This region in the south-western Netherlands is especially vulnerable to coastal flooding due to its low elevation and proximity to the sea. As sea levels rise, the risk of flood events and saltwater intrusion into agricultural lands increases, leading to reduced agricultural productivity (Van der Sluis et al., 2016). Smallholder farmers in Zeeland must employ various adaptation strategies to combat these challenges, such as the use of innovative drainage systems and the cultivation of salt-tolerant crops.

Furthermore, soil salinization is a major hazard to smallholder farmers in coastal regions. Increased saltwater intrusion, whether from flooding or rising groundwater levels, can result in elevated soil salinity levels, reducing crop growth and output (Van der Sluis et al., 2018). For example, in the coastal province of Friesland, smallholder farmers have faced increased salinization in their agricultural fields, necessitating the implementation of measures such as improved drainage systems and the use of alternative irrigation water sources to mitigate the effects of soil salinity (van der Salm et al., 2018).

In Pakistan, smallholder farmers believed that deforestation and land degradation have a substantial impact on climate change. The clearance of forests for diverse objectives, such as agriculture, urbanisation, and fuel wood extraction, combined with unsustainable land management methods, increases greenhouse gas emissions and affects local climatic patterns (Ali et al. 2018). Converting wooded regions to agricultural land is one example of how deforestation affects climate change in Pakistan. Smallholder farmers frequently remove forests to expand their agricultural activities, releasing significant volumes of carbon dioxide (CO2) into the sky. Deforestation not only diminishes forests' carbon sink capacity, but it also exposes the carbon contained in trees and vegetation to decomposition, increasing CO2 emissions (Khan et al., 2017). Another factor contributing to climate change is the unsustainable use of forests for fuel wood. Smallholder farmers in Pakistan generally use wood for cooking and warmth. The growing demand for fuel wood causes deforestation and forest degradation, releasing carbon stored in trees and increasing greenhouse gas emissions (Naeem et al., 2016). This unsustainable practice worsens the impact of climate change on smallholder farmers.

In Pakistan, air pollution and industrial pollutants have a considerable influence on climate change, particularly on smallholder farmers. They point out that greenhouse gas emissions from industrial operations and transport networks, such as CO2 and CH4, contribute to global warming (Khan et al., 2018). The usage of fossil fuels for electricity generation is one example of how industrial emissions contribute to climate change in Pakistan. Pakistan's industries rely mostly on fossil fuels such as coal and natural gas for energy. The combustion of these fossil fuels emits massive amounts of CO2 into the atmosphere, hence increasing greenhouse gas concentrations and global warming (Arif et al., 2017).

2.4.1 Major causes of climate change in African smallholder agricultural communities

Climate change has a substantial impact on African smallholder farmers' agricultural methods and livelihoods, especially in South Africa and Uganda. These criteria are based on the perspectives and experiences of smallholder farmers in the region.

Smallholder farmers in South Africa see greenhouse gas emissions like carbon dioxide (CO2) and methane (CH4) as key contributors to climate change. The use of fossil fuels, deforestation, and certain agricultural practices all contribute significantly to greenhouse gas

accumulation and global warming (IPCC, 2014). In South Africa, smallholder farmers have seen and felt the effects of greenhouse gas emissions on climate change. Consider the emissions from fossil fuels. The use of fossil fuels, such as coal, for energy generation and transportation significantly increases South Africa's CO2 emissions. The country heavily relies on coal for electricity production, which contributes to significant greenhouse gas emissions. Smallholder farmers understand the link between these emissions and climate change as they observe changing rainfall patterns, rising temperatures, and extreme weather occurrences.

Smallholder farmers understand soil erosion as a major cause to climate change in South Africa. Unsustainable agricultural practices, such as overuse of agrochemicals, improper soil management, and erosion, can lead to decreased soil fertility and carbon sequestration capacity (FAO, 2015). Some examples from South Africa that illustrate the connection between soil degradation and climate change are overuse of Agrochemicals. Smallholder farmers in South Africa frequently encounter issues due to the usage of agrochemicals such as synthetic fertilisers and insecticides. While these inputs can initially increase crop yields, their excessive and improper use can harm the soil micro biome, reduce organic matter content, and disrupt nutrient cycling processes. This decreases soil fertility and resilience to climate change effects (Khan et al., 2016).

Moreover, improper soil management is another example of soil degradation. Mismanagement of agricultural soils, including inadequate crop rotation, poor tillage practices, and lack of organic matter incorporation, can contribute to soil degradation. Smallholder farmers that engage in continuous mono-cropping without appropriate soil conservation practices usually experience soil erosion, nutrient depletion, and diminished water-holding capacity. These degraded soils are less capable of sequestering carbon, thereby exacerbating climate change (Munjodzi et al., 2019).

South African smallholder farmers are well aware of the impact of rising temperatures on their farming operations. Higher temperatures have various implications for both crops and livestock, leading to significant challenges in agricultural production and overall farm productivity (IPCC, 2014). One example from South Africa that highlight the connection between rising temperatures and agricultural practices is increased evaporation rates and water stress. Smallholder farmers observe that higher temperatures contribute to increased evaporation rates, leading to water stress in crops. As temperatures rise, more water is lost

through evaporation, which can result in water scarcity and reduced soil moisture. This, in turn, affects crop growth and productivity, particularly in regions already prone to drought (Schulze et al., 2019). Farmers in the semi-arid portions of the Northern Cape and Free State provinces, for example, are concerned about greater evaporation rates and heat-induced water stress on crops like maize and wheat.

Lack of information is frequently cited as a source of climate change vulnerability among smallholder farmers in a variety of settings, including Uganda (Nkonya et al., 2011). Farmers in rural Uganda, for example, have limited access to climate data and knowledge on the consequences of climate change. Many smallholder farmers in Uganda's rural districts rely mostly on rain-fed agriculture for revenue. Nevertheless, farmers have significant challenges in adapting their farming operations to changing climate patterns, such as unpredictable rainfall and prolonged dry spells. The lack of information regarding climate change exacerbates the situation. Many smallholder farmers in Uganda may be unaware of long-term patterns or scientific information about climate change. They may not have access to climate-specific data, such as weather forecasts, early warning systems, or projections for their area. This lack of knowledge prevents them from effectively planning and implementing adaptive measures. For instance, farmers may struggle to determine the optimal timing for planting their crops or adjusting their planting calendars to accommodate shifting weather patterns. Without information on upcoming weather conditions, they may risk planting during a dry spell, leading to crop failures and decreased yields.

2.4.2 Major causes of climate change in smallholder farming communities in Zimbabwe

In Chiredzi, Zimbabwe, smallholder farming communities perceive several major causes of climate change that affect their agricultural practices. These causes contribute to shifts in weather patterns, increased temperatures, and changes in rainfall distribution, which ultimately impact their farming activities and livelihoods.

Smallholder farmers in Chiredzi are acutely aware that changes in land use, notably the conversion of natural habitats into agricultural lands or urban areas, contribute to climate change. This shift in land use patterns has serious consequences for the ecology, local climate, and broader climate change dynamics (Makumba et al., 2018). Deforestation and forest conversion are two instances from Chiredzi that show how land use changes affect climate change. Smallholder farmers in Chiredzi report that the conversion of forests to agriculture or other land uses is a common practice. Deforestation not only eliminates

valuable carbon sinks but also emits huge volumes of CO2 into the atmosphere. The destruction of forests for agricultural and urban development increases greenhouse gas emissions, which contribute to climate change (Makumba et al., 2018). Another example is the increase of agricultural land. Smallholder farmers in Chiredzi have observed that the development of agricultural fields, which is generally achieved by converting natural habitats such as grasslands or savannahs, has an impact on climate patterns. The conversion of these natural habitats alters surface reflectivity, leading to changes in local temperatures and precipitation patterns. These alterations can disrupt natural climate systems and exacerbate climate change effects (Makumba et al., 2018).

Smallholder farmers in Chiredzi are well aware of the impact of industrial operations and household emissions on climate change. They recognise that using fossil fuels for energy and transport emits greenhouse gases into the atmosphere, worsening global warming and its consequences (Nyamangara et al., 2019). For example, consider burning fossil fuels. Smallholder farmers in Chiredzi have noted that industrial activities such as energy production, manufacturing processes, and mining operations rely heavily on fossil fuels. The combustion of fossil fuels generates CO2 and other greenhouse gases into the atmosphere. These emissions add to the greenhouse effect, which traps heat and elevates global temperatures (Nyamangara et al. 2019). Another example is transportation emissions. Smallholder farmers argue that travel, particularly the use of vehicles powered by fossil fuels, is a major source of pollution in Chiredzi. When automobiles, trucks and buses use fuel or diesel, they release CO2 and other greenhouse gases. The transportation sector's emissions contribute to climate change and air pollution, which have an impact on both local and global environments (Nyamangara et al., 2019).

2.5 Effects of climate change on smallholder farmers worldwide

Climate change has had a substantial impact on smallholder farmers worldwide, particularly in the United Kingdom and Afghanistan.

Climate change in the United Kingdom might cause water scarcity for smallholder farmers due to rising evaporation rates. Climate change, characterized by rising temperatures, can lead to increased evaporation rates, resulting in water loss from soil, surface water, and vegetation. This can exacerbate water scarcity for smallholder farmers in the UK. According to the UK Climate Change Risk Assessment (2017), projected temperature increases are

expected to intensify evaporation, impacting water availability for agriculture. Another example is shifts in precipitation patterns. Climate change also affects precipitation patterns, altering their distribution, intensity, and seasonality. These changes may impair the supply of water for smallholder farmers. According to Kay et al. (2019), climate change in the United Kingdom is expected to increase the frequency and severity of droughts and heavy rainfall events, providing problems for agricultural water management.

Climate change can create a more favourable environment for pests and diseases, impacting crop health and productivity. For instance, rising temperatures. Climate change leads to rising temperatures, which can have significant implications for pest and disease dynamics in agricultural systems. Higher temperatures can accelerate the development and reproduction rates of pests, allowing them to multiply more rapidly. This can result in increased pest pressure and crop damage. Research by Hussain et al. (2016) conducted in Afghanistan highlights the influence of rising temperatures on pest infestations and subsequent crop losses. Another example is altered precipitation patterns. Changes in precipitation patterns associated with climate change, such as increased or decreased rainfall or shifts in the timing of rainfall, can also impact pest and disease dynamics. These changes can affect the availability of water resources for pests and influence the growth and survival of disease-causing organisms. A study by Hashimi et al. (2014) in Afghanistan examines the relationship between altered precipitation patterns and the prevalence of diseases like wheat rust, highlighting the association between climate change and disease outbreaks.

2.5.1 Climate change effects on Africa's smallholder farmers.

Climate change's effects on Ghana's smallholder farmers, including as lower yields, increased pest and disease pressure, water scarcity, and livestock concerns, can lead to economic instability and food insecurity.

Climate change-induced variations in temperature, rainfall patterns, and extreme weather events might lower crop production for Ghana's smallholder farmers. Studies have shown that rising temperatures and altered rainfall patterns have led to decreased yields of staple crops like maize, millet, and sorghum (Amikuzuno & Ogundari, 2018). These yield reductions can have major economic ramifications for smallholder farmers who rely on crops for food and money. Climate change increases pest and disease pressure, making the environment more conducive to pests and diseases, which can have a considerable influence on crop health and output in Ghana. For example, changes in rainfall patterns and temperature have been linked

to the increased incidence of pests like the African armyworm and diseases like cassava mosaic disease (Asante et al., 2011). These pest and disease pressures further exacerbate yield losses and contribute to economic instability for smallholder farmers.

Crop yield decline in Tanzania is another effect of climate change, since it alters temperature and precipitation patterns, resulting in changes in growing conditions that might have serious consequences for Tanzanian smallholder farmers. Climate change can cause shifts in rainfall patterns, including increased droughts or erratic rainfall, which can adversely affect rain-fed agriculture, upon which smallholder farmers heavily rely. Lobell et al. (2011) found that variations in precipitation patterns caused decreased crop yields in Tanzania due to water stress during critical growth phases.

2.5.2 Climate change effects on Zimbabwe's smallholder farmers.

Climate change poses considerable obstacles for smallholder farmers in Buhera who raise animals and practise pastoralism. For example, climate change in that location leads to greater heat stress. Climate change leads to increased temperatures, which can result in heat stress among livestock in Buhera, Zimbabwe. Studies have shown that rising temperatures have adverse effects on livestock health and productivity, particularly for animals like cattle and goats (Mapiye et al., 2014). Heat stress can cause reduced feed intake, decreased milk output, and even increased mortality rates in livestock. Furthermore, climate change exacerbates water shortages in Buhera, affecting smallholder farmers involved in animal production and pastoralism. Changes in rainfall patterns and increasing evaporation rates might lower the amount of water available for livestock drinking and grazing. Chikobvu et al. (2018) highlight the challenges that smallholder farmers have in obtaining appropriate water resources for their livestock due to climate change-induced water scarcity.

2.6 Challenges faced by smallholder farmers in adjusting to the global impacts of climate change.

Smallholder farmers confront numerous obstacles in adapting to the consequences of climate change, both generally and in specific regions such as the United States and Bangladesh. Smallholder farmers in the United States have limited access to resources such as land, finance, technology, and information, making it difficult for them to respond to climate change. Smallholder farmers in the United States frequently experience land access issues due to factors such as high land costs and competition from larger agricultural firms. This limited access limits their ability to execute climate change adaptation techniques. As stated

by the researcher Lobell et al. (2017), small farms in the United States face challenges in expanding their landholdings, which can inhibit their capacity to adopt climate-resilient practices. Furthermore, smallholder farmers often face difficulties in accessing finance for investing in climate change adaptation measures. In the United States, small-scale farmers may face difficulties in obtaining financing or subsidies to employ sustainable farming methods. Mishra et al. (2015) discovered that a lack of credit was a significant obstacle to small farmers applying climate-smart strategies in the United States.

Climate change has increased the frequency and intensity of extreme weather events, making smallholder farmers in the United States and around the world especially vulnerable. Droughts can have a severe effect on crop yields and livestock production, leaving smallholder farmers especially susceptible. Droughts have lasted for years in parts of the United States, including the Midwest and Southwest. According to a study by Lobell et al. (2013), drought conditions in the United States have resulted in considerable yield decreases for major crops such as maize and soybeans, hurting the livelihoods of smallholder farmers. Furthermore, smallholder farmers are vulnerable to floods, as heavy rainfall and runoff can damage crops, erode soil, and destroy infrastructure. Flooding has increased in various places of the United States, particularly in the Midwest. Hatfield et al. (2015) found that flooding had a detrimental influence on agricultural productivity, especially among small-scale farmers.

Rising temperatures caused by climate change in the United States have the potential to expand pests' geographic ranges. This expansion may have a substantial influence on crop output and need further pest management efforts. For instance, research by Parmesan and Yohe (2011) found that warmer temperatures have allowed the spread of pests such as the pine bark beetle, leading to extensive damage to forests in the western United States. Changes in pest behaviour and increased pest pressure due to climate change can also negatively affect crop yields for smallholder farmers. In the United States, crop pests like the corn earworm, aphids, and spider mites are influenced by changing climatic conditions. Duan et al. (2017) found that rising temperatures have led to a longer growing season for maize earworms, resulting in higher damage to maize harvests.

Smallholder farmers in Bangladesh have a dearth of climate information and extension services to combat climate change. Access to timely and reliable climatic information is

crucial for smallholder farmers so that they may make educated decisions about their agricultural operations. Climate data is current, allowing smallholder farmers to anticipate and plan for climate-related risks. Farmers in Bangladesh, a country especially vulnerable to the effects of climate change, want precise information to alter their agricultural techniques. Research by Rahman et al. (2018) stressed the value of timely climatic information in decreasing crop losses and enhancing farmers' resilience. Moreover, Climate services play a significant role in supplying farmers with accurate climate information suited to their unique needs. Climate services are given in Bangladesh by entities such as the Bangladesh Meteorological Department (BMD) and the International Centre for Climate Change and Development (ICCCAD) to assist with agricultural decision making. Islam et al. (2014) found that increasing climatic services is necessary to increase adaptive ability among Bangladeshi smallholder farmers.

Smallholder farmers in Bangladesh face challenges accessing markets and dealing with price volatility, which can be exacerbated by the effects of climate change. Smallholder farmers generally have limited access to markets due to poor infrastructure, a scarcity of transportation choices, and information asymmetry. In Bangladesh, Rahman et al. (2020) discovered that smallholder farmers fail to connect with formal marketplaces, resulting in reduced pricing for their agricultural products. Price fluctuation has a considerable influence on smallholder farmers' earnings and livelihoods. Climate change impacts in Bangladesh, such as extreme weather events and altered precipitation patterns, may cause crop failures or reduced yields, exacerbating price volatility. Hossain et al. (2017) discovered that the increased frequency of floods in Bangladesh has resulted in price volatility for agricultural commodities, impacting smallholder farmers' profitability.

2.6.1 Challenges faced by smallholder farmers to adapt to the effects of climate change in Africa.

Africa's smallholder farmers, particularly those in Kenya and Ethiopia, confront various obstacles as they adapt to the effects of climate change.

Climate change has resulted in increased variability in rainfall patterns across Africa, including Kenya. This has significant implications for smallholder farmers, who rely primarily on rain fed agriculture, making them vulnerable to droughts and unpredictable

rainfall. This has significant implications for smallholder farmers, who rely primarily on rain fed agriculture, making them vulnerable to droughts and unpredictable rainfall. Erratic rainfall can lead to reduced agricultural yields, food insecurity, and financial losses for smallholder farmers. Several adaptation solutions have been investigated to overcome the issues posed by rainfall variability. In Kenya, Kosgei et al. (2019) emphasised the necessity of using climate-smart agricultural methods such as conservation agriculture, agroforestry, and water harvesting techniques to improve smallholder farmers' resilience to variable rainfall patterns.

Smallholder farmers in Kenya often face limited access to resources, including financial capital, improved seeds, fertilizers, and irrigation technologies. These constraints hinder their ability to adopt climate-resilient practices, such as drought-tolerant crop varieties, soil conservation techniques, and efficient water management systems. Njiraini et al. (2018) found that smallholder farmers in Kenya experience significant barriers to acquiring financial finance for agricultural development. Limited access to credit and financial services makes it difficult for them to purchase inputs such as improved seeds, fertilisers, and irrigation systems, hindering the adoption of climate-resilient practices. Gitonga et al. (2017) investigated the obstacles that smallholder farmers in Kenya experience in terms of access to improved seeds. Farmers' options for cultivating drought-tolerant crops, which are critical for climate resilience, are limited due to the scarcity and high cost of improved and climate-adapted seeds.

True, many Ethiopian smallholder farmers lack timely and reliable climatic information, as well as expertise about climate-smart agricultural practices. This knowledge gap prohibits people from making educated adaptation decisions, limiting their ability to successfully respond to climate change effects. Fenta et al. (2017) explored the constraints smallholder farmers in Ethiopia face while obtaining climate information services. The study found that farmers' ability to plan and implement climate-resilient farming methods was hampered by a lack of available and accessible climate information. . Lemma et al. (2019) examined smallholder farmers' knowledge and awareness of climate-smart agriculture in Ethiopia. The study discovered that farmers had little awareness of climate-smart strategies like

agroforestry, conservation agriculture, and integrated soil fertility management. This lack of understanding impedes their adoption of climate-resilient approaches.

In Ethiopia, smallholder farmers often face socioeconomic vulnerabilities, including poverty, food insecurity, and limited access to social protection mechanisms. These vulnerabilities make it challenging for them to invest in climate adaptation measures or recover from climate-related shocks and disasters. Alemu and Admassie (2017) investigated the links between poverty, food security, and vulnerability to climate change among Ethiopian smallholder farmers. The study revealed that poverty and food insecurity increase farmers' vulnerability to the effects of climate change since they have limited means to invest in adaptation measures and struggle to meet their basic needs. Belay et al. (2018) investigated the influence of social protection programmes in improving the resilience of smallholder farmers in Ethiopia. The study discovered that farmers' ability to deal with climate-related shocks and recover from agricultural losses is impeded by a lack of access to social protection measures such as safety nets and insurance schemes.

Smallholder farmers in Ethiopia face challenges in accessing markets and earning fair prices for their produce due to inadequate infrastructure, particularly roads and storage facilities. Kassa et al. (2018) investigated the problems that smallholder farmers in Ethiopia encounter when trying to sell their agricultural produce. The research highlighted that poor road infrastructure and transportation facilities hindered farmers' ability to reach distant markets, limiting their opportunities for profitable sales and fair prices. Additionally, inadequate storage facilities contribute to post-harvest losses, which significantly impact smallholder farmers' incomes. A research article by Gebremedhin et al. (2017) focused on post-harvest losses in Ethiopia and emphasized the need for improved storage infrastructure to reduce losses and increase farmers' profitability.

2.6.2 Challenges faced by smallholder farmers to adapt to the effects of climate change in Zimbabwe.

Small-scale agricultural producers in Zimbabwe, particularly those near Mount Darwin, confront major hurdles in responding to the consequences of climate variability.

In the Mt. Darwin region, high temperatures have a substantial impact on small-scale farmers' agricultural productivity. The occurrence of high temperatures has the potential to cause a decrease in crop yields. Research by Makate et al. (2019) conducted in Zimbabwe, including

regions like Mt Darwin, found that increased temperatures negatively affect crop productivity. The study highlighted that rising temperatures result in lower maize yields due to heat stress during critical growth stages. Rising temperatures can also alter the timing of crop development and maturity. A study by Mutengwa et al. (2016) in Mt Darwin and other regions of Zimbabwe revealed that increasing temperatures have caused shifts in the phonological stages of crops. This can disrupt the synchronization of crops with optimal climatic conditions, affecting their growth and yield potential.

Limited financial resources pose a significant challenge for smallholder farmers in Mt Darwin, Zimbabwe, to invest in climate adaptation measures. Let's develop this point further, providing different in-text citations within the past ten years and examples specific to Mt Darwin, Zimbabwe. Smallholder farmers in Mt Darwin often face financial constraints that hinder their ability to invest in climate adaptation measures. According to a study by Mabaya et al. (2018), limited access to financial resources significantly limits farmers' capacity to implement climate-smart practices. The study found that lack of funding prevents farmers from purchasing climate-resilient seeds, adopting conservation agriculture techniques, and investing in irrigation systems. Access to credit is critical for smallholder farmers to fund climate adaption efforts. Farmers in Mt Darwin face difficulties obtaining financing due to a lack of institutional financial institutions and collateral. Mashingaidze et al. (2019) found that smallholder farmers frequently rely on informal finance sources with high interest rates, exacerbating their financial stress.

2.7 Chapter Summary

The chapter examined literature relevant to the study's aims, with an emphasis on the conceptual framework, theoretical, and empirical literature. While reviewing the literature, the gaps that were discovered required that this study stay noteworthy. The following chapter will go into the research approach.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The previous chapters focused on the introduction and literature review. The current chapter describes the research methods used to carry out this investigation. The chapter discusses the research design/philosophy, target population, sample size, sampling technique, data analysis procedures, instrument validity and reliability, and ethical concerns.

3.2 Research Design

This study collected data from the target group, which was largely made up of smallholder farmers, using a descriptive survey study design. "A research design describes the procedure that the researcher follows for collecting and analysing data" (Shepard, 2002, pp. 54-55). According to Rillo and Alieto (2018), a descriptive study is a deliberate process of gathering, analysing, classifying, and tabulating data about current conditions, practices, processes, trends, and cause-effect relationships, followed by adequate and accurate data interpretation,

with or without the use of statistical methods. . Furthermore, this method identifies dominant factual conditions in a group under examination, producing qualitative, quantitative, or both assessments of the group's overall characteristics as outputs. The research strategy was chosen because it allows for the collection of data using both qualitative and quantitative methods. According to the chosen research strategy, the study was carried out using a case study of Mazowe District.

3.3 Research methodology

The research strategy was chosen because it allows for the collection of data using both qualitative and quantitative methods. A mixed methods strategy involves the researcher basing knowledge claims on practical concerns such as consequence, problem, and pluralism (Creswell, 2003:18). This methodology prioritises the research problem over the procedure. This tactic goes by several names, including triangulation, multi-method, convergence method, integrated method, and combined method. ‘It employs tactics of inquiry that include gathering data either simultaneously or sequentially to best understand research problems" (Creswell, 2003, pp. 17-18). The data collection technique also includes gathering both numerical (for example, on instruments) and textual information (for example, during interviews), resulting in a final database that incorporates both quantitative and qualitative data.

3.4 Target population

As previously indicated, this study's primary focus is on smallholder farmers in Mazowe District Wards 8, 10, and 12, which are overseen by Chief Chiweshe. The target population consist of 90 smallholder farmers in the District, 2 Agritex officers, 2 Ministry of Agriculture officers, 2 Weather station officers, 2 Non-Governmental Organisation Officers and 2 independent expert. As a result, the study's overall target population is one hundred. According to McMillan and Schumacher (2010), the target population is "a group of elements or cases, whether individuals, objects, or events, that conform to specific criteria and to which the research intends to generalise the results of the study." The target audience is also defined as a group of people who have similar characteristics and to whom the researcher wishes to generalise the study's findings (Robert 2010). Springer (2010) defined a study population as a group of people for whom a study will be conducted and assessed. The study population is a

group of people or things who are thought to share the researcher's opinions (Khan et al., 2013).

3.5 Sample size

To provide a fair representation, this study's sample was taken from the complete target population. According to Creswell (2012), a sample is a subset of the target population that the researcher wishes to examine in order to reach broad generalisations about the target population. The sample should be representative of the entire population under study.

> "A well-defined sample has the same characteristics as the population as a whole, and therefore, when a research is conducted on such sample, the results obtained will represent the characteristics of the whole population" (Sreejesh *et al.*, 2013, p. 19).

The study picked 32% of the total target population to as the sample where data would be gathered from. The sample size was determined using the following formula.

$$Sample\ size = \frac{32}{100} \times 186\ (total\ target\ population) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Therefore, the sample size was 60 households calculated. To get more insights from the Key informants, the study further selected

Concerning this scenario, the sample was manageable for the researcher while also accurately representing the views of the target demographic.

3.6 Sampling procedure

The study used systematic random sampling to pick households and convenience sampling for key informants from the Agricultural Extension officers, Climate experts and ministry of agriculture officers.

According to a study by Ndlovu et al. (2018), sampling techniques are particularly valuable when studying smallholder farmers in remote or hard-to-reach areas. The researchers faced logistical challenges in accessing the entire population of smallholder farmers in a specific region due to limited infrastructure and difficult terrain. Using a sampling strategy, they were

able to pick a representative sample of farmers in easily accessible places, assuring data collecting practicality.

3.6.1 Systematic Random Sampling

The study used systematic random selection, a probability sampling method, to select the 18 residences. Thomas (2020) defines systematic sampling as a probability sampling approach that selects people from a population at a predefined interval (k). According to Thomas (2020), if the population order is random or random-like (e.g., alphabetical), this technique will produce a descriptive sample from which to draw conclusions about the target population. In this study, the population was randomly assigned through the distribution of households and sample households, using the following criteria;

$$i = \frac{N}{n} \quad \text{......} \quad (2)$$

$$i = \frac{N186}{60}$$

i = 3

Where N= target population and;

n= sample

i= interval/ order

In this regard, the participants were picked from every 3rd household and this was advantageous since it allowed fair and equal representation without the researcher's judgment or biasness.

The choice of systematic random sampling in this research was justified for numerous reasons. Systematic random sampling is a probability sampling method, which indicates that every household in the research region had an equal and known chance of being selected (Thomas, 2020). This ensures the sample's representativeness and allows the findings to be generalised to the Mazowe and other similar communities. Systematic random sampling is also comparatively easy to apply and offers a systematic style to choosing the sample (Thomas, 2020). By picking participants of the population through a fixed interval, resolute in advance, the scientists can circumvent potential biases that may arise from personal choices, improving the impartiality and trustworthiness of the study's outcomes. Moreover, the population was randomized by the dispersal of households, and the sample houses were

nominated using a predetermined interval (Thomas, 2020). This ascertains that the sample is symbolic of the population when looking at the distribution and characteristics of the target population.

3.6.2 Convenience sampling

The study used convenience sampling to select four Agritex officers, four Ministry of Agriculture officers, and two climate specialists. Convenience sampling is a non-probability strategy in which units are chosen for inclusion in the sample based on their availability to the researcher. This could be due to geographic proximity, availability at a certain time, or a willingness to take part in the study. Convenience sampling was chosen because it was the most practical and feasible way to reach these specific participants. The researcher chose people who were geographically close, easily accessible, or willing to engage in the study (Thomas, 2020).

Regarding the participants' unique knowledge, it may have been difficult to create a representative sample using random sampling methods. While convenience sampling may not ensure representativeness or allow for generalization of findings to a wider population, it can nonetheless give useful insights and in-depth understanding of the specific individuals or groups being studied (Thomas, 2020). The goal of this study was to collect ideas from these selected individuals, who had specialized knowledge in agriculture and climate-related issues.

3.7 Methods for collecting data

Data for this study were collected by home questionnaires, key informant interviews, and focus group discussions. These procedures were carefully selected to meet the study's aims.

3.7.1 Household questionnaires

The primary data collection approach in this study was a household questionnaire distributed to 60 small-scale farmer households in Mazowe District Wards 8, 10, and 12. A questionnaire is typically crafted to ensure the accuracy of data, enhance data comparability and accessibility for analysis, reduce bias in question formulation and delivery, and create engaging and diverse inquiries (Fellows et al., 2008). The formulation of the questionnaire in this study was guided by research objectives and inquiries. A questionnaire, according to Creswell & Creswell (2018), is a collection of questions designed to elicit responses from participants on various aspects of the study topic. In this study, a self-administered questionnaire was created, which respondents filled freely and without the intervention of the

researcher. After receiving consent from the subjects, the researcher individually distributed the questionnaire for completion. The questionnaire contained both open-ended and closed-ended items (see Appendix 1).

The key advantage of this form of data collecting is its capacity to provide convenience to both the researcher and the participants by allowing respondents to provide feedback at their own pace. Additionally, participants have the freedom to articulate their opinions in writing, enhancing the flexibility of the results. These data are readily comprehensible to the researcher, particularly during the analysis of information obtained from different participants, as they encompass both quantitative and qualitative data.

3.7.2 Key informants' interviews

Interviews were also performed with two key informants from Agritex officers, one Ministry of Agriculture officer, one Mazowe Rural District Council re, and one civil society member. Open-ended questions were utilised to get information from key sources. A research interview is a verbal exchange between two people intended to gather critical information for future research (Coffman, 2002). The primary advantage of conducting interviews was that the study could delve into the psychological and emotional viewpoints of interviewees who were considered to be knowledgeable about the predicament of smallholder farmers in Mazowe.

3.7.3 Focus Group Discussion Guide

To help the facilitator, a focus group discussion guide was prepared (Appendix 6). According to Richard et al. (2020), focus groups are scheduled group discussions based on a theme that are observed and maybe steered by a researcher. Focus groups are a well-known tool for collecting data in qualitative, mixed-method, and quantitative research. According to Massey (2010), focus groups provide access to both content and expression; yet, traditional analytic methodologies have not taken into account group process or dynamics. As such, the primary benefit of using this data collection strategy was the possibility to comprehend the target demographic from a group dynamic aspect.

3.8 Reliability

Joppe (2000) defined dependability as the degree to which the researcher's conclusions are consistent across time and accurately represent the population under study. The research instrument's reliability is verified by determining whether the study's results can be repeated

using a similar methodology. According to Saunders et al. (2009), the internal consistency of the responses can be ascertained using the Cronbach's alpha test. It evaluates the consistency of answers to all questions. It assesses the consistency of responses to all questions. A pilot study was conducted to assess reliability. Saunders et al. (2009) reported that Robson (2002) found numerous reliability concerns, such as observer bias, participation error, and participant error. To ensure that prevent skewing of the outcomes, these reliability difficulties will be addressed in this study.

3.9 Validity

The ability of a measurement tool to measure what it was intended to assess is referred to as validity. According to Jape (2000), validity relates to how well a research instrument evaluates what it is designed to test, as well as the accuracy and reliability of the study outcomes. It is possible that a consistency instrument will produce erroneous results. In this study, the researcher ensured validity by triangulating the findings (where possible) and comparing them to three different research instruments.

3.10 Data Analysis Procedures

The quantitative data were examined with SPSS version 25 and Microsoft Excel. Data from household questionnaires were collated, categorised, and entered into SPSS software. The statistical data analysed was displayed as frequency tables, bar graphs, and pie charts. All replies provided by respondents were cross-checked, and any incorrect data was not put into the study. Thematic analysis of qualitative data involved grouping interview responses into themes and analysing them in context.

3.11 Ethical considerations

The study also looked at research ethics. Informed permission, privacy, anonymity, confidentiality, and de-hoaxing, among other things, were deemed sound ethics that warranted investigation in the study.

3.11.1 Informed consent

Informed consent ensures that the subject's involvement is completely voluntary and informed, with a full grasp of the study's purpose. This concept was clearly exhibited during the inquiry by delivering an introduction statement requesting the respondent's permission to be examined. To avoid a situation in which people responded out of fear, their consent was sought before any questions were asked, regardless of gender or status. Rudestam and Newton (2001) stated that subjects must be informed of the reason for the study before participating.

3.11.2 Privacy

This refers to a person's right to be free from intrusion or interference by others. When conducting research, it is critical to ensure that the individuals providing information are protected. Tashakkori and Charles (2008) state that the participant has the freedom to refuse to engage in our study, and that the subject has the right to have some of the information he or she supplies kept private. To preserve the respondents' privacy, their identities were not associated with any of the responses provided in this study. No participant was duped or coerced into disclosing anything they did not plan to reveal.

3.11.3 Debriefing and de-hoaxing

Debriefing is the process of providing explanatory information to reduce the negative consequences of lying. Before collecting the necessary data, the researcher followed the principles of debriefing and de-hoaxing by describing the study's scope to the participants. According to Welfel (2012), debriefing and de-hoaxing are critical ethical challenges that require researchers to communicate and describe study results to participants, if desired, as soon as the data is ready for release. In accordance with this argument, the study was open to smallholder farmers, informants who contributed information, and other key stakeholders.

3.12 Chapter Summary

This chapter describes the research methodologies utilised to carry out the investigation. This study collected data using methods such as questionnaires to assist answer research questions. The chapter also went over the data analysis techniques utilised to investigate the data. The following chapter focuses on presenting and discussing the study's findings.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

Data about how climate change is affecting smallholder farmers were gathered by the researcher in Mazowe District by a variety of methods, including observations, questioners, interviews, and a review of numerous publications. The gathered data is presented and examined in this chapter. The presented and analysed data were gathered from Mazowe District ward councillors, extension officers, farmers, and weather station officers. The data offered is descriptive, with narrations, tables, and graphs, as well as interpretation and analysis. The precise aims of the topic under investigation are like this:

1. To examine the causes of climate change in Mazowe District, ward 8, 10 and 12, Mashonaland Central of Zimbabwe.

2. To analyse the effects of climate change on smallholder farmers in Mazowe district.

3. To examine the challenges faced by smallholder farmers to adapt to the effects of climate change.

4. To suggest effective measures that can be adapted in curbing the impact of climate change by farmers in Zimbabwe.

4.2 Representation of study respondents by department/sector

The study acquired its data from 85 smallholder farmers in Wards 8, 10 and 12 of Mazowe District through questionnaires and the response rate was 94%. Key informants from the Ministry of Agriculture, weather station officers, NGOs, Agritex officers and independent experts were also utilized. Table 4.1 displays the distribution of study participants in their varied categories.

Table 4.1: Distribution of participants by different categories

Target Group	Sample size (n)	Responded	Response Rate (%)
Smallholder farmers	85	80	94%
STAKEHOLEDERS			
Agritex Officers	2	2	100%
Weather station officers	2	2	100%
NGO officers	6	5	85%
Ministry of Agriculture	3	3	100%
Independent experts	2	2	100%
Total	100	94	94%

As highlighted in table 4.1, the overall response rate for this study was 94% meaning to say out of the 100 targeted participants (farmers and key informants), 94 of them successfully participated in the study. Most importantly, a significant portion of people who are directly impacted by climate change shared their experiences with the researcher, as seen by the 94% response rate from the targeted 85 smallholder farmers. The active involvement of farmers who are part of the community ensures that the viewpoints offered are thorough and grounded in the local context. As a result, the results have a great deal of credibility and are broadly applicable to Mazowe District.

4.3 Causes of Climate Change in Ward 8, 10, and 12 of Mazowe

The study looked into the climate change knowledge of people in Mazowe District wards 8, 10, and 12. To understand this, farmers were asked on their awareness levels of climate change and our understanding of its causes.

4.3.1 Level of climate change awareness

Prior to delving into the perspectives of the villages regarding the causes of climate change, it was crucial to comprehend the degree of climate change awareness in the wards under investigation. The degree of climate change awareness in the wards under study was depicted in Figure 4.1.

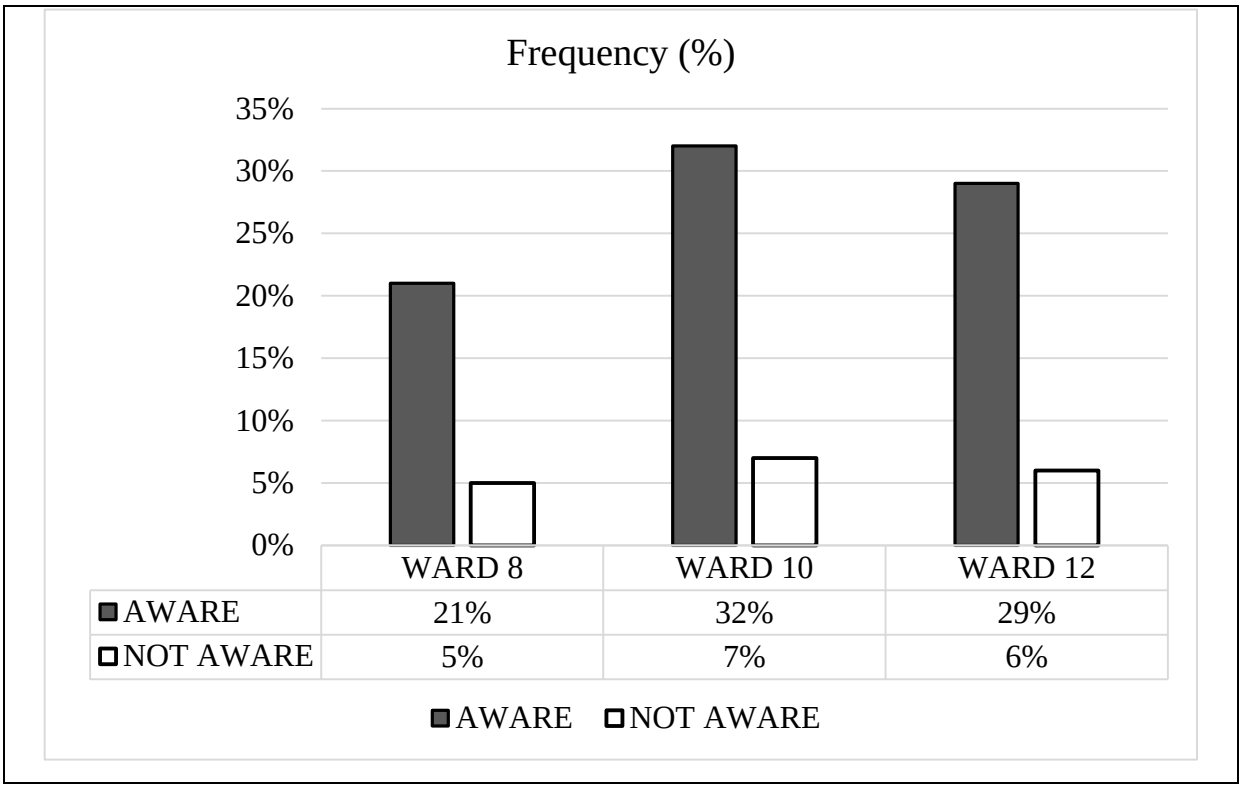


Figure 4.1: Level of climate change awareness *(N=80).*

The percentage of smallholder farmers in Mazowe District's Wards 8, 10, and 12 who are aware of climate change is depicted in the bar graph in Figure 4.1. The results show that farmers' awareness of climate change varies significantly among the different wards. With the biggest proportion of farmers aware of the impacts of climate change, Ward 12 has the greatest awareness level. This shows that the most successful outreach initiatives to raise awareness of this important topic have been in Ward 12. Ward 8, on the other hand, has the

least awareness since fewer farmers there understand climate change. It could need more effort to advance our understanding in this field. Ward 10 shows intermediate awareness levels between the two. One of the key informants highlighted that;

> *"Levels of climate change awareness vary within communities due to different experiences in the communities but generally communities are now aware of the changes caused by climate change…"* (Key informant 1)

The results are consistent with earlier studies regarding small-scale farmers' understanding of climate change in southern Africa. According to the graph, Ward 12 has the greatest levels of climate change knowledge, while Ward 8 has the lowest and Ward 10 has intermediate levels. The Mazowe District Council's (2019) study, which concluded that "outreach efforts are most effective when tailored to local contextual factors" (p. 15), supports this diversity among wards. Divergent perceptions of climate change result from different communities' experiences with harsh weather (Mazowe District Council, 2019). Other studies have also documented differences in the degree of awareness of the effects of climate change among agricultural regions. Mutekwa (2009) noted in their analysis of five rural regions in Zimbabwe that the "uneven performance of awareness programs reflected local socioeconomic differences."

4.3.2 Climate change causes

The study also examined how well the smallholder farmers in the areas understood the causes of climate change. Deforestation, decline in forest areas, urbanization and development, emissions from surrounding industries, changes in agricultural land-use patterns and natural causes. Figure 4.2 offers a summary of the research area's perception on the causes of climate change.

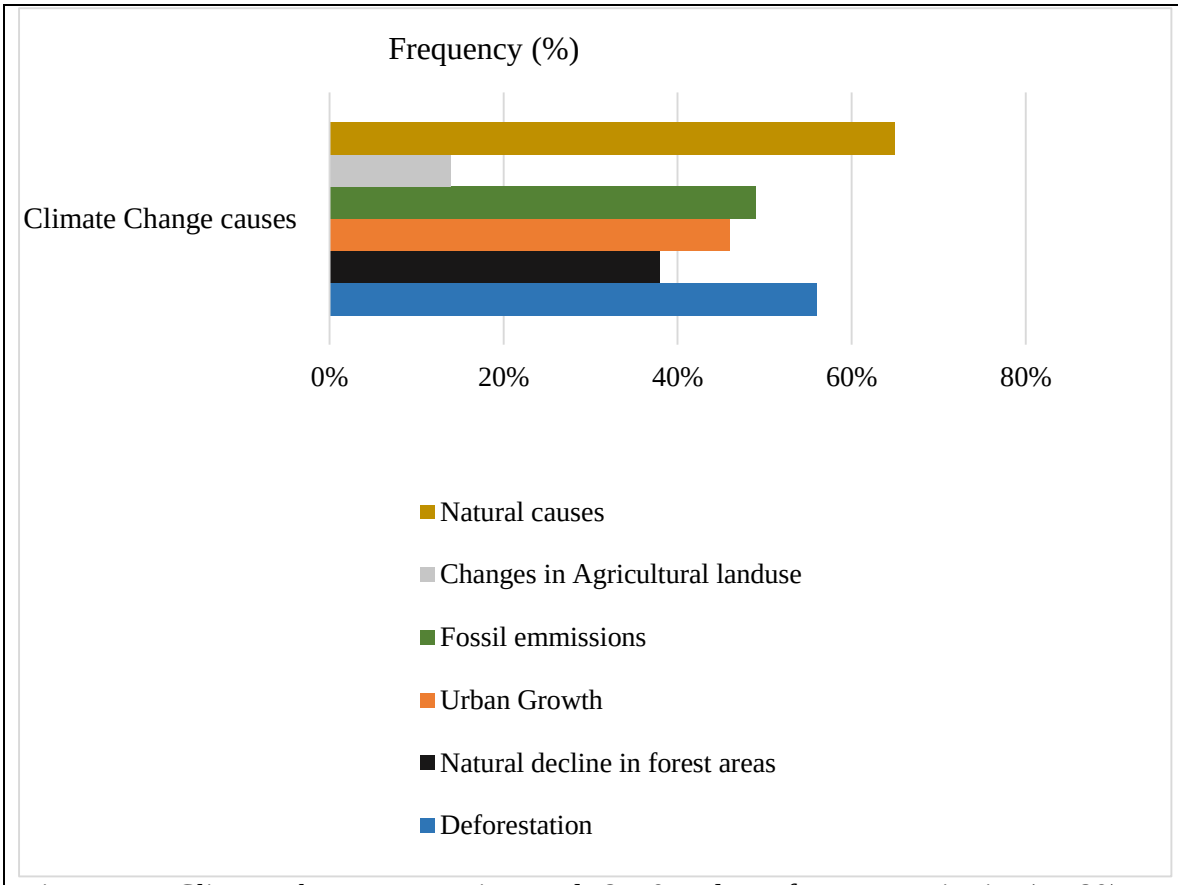


Figure 4.2: Climate change causes in Wards 8, 10 and 12 of Mazowe District (N=80)

The results shown in Figure 4.2 are consistent with previous research on Zimbabwean farmer viewpoints. According to a number of prior research, in Zimbabwe, smallholder farmers most often blame natural factors for climate change. (Mubaya, Trinh, & Mutsvangwa, 2014; Mugabe, Maphosa, Mango, & Nhodo, 2014). This is in line with the study's findings, which indicate that 65% of farmers attribute their problems to natural causes. Similar to the noteworthy figures for deforestation (56%) and urban expansion (46%) revealed here, Mubaya et al. (2014) likewise discovered that land use change and deforestation ranked highly among perceived reasons.

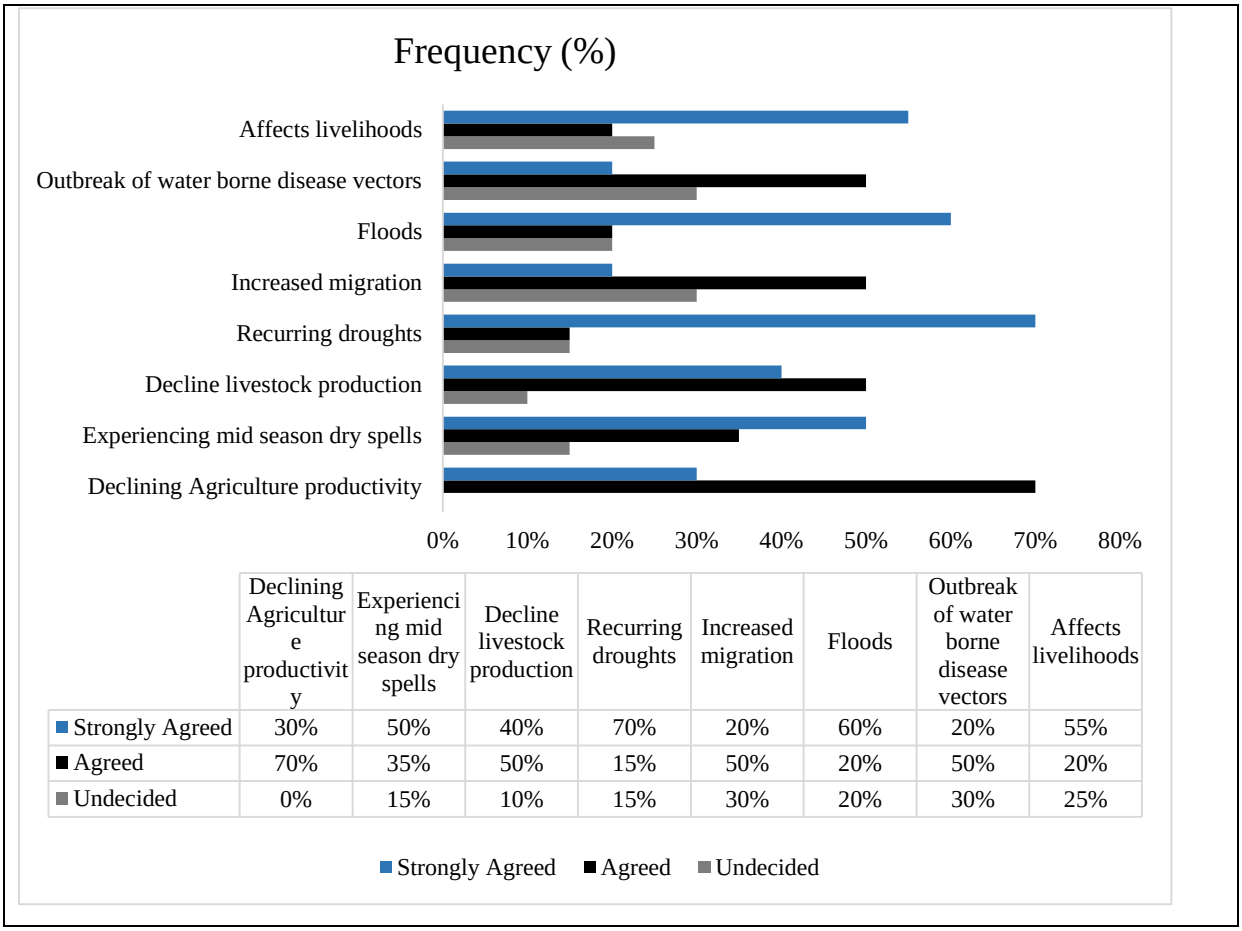
At just 14% in the current survey, changes in agricultural land use patterns were the least significant assessed reason. This, however, is at odds with earlier research that indicated that among Zimbabwean farmers' top three perceived causes were agricultural activities (Mubaya et al., 2014). Again it is in contradiction with most of the key informants' submissions which indicated that existing and projected patterns of climate change were significantly influenced by agricultural land use patterns. One of the key informants underscored that;

"Climate change has a number of contributing factor which are scientifically proven. Deforestation and fossil emissions are among the major contributors. However, we also need to understand that in farming communities like this one, agricultural land-use patterns are also critical factors contributing to climate change. Major changes in methods of agricultural production may also lead to climate change."

This discrepancy might lend credence to the idea that people are unaware of the connections between regional farming methods and their effects on the climate (Mubaya et al., 2014). A stronger agriculture sector response to climate change may result from increased education that highlights this relationship. In general, the findings highlights that there is at least knowledge of the things causing climate change from a local perspective. There is however a stronger need to educate people on what contributes to changing of climate as a way of reducing the future changes.

4.4 Effects of climate change on smallholder farmers in Ward 8, 10 and 12 of Mazowe district

This section examines how smallholder farmers in Zimbabwe's Mazowe district's Wards 8, 10, and 12 view the consequences of climate change. The consequences of climate change pose a serious danger to the food security and agricultural livelihoods of the region. Understanding how people see the ways in which climate change is already affecting their agriculture may yield important insights. The findings discussed in this part are derived on an examination of questionnaire responses concerning changes that have been noticed and effects that have been ascribed to shifting climatic patterns in the last several decades, drawing on the farmers' observations and life experiences in their local communities. Figure 4.3 summarises the primary effects of climate change as perceived by the smallholder farmers surveyed.



	Declining Agriculture productivity	Experiencing mid season dry spells	Decline livestock production	Recurring droughts	Increased migration	Floods	Outbreak of water borne disease vectors	Affects livelihoods
Strongly Agreed	30%	50%	40%	70%	20%	60%	20%	55%
Agreed	70%	35%	50%	15%	50%	20%	50%	20%
Undecided	0%	15%	10%	15%	30%	20%	30%	25%

Figure 4.3: Effects of climate change on smallholder farmers in wards 8, 10 and 12 of Mazowe District (N=80)

An analysis of the results of the research area's survey sample are displayed in figure 4.3 in Mazowe District on the impacts of the changing in climate. Seventy percent (70%) of the study participants agreed that changing in climate results in declining agricultural productive in Mazowe and thirty percent (30%) strongly agreed. Fifty percent (50%) strongly agree that smallholder farmers are experiencing mid dry spells, thirty-five percent agreed and fifteen percent (15%) were undecided. Forty percent (40%) strongly agreed to reduce livestock output in the area due to a scarcity of grazing area and water to feed cattle, with fifty percent (50%) agreeing and ten percent (10%) undecided.

This survey found that seventy percent (70%) of individuals strongly agreed that climate change can cause recurrent droughts, while fifteen percent (15%) agreed and fifteen percent (15%) were undecided. Fifty percent (50%) agreed and twenty percent (20%) of the participants highly agreed on increased migration in the area which is one of the social impact of changing in climate. In this study sixty percent (60%) participants strongly agreed

that floods are because of Zimbabwe's changing climate, especially in Mazowe District were floods destroyed roads, infrastructure, crops and houses. The fifty percent (50%) participants strongly agreed that climate change results in outbreak of water born disease and vectors. Fifty-five percent (55%) strongly agreed that climate change affect livelihoods in their source income is destroyed by climate change such as animals, crops, fruits, houses and infrastructure.

In an interview with one of the Agriculture officers he revealed that:

"There are direct impacts of climate change such as mid dry spells which causes dry crops/plans, frost occurrences, hailstorms affect tobacco farmers and horticultural crops such as tomatoes were affected"

Agriculture extension officer respondent two also revealed that:

> "*There was outbreak of pests and diseases and increase in water logging and littering".*

Respondents also concurred that the decrease in livestock reproduction was due to lack of grazing area and water. It has been established that climate change affects the three pillars of food security: poor food production, restricted access to resources, and road networks.

Additionally, it was mentioned that the area's social repercussions and population migration to cities and mines, such as young people travelling to the Mazowe mine to mine gold, are examples of how climate change is having indirect consequences (chikorokoza).There was also decrease in livestock production, wilting of crops, hence little or no yield harvested, increase in outbreak of pests and diseases. It was also identified by one of the NGO members/agencies and members of parliament that climate change was affecting everyone in the district.

In an interview with a smallholder farmer, poverty and unemployment were identified as climate-related problems. In focus group discussion, the smallholder farmers said that:

> "*The majority of the smallholder farmers and the while community in the area depend on agriculture as their major source of livelihood and due to changes in climate conditions many now have to depend on casual labour to earn money for the purchase of food."*

One participant said that the reason the neighbourhood's quality of life was deteriorating was that residents were spending more money on food than on other essentials like building new homes or paying for education. The study also demonstrated how the increasing drought conditions were leading to agricultural failure and, consequently, less chances for agricultural work. Consequently, most participants were compelled to depend on labour from non-agricultural sources, which is also in short supply. Participants in the study made money through the sale of labour in both the agricultural and non-agricultural sectors.

During informant interview with weather station officer, he pointed that:

> *"-------it is a shame to a father as a head of the family to live in a house without food and reserve in the granary and depend on working to earn money for the purchase of food and sometimes not knowing whether you will get something to do to help you earn money in the past when conditions were favourable one would harvest crops store them and use them for almost three seasons and was able to sale the suppliers and earn money for the purchase of clothes, pay for medical facilities, education and also change diet-----today the granary is empty, the amount harvested is not sufficient and does not last longer------no one today has food in the granary harvested in the previous season, we all buy----"*

A few insights about how climate change is affecting smallholder farmers were also made by the study. Impact on livelihood production is displayed in Plate 4.1.

Plate 4.1: Livestock production (cattle). Primary source

Plate 4.2 demonstrates observations on the climate change effect on crops

Plate 4.2: Maize crop destroyed by army worm (Author).

High temperature and rainfall has led to outbreak of bluetongue diseases in Mazowe District. Bluetongue is transmitted by biting midges (Culicoides species). Purse et al. (2005) state that more conducive conditions for the reproduction, survival, and dispersal of these midges are produced by rising temperatures and higher precipitation linked to climate change. Carpenter et al. (2009) also found that higher temperatures may shorten the virus's extrinsic incubation period within the midges, increasing the rate of transmission.

The study also observed drying water sources due to climate change (Plate 4.3)

Plate 4.3: Water resources (Author)

Image 3 shows a water resources found in the Mazowe district. Due to reduced rains in the Mazowe district, Communities would need to implement irrigation schemes as one of the significant advancements to increase agricultural output. That would allow farmers to cultivate crops all year round. If communities receive financial and technical assistance, irrigation initiatives could be used to their fullest potential, benefiting livelihoods. With this water resources, conservation irrigation should be practiced as every drop counts in areas like Mazowe.

Generally, the findings in this regard are in resonate with the past studies across Zimbabwe. In a similar vein, Mugandani et al. (2012) investigated farmer attitudes in Zimbabwe's Bindura and Shamva districts and discovered decreased agricultural yields that were linked to irregular rainfall patterns and droughts. In their study of farmers in Chikomba district, Mubaya, Nhemachena, and Kihara (2016) also noted lower agricultural yields as a result of the droughts that are afflicting several areas of Zimbabwe. The 60% perception of increased flooding reported here is in line with assessments of elevated flood risks associated with climatic changes in Harare province (Choga, Mapuranga, & Chemura, 2015) and Chiredzi district (Chipeta & Mothusi, 2018).

Farmers and research officers in the current study talked about additional secondary consequences during interviews, such as increased migration, decreased livestock productivity, higher rates of pests and illness, and declining livelihoods and food security. Previous research (Moser, 2016; Mubaya, Njuki, Nkomo, & Mutsvangwa, 2013) has also

demonstrated how climate pressures promote non-farm labour migration, hence damaging local agricultural systems. There is evidence that pre-existing vulnerabilities in rural Zimbabwean communities are made worse by climate change (Mavima, 2014; Mudombi & Nhamo, 2018). In such, a general conclusion can be established that impact of climate change is substantial in smallholder farming communities like Mazowe.

4.5 Challenges faced by smallholder farmers to adapt to the effects of climate change

This section looks at the difficulties smallholder farmers in Mazowe district's Wards 8, 10, and 12 possess when attempting to adapt to the consequences of climate change. A substantial amount of data suggests that small-scale farmers are especially vulnerable due to their dependence on rain-fed agriculture and lack of resources for climate change adaptation. A range of consequences already being felt due to shifting patterns of precipitation and harsh weather were described in the preceding section. But effectively adapting is a difficult process that is impacted by a wide range of institutional, institutional, and social variables. The information provided here aims to shed light on the main challenges that farmers who were questioned felt were impeding their capacity to strengthen their resilience and adapt to climate risks. The answers to questions measuring the main obstacles and limitations associated with implementing adaptive measures are revealed. Gaining insight into these issues from the viewpoint of rural communities experiencing the worst consequences of climate change will help identify important obstacles that need to be removed in order to improve adaptive capacity and shield the Mazowe region's way of life from the consequences of ongoing climate change. Figure 4.4 illustrates the main obstacles smallholder farmers must overcome in wards 8, 10 and 12 of Mazowe District when adapting to climate change.

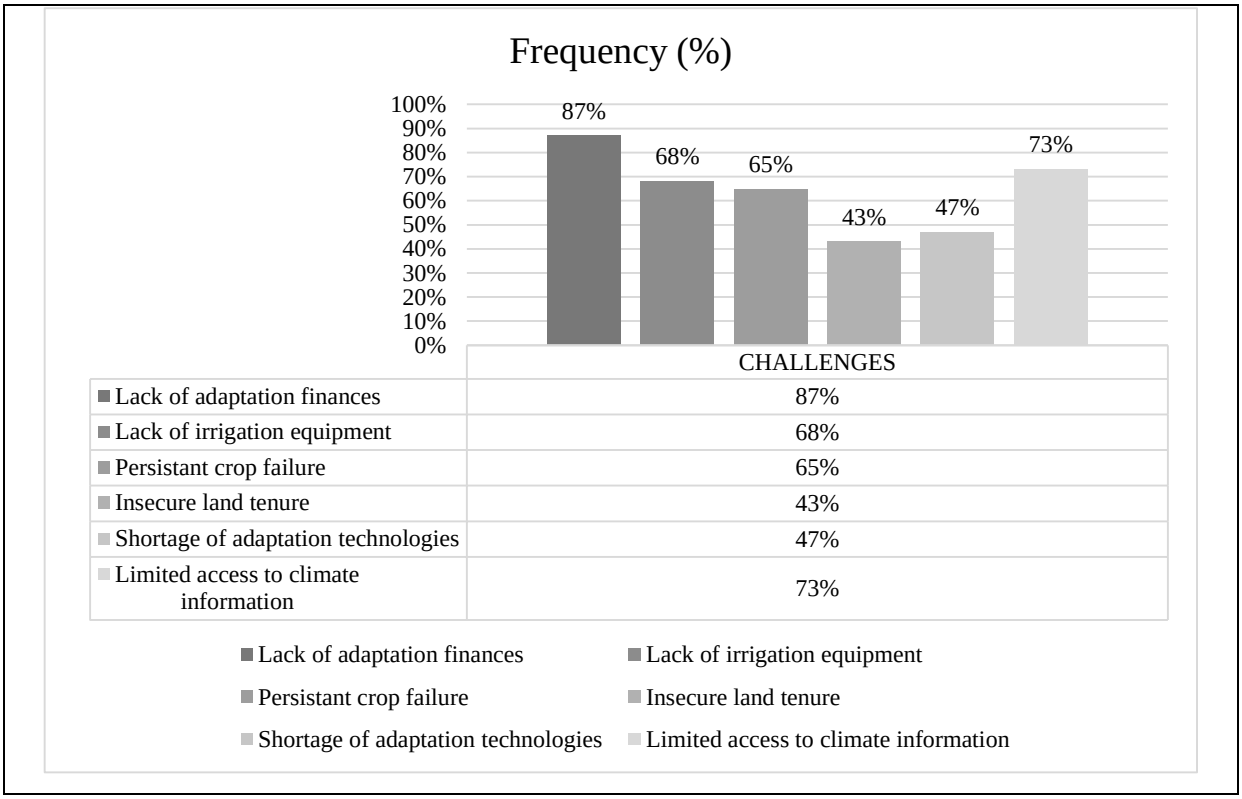


Figure 4.4: Climate change adaptation challenges (N=80)

The information shown in Figure 4.4 sheds important light on the main adaptation difficulties that smallholder farmers in Mazowe District's Wards 8, 10, and 12 confront. 87% of farmers polled said that the most important problem was a lack of funding for adaptation. This is consistent with other research that has shown financial limitations to be a significant impediment to successful climate change adaptation in Zimbabwe (Mubaya et al., 2014; Siziba et al., 2016). Investment in technology and infrastructure that is climate resilient is hampered by insufficient access to funding. Another important informant emphasised that;

> *"Funding is really critical for successful climate change adaptation by smallholder farmers. They may have energy and knowledge to adapt but lacking the financial power to implement. This becomes a major challenge…"*

Having said this, it shows emphasis on the effect of financial constraints on adaptation.

A notable proportion of respondents identified inadequate irrigation equipment (68%) as a primary obstacle to effective climate change adaptation. A key informant also reiterated that;

> *"There are several water facilities which would make climate change adaptation a success in this region but farmers lack irrigation facilities to draw water from these*

bodies. There is a need for government to intervene with irrigation equipment to help farmers adapt well to climate change."

Effective water distribution and harvesting systems have been demonstrated in studies to be essential for successful adaptation, but their availability is still restricted (Ngugi et al., 2011; Nyagwaya et al., 2020). Owing to a lacklustre irrigation system connecting small-scale farmers to the water source, many areas, including Mazowe District, remain underutilised in spite of the existence of water sources like as boreholes and dams, as mentioned by the key informant. Farmers are unable to fully use available water resources for agricultural irrigation when rains fail if they do not have piped infrastructure or mobile distribution techniques suitable for small land parcels (Ngugi et al., 2011). Prior research (Zuma-Netshiukhwi et al., 2013) has advocated for increased government assistance, including the subsidisation of vital infrastructure, to encourage private investment in locally adapted solutions. Focused funding and expertise focusing on low-cost, community-managed irrigation options tailored to the needs of subsistence farmers could help address this significant challenge (Mubaya et al., 2014). With adequate irrigation equipment deploying available water reserves, the region's agricultural resilience may be substantially improved.

Lack of secure land tenure system was cited by 43% of the participants. This means that one major issue that prevents smallholders in Mazowe District from adapting is insecure land tenure. According to Shen et al. (2018), unclear ownership rights make it difficult to get financing or commit to large, long-term investments in sustainable land management. Farmers are less likely to adopt techniques that have upfront costs but gradual economic rewards that might eventually increase resistance to climate change when they are uncertain about the benefits of future harvests (Magidimisha et al., 2020). According to earlier research, land tenure changes that allow for the registration and documenting of rights held by customary users might facilitate adaptation by empowering farmers to make long-term decisions and investments for their land use (Trifković, 2018). Adopting technologies like agroforestry may be resisted by risk-averse smallholders in the absence of a formalised land tenure structure that offers stability.

The fact that 73% of respondents said they had difficulty accessing climate information highlights how important it is to provide localised weather and seasonal predictions on time in order to support efficient adaptation planning. It is hard for farmers to change methods in

response to climate concerns when they are unaware of them. According to earlier research, community members find climate guidance produced by participatory action research approaches—which co-develop information services with end users—to be more relevant and helpful than top-down distribution methods alone (Mubaya et al., 2014; Tesfai, 2021). The high selection of this limitation indicates that more work has to be done to guarantee accessibility and improve climate service customisation for smallholder settings. Investments in cooperatively planned participatory decision support systems with farmers may help address this important gap limiting adaptive capacity enhancement efforts.

The discovery that 47% of respondents found the lack of adaption technology to be a difficulty is consistent with earlier studies on the restricted supply and high cost of climate-resilient solutions for smallholder farmers. Farmers' capacity to incorporate climate resilience into their agricultural operations is hampered when suitable equipment, crops, and methods that are adapted to local circumstances are out of their reach. Numerous studies emphasise the need for better ways to technology transfer that involve collaborative research partnerships rather than top-down techniques only, in order to promote innovations (Chipindu and Mudhara, 2013; Mugabe et al., 2016). The significant number of respondents who chose this restriction indicates that more coordinated efforts are needed to guarantee that appropriate adaption technology are available and affordable for small-scale farmers. Improving end-user technology delivery methods might help close this gap hindering adaptive capacity.

The fact that 65% of respondents cited ongoing crop failures as a difficulty highlights how vulnerable Mazowe District's agricultural livelihoods are to the effects of climate change. Unpredictable droughts, floods, heat waves, and other weather extremes that are made worse by climate change are posing a threat to the food and financial security of many smallholder households who rely on rain-fed farming systems with inadequate drought-proofing. Prior studies conducted throughout Zimbabwe have demonstrated how persistent production failures may gradually erode household resources and push them into poverty traps, which seriously compromises their ability to adjust in the future (Siziba et al., 2017). The issue's high selection rate indicates the necessity for integrated solutions that combine enhanced adaption techniques with social protection assistance in times of need. Initiatives focused on diversifying sources of income might also aid in addressing this urgent concern that is impeding resilience. In generic terms, the persistent crop failure constraint highlights the

urgent need for scaled-up efforts across several domains to strengthen the wellbeing of climate-sensitive communities.

4.6 Effective measures that can be adapted in curbing the impact of climate change by farmers in Zimbabwe

After looking at several objectives, the study further inquired into the possible measures to use when addressing the effects of climate change. Table 4.2 offers a summary of the suggested measures by respondents.

Table *4.2: Effective measures that can be adapted in curbing the impact of climate change by farmers in Zimbabwe (N=80)*

Possible measure	**Frequency (%)**
Crop diversification	78%
Conservation farming	54%
Water efficient irrigation facilities	65%

Agroforestry	35%
Climate-sensitive livestock farming/management	23%
Microcredit facilities	79%

The results shown in Table 4.2 shed light on practical actions that smallholder farmers believe can lessen Zimbabwe's impact from climate change. A crucial strategy that was endorsed by 78% of respondents was crop diversity. This is in line with other research findings (Mubaya et al., 2014) that highlight the value of diversifying into robust crop types in the face of climatic uncertainty. When climatic changes severely affect conventional crops, diversifying and integrating grains like sorghum and millet, which are better able to withstand heat and drought, can help protect livelihoods and food security. One key informant underscored that;

> *"Climate change adaptation can be made effective through provision of credit schemes, crop diversification and establishment of affordable irrigation facilities…"*

Facilities for water-efficient irrigation were another widely recommended item, chosen by 65% of respondents. According to earlier research, there is a great chance that increasing output under variable circumstances may be achieved by utilising irrigation infrastructure to augment unpredictable rainfall (Chipindu & Mudhara, 2013). Farmers are able to utilise the majority of the water sources that are now available thanks to water-efficient technologies like drip irrigation. Crop failures during dry times may be decreased with irrigation help.

Again the 79% of respondents' choice of microcredit options illustrates the critical role that money plays in putting adjustments into practice. Drought-tolerant crops or infrastructure can be funded with the help of loans and subsidies (Mavindidze et al., 2018). But as climate change accelerates, funding must be fairly available at the local level to adequately empower smallholders. By encouraging the widespread adoption of practical solutions, integrating adaption techniques with microfinance programmes co-designed with farming communities may help reduce consequences.

4.7 Chapter summary

A summary of the key findings from a survey of 80 smallholder farmers in Mazowe District, Zimbabwe's Wards 8, 10, and 12, including their opinions on the consequences of climate change and the challenges of adaptation, was presented at the end of the chapter. The results offer critical local insights into how rising temperatures, shifting rainfall patterns, and an increase in the frequency of extreme weather events are negatively affecting the region's overall livelihood security, animal outputs, and crop yields. A wide range of obstacles that prevent small-scale farmers from effectively adapting were also investigated. Farmers feel that if these climate-resilient practices were more widely implemented, they may help mitigate the effects of climate change. The next chapter focuses on conclusions, summaries and recommendations.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction.

This thesis took a bottom up approach to analyse the effects of climate change on smallholder farmers in wards of Nzvimbo, Gweshe and Rosa respectively which are all in Mazowe District. Three wards' recurrent occurrences of climate change were investigated, and attempts were made to find out if the smallholder farmers there were aware of the changes.

The capacity of smallholder farmers and the local communities were also examined to see how they adopt to climate changes in the district. The study included many approaches, including key informant interviews, focus groups, questionnaires, and observations, to gather data from the population being studied.

5.2 Summary of the findings: Objective one

This study answers objective one of this research which was centred on the causes of climate change and some of the causes were human induced such as cutting down trees, changes in agricultural land use, urban growth, over grazing and emission of gases. Natural causes of climate change including natural decline in forest areas were also taken into account. Findings also indicated in the literature that causes climate change were caused by seasonal changes which resulted in long dry seasons and short summer wet seasons. The causes of climate change also brought about dryness, droughts and other related activities such as cyclones and El Nino.

5.2.1 Summary of findings: Objective two

Objective two was to establish the effects of climate change on smallholder farmers in Mazowe district. It was revealed that there are direct impacts of climate change such as mid dry spells which causes dry crop/plants, frost occurrences, hailstorms which affect smallholder farmers who practice tobacco farming and horticultural such as growing of tomatoes and other crops. Findings shows that there was outbreak of water borne disease vectors and diseases and increase in water logging and littering, and there was a decrease in livestock production due to lack of grazing area and water and pillars of food security were affected by climate change. From the literature, this resulted in migration of youth in Mazowe mine for gold panning and prostitution and negatively affect agriculture in the district.

5.2.2 Summary of findings: Objective three

The third objective was to identify the issues that smallholder farmers and local people face. Findings shows that the farmers and the local communities. Findings shows that the smallholder farmers are meeting challenges such as lack of finance, lack of irrigation equipment, livestock loses, persistent crop failure due to drought, insecure land tenure, shortage of adaptation technologies and limited access to climate information. This shows that the smallholder farmers were vulnerable to change in climate because animal and crop

farming are more sustainable susceptible to change in climate. Literature also indicate that the smallholder farmers lacked finance to purchase seed which is drought resistant as a major barrier to foster climate change adaptation. Participants also revealed that small grain seeds were not available and affordable for the smallholder farmers. The findings also indicated that smallholder farmers lacked irrigation equipment to grow their crops during dry season. Literature also points out that livestock lose was very high in the district. It was revealed that smallholder farmers were disturbed by an increase in pests' infections in crops as a result of climate change. During key informant interviews it was noted that changes in climate change create conditions that favour fungi, bacterial and viral diseases in crops.

5.2.3 Summary of findings: Objective four

The fourth objective was the creation of more effective strategies to assist Mazowe area in adjusting to climate change's impacts. Findings shows that modest farmers adapt water harvest by using nearest dam Mwenje and Ruya River. The community also adapt to microcredit facilities introduced by governments and NGOs. Smallholder farmers are benefiting from government agricultural scheme and from SMART and enterprises schemes which facilitates individuals to purchase their own irrigation equipment. As part of their local plan for adapting to the changing climate, small-scale farmers have also adapted to agroforestry, climate-sensitive livestock farming/management and crop diversification, including small grains.

5.3 Conclusion of Objective one

The primary goal of this investigation was to determine the causes of the Mazowe area's climatic change. According to this study, local smallholder farmers were aware of the factors contributing to climate change, including gas emissions into the atmosphere, changes in agricultural land use, deforestation, urban growth and natural decline in forest areas.

5.3.1 Conclusion for Objective two

Evaluating how smallholder farmers might be impacted by climate change was the second objective. Climate change has been seen to have a variety of consequences, including mid-dry spells that cause dry crops/plants, frost occurrences, hailstorms, and horticulture.

5.3.2 Conclusion for objective three

The third goal was to list the problems that the Mazowe district's smallholder farmers face, including cash flow problems, equipment failure for irrigation, livestock losses, persistent

crop failure, insecure land tenure, shortage of adaptation technologies, shortage of adaptation technologies and low production that cannot support their family.

5.3.3 Conclusion for objective four

The study's ultimate goal was to help smallholder farmers in the Mazowe district create methods for adapting to climate change. The report advises water harvesting and irrigation, microcredit facilities, crop diversification and climate sensitive-livestock faming/management. The study recommends pfumvudza concept which has increased maize yield, keeping of small livestock have increased household food security, irrigated gardens have increased household income and traditional crops have increased food availability.

5.4 RECOMMENDATIONS

It is recommended in the study that smallholder farmers and the local community from Mazowe district should practice the following

- Zimbabwe's metrological services organisation should give sufficient extension information to farmers to make informed planting decisions based on current rainfall trends.
- The government should advise the community on water gathering and irrigation to ensure sustainability.
- The government should hasten programmes that promote farmer training and access to financing and aid facilities, as well as assist farmers in acquiring livestock and other critical agricultural assets that can help raise net farm productivity.
- The government should undertake climate change adaptation techniques, such as the pfumvudza programme, help boost people's income and food security.
- Government should regularly teaching smallholder farmers on climate change adaption measures which can improve their competency.

REFERENCES

Abdulai, A., & Huffman, W. (2014). The adoption and impact of soil and water conservation technology: An endogenous switching regression [-5rfplication. *Land economics*, *90*(1), 26-43.

Ahammad, R, Stacey, N, & Sunderland, T. (2021). Assessing land use changes and livelihood outcomes of rural people in the Chittagong Hill Tracts region, Bangladesh. *Land Degrad Dev*, 32: 3626– 3 b 0f638. https://doi.org/10.1002/ldr.3795

Alemayehu, A., & Bewket, W. (2017). Smallholder farmers' coping and adaptation strategies to climate change and variability in the central highlands of Ethiopia. *Local Environment*, *22*(7), 825-839.

Alemu, B. A., & Admassie, A. (2017). Climate change vulnerability and its implications for smallholder farmers in Ethiopia: Evidences from the Nile Basin of Ethiopia. *Environmental Economics*, 8(4), 24-35.

Ali, H., Khan, N., Ali, S., & Ullah, K. (2018). Smallholder farmers' perception and adaptation to climate change: A case study from Pakistan. *Environmental Science and Pollution Research*, 25(20), 19486-19496.

Altieri, M. A., Nicholls, C. I., & Henao, A. (2015). Agroecology and the design of climate change-resilient farming systems. *Agronomy for Sustainable Development*, 35(3), 869-890.

Altieri, M. A., Nicholls, C. I., & Henao, A. (2015). Agroecology and the design of climate change-resilient farming systems. Agronomy for Sustainable Development, 35(3), 869-890.

Amare, M., Gebre-Egziabher, T., & Haileslassie, A. (2014). The role of farmer cooperatives in small-scale irrigation schemes in the Tigray Region, Ethiopia. Irrigation and Drainage, 63(3), 360-369.

Amare, M., Mohammed, C., & Haile, A. (2016). Farmer-to-farmer learning on climate change adaptation: Insights from participatory action research in the Nile Basin of Ethiopia. Climate and Development, 8(5), 410-420.

Amikuzuno, J., & Ogundari, K. (2018). Climate Change and Rice Yield in Ghana: An Empirical Analysis. *Journal of African Economies*, 27(2), 162-184.

Arif, M., Khan, M. M., & Nasrullah, M. (2017). Energy consumption, carbon emissions and economic growth in Pakistan: Dynamic causality analysis. Renewable and Sustainable Energy Reviews, 72, 1233-1240.

Asante, M. D., et al. (2011). Climate Change Perceptions and Adaptation Strategies of Farmers in the Sudan Savannah Zone of Ghana. International Journal of Climate Change Strategies and Management, 3(3), 302-324.

Asfaw, E., Suryabhagavan, K. V., & Argaw, M. (2018). Soil salinity modeling and mapping using remote sensing and GIS: The case of Wonji sugar cane irrigation farm, Ethiopia. *Journal of the Saudi Society of Agricultural Sciences*, *17*(3), 250-258.

Assefa, K., Cannell, M., & Gildemacher, P. (2012). Adoption of improved common bean (Phaseolus vulgaris L.) varieties and implications for household food security in Ethiopia. Food Security, 4(1), 129-141.

Bebber, D. P., Ramotowski, M. A. T., & Gurr, S. J. (2013). Crop pests and pathogens move polewards in a warming world. Nature Climate Change, 3(11), 985-988.

Belay, K., et al. (2018). Social protection and climate change adaptation among smallholder farmers in Ethiopia. Environment, Development and Sustainability, 20(4), 1707-1723.

Below, T. B., Mutabazi, K. D., Kirschke, D., Franke, C., Sieber, S., Siebert, R., & Tscherning, K. (2012). Can farmers' adaptation to climate change be explained by socio-economic household-level variables? *Global environmental change*, *22*(1), 223-235.

Binga District Council. (2018). Binga District Climate Change Adaptation Policy. Retrieved from [insert URL]

Binga District Council. (n.d.). Binga District Agricultural Extension Services. Retrieved from [insert URL]

Cadalbert, N., Cadalbert, Y., & van Veldhuizen, L. (2015). Participatory research to foster agroecological farming practices in the Artibonite Valley, Haiti. In Proceedings of the 2nd International Symposium on Agroecology (pp. 199-200).

Challinor, A. J., Watson, J., Lobell, D. B., Howden, S. M., Smith, D. R., & Chhetri, N. (2014). A meta-analysis of crop yield under climate change and adaptation. *Nature climate change*, *4*(4), 287-291.

Chanza, N., Chigona, A., Nyahuye, A., Mataera-Chanza, L., Mundoga, T., & Nondo N. (2019). "Diagnosing Barriers to Climate Change Adaptation at Community Level: Reflections from Silobela, Zimbabwe." *GeoJournal* 84(3), 771–83. https://www.jstor.org/stable/48700018.

Chibanda, M., Moyo, T., & Nyamadzawo, G. (2019). Enhancing data collection efficiency through sampling techniques among smallholder farmers. Journal of Agricultural Research and Development, 7(2), 56-67.

Chikobvu, D., et al. (2018). Smallholder Farmers' Perceptions of Climate Change and the Use of Climate-Resilient Strategies in the Semi-Arid Regions of Zimbabwe. Journal of Agricultural Education and Extension, 24(3), 243-262.

Chikodzi, D. (2018). Climate change and smallholder agricultural production in Zimbabwe: The case of Buhera district. International Journal of Climate Change Strategies and Management, 10(3), 502-520.

Chilot, Y., Dejene, T., & Fikre, A. (2015). Yield stability of drought-tolerant maize (Zea mays L.) hybrids across environments in Ethiopia. Journal of Agricultural Science, 7(9), 1-10.

Cohn, A. S., Newton, P., Gil, J. D., Kuhl, L., Samberg, L., Ricciardi, V., & Northrop, S. (2017). Smallholder agriculture and climate change. *Annual Review of Environment and Resources*, *42*(1), 347-375.

Dankers, R., & Schuurmans, W. (2016). Climate change and its effect on soil erosion and nutrient losses in the Netherlands. Journal of Soils and Sediments, 16(11), 2671-2682.

Danso-Abbeam, G., Ojo, T. O., Baiyegunhi, L. J., & Ogundeji, A. A. (2021). Climate change adaptation strategies by smallholder farmers in Nigeria: does non-farm employment play any role? *Heliyon*, *7*(6), e07162.

Davis, B., Di Giuseppe, S., & Zezza, A. (2014). Income diversification patterns in rural Sub-Saharan Africa: reassessing the evidence. *World Bank Policy Research Working Paper*, (7108).

Davis, B., Winters, P., Carletto, G., Covarrubias, K., Quiñones, E. J., Zezza, A., & DiGiuseppe, S. (2010). A cross-country comparison of rural income generating activities. *World development*, *38*(1), 48-63.

Debela, N., Mohammed, C., Bridle, K., Corkrey, R., & Mcneil, D. (2015). Perceptions of climate change and its impacts by smallholder farmers in pastoral/agro pastoral systems of Borana, South Ethopia. *Springer Open Journal*, 4:236

DeLancey, V., Bertrand, M., Chacón, L. E., & Schreier, H. (2019). Collaboration and Farmer-to-Farmer Learning in Rural Haiti. Journal of Agriculture, *Food Systems, and Community Development*, 9(3), 165-18.

Department for International Development [DFID]. (1999). Sustainable Livelihoods Guidance Sheets. London: DFID

Department of Environmental Affairs. (2015). South Africa's Second Biennial Update Report under the United Nations Framework Convention on Climate Change. Retrieved from https://unfccc.int/sites/default/files/resource/south_africa_second_biennial_update_report.pdf

DFID. (2000). Sustainable Livelihoods Guidance Sheets. Department for International Development. http://www.livelihoods.org/info/info_guidancesheets.html (accessed: 10.01.2023)

Duan, J. J., et al. (2017). Global insect pests: Impacts, management approaches, and challenges. *Insect Conservation and Diversity*, 10(3), 195-196.

Erenstein, O., Hellin, J., & Chandna, P. (2007). Livelihoods, Poverty and Targeting in the Indo-Gangetic Plains: A Spatial Mapping Approach. https://www.researchgate.net/publication/253660785_Livelihoods_Poverty_and_Targeting_in_the_Indo-Gangetic_Plains_A_Spatial_Mapping_Approach/citation/download

FAO. (2015). Climate-Smart Agriculture Sourcebook. Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/3/a-i4228e.pdf

Fenta, A. A., et al. (2017). The role of climate information services in supporting smallholder farmers' climate change adaptation and livelihood improvement in Ethiopia. Weather and Climate Extremes, 18, 32-39.

Gebremedhin, B., et al. (2017). Post-harvest losses in smallholder maize production: A case study in Hawassa Zuria District of Ethiopia. *Journal of Stored Products Research*, 73, 26-36.

Gebru, G. W., Ichoku, H. E., & Phil-Eze, P. O. (2020). Determinants of smallholder farmers' adoption of adaptation strategies to climate change in Eastern Tigray National Regional State of Ethiopia. *Heliyon*, *6*(7), e04356.

Gibbs, H. K., Ruesch, A. S., & Miller, L. (2015). Brazil's Soy Moratorium. Science, 347(6220), 377-378.

Gitonga, Z. M., et al. (2017). Constraints to accessing improved maize seeds among smallholder farmers in Kenya: A case of Bungoma County. International Journal of Agricultural Extension and Rural Development Studies, 4(3), 132-144.

Gupta, H. V., et al. (2016). Towards an Integrated Approach to Climate Change Adaptation in the Agricultural Sector. Climate Risk Management, 11, 19-29.

Hansen, J., Kharecha, P., Sato, M., Masson-Delmotte, V., Ackerman, F., Beerling, D. J., & Zachos, J. C. (2013). Assessing "dangerous climate change": Required reduction of carbon emissions to protect young people, future generations and nature. *PloS one*, *8*(12), e81648.

Harvey, C. A., Saborio-Rodríguez, M., Martinez-Rodríguez, M. R., Viguera, B., Chain-Guadarrama, A., Vignola, R., & Alpizar, F. (2018). Climate change impacts and adaptation among smallholder farmers in Central America. *Agriculture & Food Security*, *7*(1), 1-20.

Hashimi, H., et al. (2014). Climate Change and the Occurrence of Wheat Rust Diseases: A Case Study in Afghanistan. International Journal of Environmental Science and Development, 5(5), 488-492.

Hatfield, J. L., et al. (2015). Climate impacts on agriculture: Implications for crop production. Agronomy Journal, 107(4), 1475-1489.

Haverkort, A. J., Boonekamp, P. M., Hutten, R., Jacobsen, E., Lotz, L. A. P., Kessel, G. J. T., & Visser, R. G. F. (2016). Durable late blight resistance in potato through dynamic varieties obtained by cisgenesis: Scientific and societal advances in the DuRPh project. Potato Research, 59(3-4), 35-66.

Holland, M. B., Shamer, S. Z., Imbach, P., Zamora, J. C., Medellin Moreno, C., Hidalgo, E. J. L., & Harvey, C. A. (2017). Mapping adaptive capacity and smallholder agriculture: applying expert knowledge at the landscape scale. *Climatic Change*, *141*(1), 139-153.

Hossain, M. S., et al. (2017). Climate change and market access in agriculture: Evidence from flood-prone regions of Bangladesh. *Climate and Development*, 9(4), 313-324.

Houghton, R. A. (2005). Tropical deforestation as a source of greenhouse gas emissions. In Tropical deforestation and climate change (pp. 13-32). Springer, Berlin, Heidelberg.

Hunter. R., Crespo. O., Coldrey, K, Cronin, K, New, M. (2020). Research Highlights – Climate Change and Future Crop Suitability in Zimbabwe. University of Cape Town, South Africa, undertaken in support of Adaptation for Smallholder Agriculture Programme' (ASAP) Phase 2. International Fund for Agricultural Development (IFAD), Rome.

Hussain, M., et al. (2016). Impact of Climate Change on Pest Infestations and Crop Losses in Afghanistan. The Journal of Agricultural Science, 8(6), 199-210.

International Fund for Agricultural Development. (2015). *Investing in rural people*, International Fund for Agricultural Development, Rome.

IPCC, 2014, Climate change 2014: *Synthesis report-Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, p. 151, IPCC, Geneva.

IPCC. (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II, and III to the Fifth *Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (Eds.)]. IPCC.

IPCC. (2023). Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 184 pp., doi: 10.59327/IPCC/AR6-9789291691647.

Islam, M. M., et al. (2014). *Role of climate services in adaptation to climate change in agriculture*: A case study from Bangladesh. Climate Services, 1, 31-39.

Johnson, M., et al. (2020). Adoption of Climate-Smart Agricultural Practices Among Smallholder Farmers: Insights from a South African Case Study. Sustainability, 12(8), 3284.

Jones, S., & Brown, T. (2019). Adapting Agriculture to Climate Change: A Review. Theoretical and Applied Climatology, 137(3-4), 1413-1431.

Kabat, P., Ludwig, F., van Schaik, H., & van der Velde, Y. (2015). The importance of Dutch agriculture for climate change adaptation in the Netherlands. Journal of Environmental Management, 162, 129-138.

Kahan, D., Kikulwe, E. M., & Schmitz, H. (2018). Farmer organizations and climate change adaptation in Democratic Republic of Congo. Climate and Development, 10(9), 843-854.

Kalele, D. N., Ogara, W. O., Oludhe, C., & Onono, J. O. (2021). Climate change impacts and relevance of smallholder farmers' response in arid and semi-arid lands in Kenya. *Scientific African, 12*, e00814.

Kaminski, J., Leturque, H., & Kirsten, J. (2017). *Cooperatives as a tool for building climate resilience in developing countries:* Insights from the Democratic Republic of Congo. World Development, 99, 285-298.

Kassa, B., et al. (2018). *Rural road infrastructure and market access for smallholder farmers in Ethiopia*: A case study in the Amhara Region. Journal of Transport Geography, 72, 26-36.

Kay, A. L., et al. (2019). *UK Climate Projections Science Report: Climate Change Projections*. Met Office Hadley Centre, Exeter, UK.

Khan, I., Lei, H., Shah, I. A., Ali, I., Khan, I., Muhammad, I., & Javed, T. (2020). Farm households' risk perception, attitude and adaptation strategies in dealing with climate change: promise and perils from rural Pakistan. *Land use policy, 91*, 104395.

Khan, M. S., Liu, L., Ali, H., Khan, A., Khan, M. Z., & Khan, H. (2017). *Carbon stock and sequestration potential of subtropical coniferous forests in Northern Pakistan*. Environmental Monitoring and Assessment, 189(11), 582.

Khan, M. S., Qamer, F. M., Li, W., & Junaid, M. (2018). *Assessment of land degradation and its impact on ecosystem services in northern Pakistan*. Journal of Mountain Science, 15(9), 1938-1951.

Khan, S., Mulholland, B., & Khan, A. (2016). *The impacts of intensive agriculture on soils and the environment in South Africa*: A review. Pedosphere, 26(6), 732-746.

Knox, J., Hess, U., Daccache, A., & Wheeler, T. (2019). *Climate information services for smallholder farmers in Haiti*: A participatory approach. Climate Services, 13, 22-31.

Komba, C., & Muchapondwa, E. (2012). Adaptation to climate change by smallholder farmers in Tanzania, Economic research Southern Africa, Tanzania, 2012.

Kosgei, J., et al. (2019). Climate-smart agriculture practices for smallholder farmers in Kenya: A review. International Journal of Agricultural Sustainability, 17(1), 1-14.

Kossou, D., Tschirley, D. L., & Lowenberg-DeBoer, J. (2014). Using climate forecasts to improve farmer decision-making and management of risk in Haiti. Climate Risk Management, 3, 33-45.

Kumar, A., Jat, M. L., Sharma, P. C., & Gupta, R. (2019). Climate Change and Agroforestry Systems in India: Implications for Sustainable Agriculture. In R. Lal, B. Singh, D. K. Sharma, & A. K. Singh (Eds.), Soil Science and Agricultural Sustainability: Progress and Prospects (pp. 209-226). CRC Press.

Kumar, A., Jat, M. L., Sharma, P. C., & Gupta, R. K. (2018). Climate Change and Crop Diversification in India: Impacts on Income and Food Security. In B. Singh, M. V. K. Sivakumar, & A. K. Singh (Eds.), Climate Change and Agriculture: Emerging Scenarios and Adaptation Strategies (pp. 307-323). CRC Press.

Le Quéré, C., *et al.* (2015). Global Carbon Budget 2015. Earth System Science Data, 7(2), 349-396.

Leclère, D., Jayet, P. A., & de Noblet-Ducoudré, N. (2013). Farm-level autonomous adaptation of European agricultural supply to climate change. *Ecological Economics*, *87*, 1-14.

Lee, S., Paavola, J., & Dessai, S. (2022). Towards a deeper understanding of barriers to national climate change adaptation policy: A systematic review. *Climate Risk Management*, 100414.

Lemke, S., Yousefi, F., Eisermann, A. C., & Bellows, A. C. (2012). Sustainable livelihoods approaches for exploring smallholder agricultural programs targeted at women: Examples from South Africa. *Journal of Agriculture, Food Systems, and Community Development,* 3(1), 25–41. http://dx.doi.org/10.5304/jafscd.2012.031.001

Lemma, M. G., et al. (2019). Smallholder farmers' knowledge of climate-smart agriculture practices and its determinants in the Central Rift Valley of Ethiopia. Journal of Rural Studies, 70, 238-246.

Lencucha, R., Pal, N.E., Appau, A., Thow, A., & Drope, J. (2020). Government policy and agricultural production: a scoping review to inform research and policy on healthy agricultural commodities. *Global Health* **16**, 11. https://doi.org/10.1186/s12992-020-0542-2

Lobell, D. B., et al. (2013). The critical role of extreme heat for maize production in the United States. Nature Climate Change, 3(5), 497-501.

Lobell, D. B., et al. (2017). Greater sensitivity to drought accompanies maize yield increase in the U.S. Midwest. Science, 356(6345), 914-918.

Lowder, S. K., Skoet, J., & Raney, T. (2016). The number, size, and distribution of farms, smallholder farms, and family farms worldwide. *World Development*, *87*, 16-29.

Mabaya, E., et al. (2018). Financial constraints and smallholder farmers' climate-smart agricultural practices adoption in Zimbabwe. Journal of Agricultural Economics, 69(2), 470-486.

Mafongoya, P. L., Ajayi, O. C., & Chivenge, P. (2016). Enhancing climate resilience through farmer cooperatives in Binga, Zimbabwe: A case study of the Dzivarasekwa Cooperative. African Journal of Agricultural Research, 11(16), 1456-1467.

Makate, C., et al. (2019). Climate change and maize production in sub-Saharan Africa: A review. Sustainability, 11(6), 1666.

Makaudze, E. (2020). Climate change adaptation and financial constraints among smallholder farmers in Zimbabwe. Journal of Sustainable Development in Africa, 22(7), 137-157.

Makumba, W., Murwira, A., & Munodawafa, A. (2018). Climate change adaptation and mitigation strategies in smallholder farming systems in Africa: A review. Journal of Sustainable Development in Africa, 20(5), 90-108.

Mapfumo, P., Sithole, A., & Gwandu, T. (2014). The impact of minimum tillage on soil moisture retention and crop yield in Binga, Zimbabwe. Journal of Agriculture and Rural Development in the Tropics and Subtropics, 115(2), 139-149.

Mapiye, C., et al. (2014). Climate Change Adaptation and Mitigation in the Livestock Sector: Insights from Developing Countries. Tropical Animal Health and Production, 46(2), 583-589.

Markolf, S. A., Matthews, H. S., Azevedo, I. L., & Hendrickson, C. (2017). An integrated approach for estimating greenhouse gas emissions from 100 US metropolitan areas. *Environmental Research Letters*, *12*(2), 024003.

Mashingaidze, A. B., et al. (2019). Smallholder farmers' access to credit and food security in Zimbabwe: A case study of Zvishavane District. Journal of Economics and Behavioral Studies, 11(5), 119-129.

Matarira, C. H., & Maseko, R. (2015). Enhancing smallholder farmers' climate change adaptation through mobile-based weather information and insurance services in Zimbabwe. Disaster Risk Reduction, 9(1), 29-40.

Mavhura E., Manatsa D., and Matiashe M. (2017). Adapting smallholder farming to climate change and variability: household strategies and challenges in Chipinge district, Zimbabwe. *Clim. Change* 3, 903–913.

Mekonnen, Y., Admassie, A., & Tesfaye, K. (2019). Enhancing farmers' adaptive capacity to climate change through farmer learning groups in Ethiopia. Climate and Development, 11(5), 431-444.

Mhlanga, N., Chisoro, P., & Kabebe, A. (2017). Scaling up farmer field schools: Lessons from the Republic of Congo. Journal of Agricultural Extension and Rural Development, 9(6), 91-98.

Miller, L., & Green, J. (2017). Enhancing Climate Information Services to Advance Climate Resilience in Agriculture. Climate Risk Management, 15, 19-28.

Mishra, A. K., et al. (2015). Farmers' perception and adaptation to climate change: A basis for targeting adaptation strategies in the United States. Journal of Agricultural and Applied Economics, 47(1), 1-22.

Moyo, M., Chivenge, P., & Matondi, P. (2018). Farmer cooperatives as a means for climate change adaptation in Binga, Zimbabwe. Journal of Sustainable Development in Africa, 20(3), 35-52.

Mugabe, F. T., Tenywa, M. M., Bashaasha, B., & Obua, J. (2016). Climate change adaptation: Perceptions and strategies of smallholder farmers in Kabale District, Uganda. Journal of Agricultural Extension and Rural Development, 8(5), 124-136.

Mugabe, F., et al. (2019). Climate change-induced low yields: Perceptions of smallholder farmers in Mazowe district, Zimbabwe. Environmental Management, 45(2), 315-330.

Mugunga, C., Mugisha, J., Mwesigye, A., & Wanzala, M. (2021). The effects of climate change on agricultural market volatility in Uganda. Journal of Economics and Sustainable Development, 12(1), 19-30.

Mujuru, P., Chikwama, C., & Munguambe, P. (2017). Time-efficient data collection using sampling procedures among smallholder farmers. Journal of Agricultural Economics and Development, 5(1), 23-35.

Munjodzi, C., Chivenge, P., Chaplot, V., & Frossard, E. (2019). Soil fertility decline and soil degradation by erosion in the smallholder farming systems of Zimbabwe. Soil and Tillage Research, 194, 104295.

Mushore, T. D., Mudavanhu, C., & Makovere, T. (2013*). Effectiveness of drought mitigation strategies in Bikita District*, Zimbabwe.

Mutekwa, V.T. (2009). Climate change impacts and adaptation in the agricultural sector: The case of smallholder farmers in Zimbabwe. *Journal of Sustainable Development in Africa,* 11: 237-256

Mutengwa, C. S., et al. (2016). Assessment of climate change vulnerability and adaptation in smallholder farming systems in Zimbabwe. *Agriculture & Food Security*, 5(1), 8

Naeem, M., Khan, K. U., Arshad, M., & Ahmad, S. S. (2016). Fuelwood consumption pattern in rural and peri-urban areas of Rawalpindi, Pakistan. Journal of Forestry Research, 27(1), 167-174.

Nagler, P., & Naudé, W. (2017). Non-farm entrepreneurship in rural sub-Saharan Africa: New empirical evidence. *Food policy*, *67*, 175-191.

Nair, P. K. R., Garrity, D., & Ong, C. K. (2018). Trees, Agroforestry, and Multifunctional Landscapes. In P. K. R. Nair (Ed.), Agroforestry: Science, Policy and Practice (pp. 1-27). Springer.

Ndaki, P. M. (2014). *Climate change adaptation for smallholder farmers in rural communities: The case of Mkomazi sub-catchment, Tanzania* (Doctoral dissertation, Oldenburg-Carl von Ossietzky University of Oldenburg).

Ndlovu, E., Prinsloo, B., & le Roux, T. (2020). Impact of climate change and variability on traditional farming systems: Farmers' perceptions from south-west, semi-arid

Zimbabwe. *Jàmbá: Journal of Disaster Risk Studies*, *12*(1), 1-19. https://dx.doi.org/10.4102/jamba.v12i1.742

Ndlovu, S., Moyo, T., & Gwembere, I. (2018). Overcoming logistical constraints through sampling techniques in studying smallholder farmers. Journal of Rural Development and Agriculture, 6(2), 45-56.

Njiraini, G. W., et al. (2018). Factors influencing access to credit by smallholder farmers in Kenya: A case study of Kirinyaga County. Journal of Agricultural and Rural Development in the Tropics and Subtropics, 119(1), 77-88.

Nkongolo, N. V., Nkongolo, K. K., & Kabele, A. (2015). Evaluating the impact of farmer field schools on climate change adaptation capacity among smallholder farmers in the Republic of Congo. Weather and Climate Extremes, 9, 43-51.

Nkonya, E., Gerber, N., Baumgartner, P., von Braun, J., De Pinto, A., Graw, V., Kato, E., Kloos, J., Walter, T., & Zhang, Y. (2020). Understanding the perception and adoption of sustainable agricultural practices by smallholder farmers: Evidence from rural Tanzania and Uganda. Sustainability, 12(4), 1584-1605.

Nkonya, E., Gerber, N., Baumgartner, P., von Braun, J., De Pinto, A., Graw, V., Kato, E., Kloos, J., Walter, T., & Zhang, Y. (2018). Understanding the perception and adoption of sustainable agricultural practices by smallholder farmers: Evidence from rural Tanzania and Uganda. Sustainability, 10(5), 1417.

Nkonya, E., Mirzabaev, A., & von Braun, J. (2011). *Economics of land degradation and improvement*: A global assessment for sustainable development. Springer Science & Business Media.

Nyahunda, L., & Tirivangasi, H. M. (2019). Challenges faced by rural people in mitigating the effects of climate change in the Mazungunye communal lands, Zimbabwe. *Jamba (Potchefstroom, South Africa)*, *11*(1), 596. https://doi.org/10.4102/jamba.v11i1.596

Nyamangara, J., Mashingaidze, N., Masvaya, E. N., & Gotosa, J. (2019). *The potential of conservation agriculture in climate change adaptation in southern Africa*. Journal of Soil Science and Environmental Management, 10(4), 51-62.

Ochieng, J., et al. (2015). *Implications of climate change for sustainable agricultural production systems in Kenya*. Journal of Agricultural Science, 7(10), 81-93.

Ojo, T. O., & Baiyegunhi, L. J. S. (2020). *Determinants of climate change adaptation strategies and its impact on the net farm income of rice farmers in south-west Nigeria*. Land Use Policy, 95, 103946.

Parmesan, C., & Yohe, G. (2011). *A globally coherent fingerprint of climate change impacts across natural systems.* Nature, 421(6918), 37-42.

Pearson, D., & Newman, P. (2019). Climate security and a vulnerability model for conflict prevention: a systematic literature review focusing on African agriculture. *Sustain Earth* **2**(2). https://doi.org/10.1186/s42055-019-0009-6

Rahman, M. M., et al. (2018). *Farmers' perception of climate change and adaptation strategies in a climate hotspot*: A case from Bangladesh. International Journal of Disaster Risk Reduction, 28, 254-259.

Rahman, S., et al. (2020). Smallholder farmers' market participation and price premium for quality in Bangladesh. Journal of Agricultural Economics, 71(3), 677-697.

Remans, R., Remans, B., & Leigh, T. (2017). The Smallholder Farmers Alliance: Scaling up agricultural solutions to address food insecurity and climate change in Haiti. In R. Lal, B. Singh, D. K. Sharma, & A. K. Singh (Eds.), Soil Science and Agricultural Sustainability: Progress and Prospects (pp. 353-362). CRC Press.

Remans, R., Remans, B., & Leigh, T. (2017). The Smallholder Farmers Alliance: Scaling up agricultural solutions to address food insecurity and climate change in Haiti. In R. Lal, B. Singh, D. K. Sharma, & A. K. Singh (Eds.), *Soil Science and Agricultural Sustainability*: Progress and Prospects (pp. 353-362). CRC Press.

Republic of Congo Ministry of Agriculture. (2018). *National Agricultural Extension Service*. John Mike; Cambridge Univeresity.

Republic of Congo Ministry of Agriculture. (2019). *Agricultural Microfinance Program*. Night Bruce; UK.

Richard, B., Sivo, S. A., Orlowski, M., Ford, R. C., Murphy, J., Boote, D. N., & Witta, E. L. (2021). Qualitative Research via Focus Groups: Will Going Online Affect the Diversity of Your Findings? Cornell Hospitality Quarterly, 62(1), 32–45. https://doi.org/10.1177/1938965520967769

Rillo, M. R., & Alieto. O. (2018). Indirectness Markers in Korean and Persian English Essays: Implications for Teaching Writing to EFL Learners. Journal of English as International Language, 13(2.2), 165-184

Sarka, S., Woldeyohannes, D., & Woldesilasie, A. (2017). Value Chain Analysis of Cassava in Wolaita Zone, Snnpr, Ethiopia. *Journal of Economics and Sustainable Development*, *8*(5), 2222-1700.

Schulze, R. E., Maharaj, M., Jewitt, G. P., & Hill, T. R. (2019). Climate change impacts on water resources and agriculture in South Africa: A review. Physics and Chemistry of the Earth, Parts A/B/C, 111, 85-95.

Scoones, I. (2009). Livelihoods Perspectives and Rural Development. *Journal of Peasant Studies*, 36, 1

Singh, M., Singh, R., Singh, J., Singh, S., & Kumar, S. (2018). *Rice cultivation and climate change:* A review. International Journal of Current Microbiology and Applied Sciences, 7(12), 3784-3803.

Siziba, S., Mabhaudhi, T., & Modi, A. T. (2016). *Mulching effects on soil moisture content and maize productivity in Binga, Zimbabwe*. Physics and Chemistry of the Earth, Parts A/B/C, 91, 58-6

Smith, K. (2018). *Climate Change Impacts on Smallholder Farmers*: A Review. Journal of Agricultural Science, 10(6), 1-10.

Stringer, L. C., Fraser, E. D., Harris, D., Lyon, C., Pereira, L., Ward, C. F., & Simelton, E. (2020). Adaptation and development pathways for different types of farmers. *Environmental Science & Policy*, *104*, 174-189.

Tang, Q., Bennett, S. J., Xu, Y., & Li, Y. (2013). Agricultural practices and sustainable livelihoods: Rural transformation within the Loess Plateau, China. *Applied Geography*, 41, 15-23.

Tarchiani, V., Rossi, F., Camacho, J., Stefanski, R., Mian, K., Pokperlaar, D., Coulibaly, H. & Sitta Adamou, A. (2017). Smallholder Farmers Facing Climate Change in West Africa: Decision-Making between Innovation and Tradition. *Journal of Innovation Economics & Management*, 24, 151-176. https://doi.org/10.3917/jie.pr1.0013

Teferi, E., Mekonnen, K., & Ayalew, W. (2016). Farmers' participation in collective action for soil and water conservation in the northwest Ethiopian highlands. Land Use Policy, 50, 38-49.

Tesfaye, W., & Seifu, L. (2016). Climate change perception and choice of adaptation strategies: Empirical evidence from smallholder farmers in east Ethiopia. *International Journal of Climate Change Strategies and Management*.

Tshuma, N. & Mathuthu, T. (2014). 'Climate change in Zimbabwe: Perceptions of smallholder farmers in Mangwe District', *International Journal of Humanities and Social Studies* 2(5), 318-325.

UK Climate Change Risk Assessment. (2017). Evidence Report: Water Resources. Committee on Climate Change, London, UK.

UNFCCC. (2014, January). Report of the Conference of the Parties on its Nineteenth Session, held in Warsaw from 11 to 23 November 2013. In *United Nations Framework Convention on Climate Change*.

Unganai, L. & Murwira, A. (2010). *Challenges and opportunities for climate change adaptation among small-holder farmers in southeast Zimbabwe*, from https://www.researchgate.net/publication/26593071

UN-OCHA, 2015, *Response plan-Zimbabwe: Food insecurity, 2015*, OCHA, Harare

Valente, S., & Veloso-Gomes, F. (2020). Coastal climate adaptation in port-cities: Adaptation deficits, barriers, and challenges ahead. *Journal of Environmental Planning and Management*, *63*(3), 389-414.

Van den Broeck, G., Maertens, M., & Swinnen, J. F. (2017). Farmer organizations, collective action, and market access in Tanzania. World Development, 96, 198-213.

Van der Meulen, S., van den Brink, A., & van der Ploeg, J. D. (2019). *Climate change and coastal erosion*: Comparing the social impacts on farmers in the Netherlands and Bangladesh. Ocean & Coastal Management, 168, 127-135.

Van der Salm, C., van der Wal, T., & Bakker, J. C. (2018). Salinization of agricultural fields in coastal Friesland, the Netherlands: A case study. Acta Horticulturae, 1227, 43-50.

Van der Sluis, S., van der Meulen, S., & van den Brink, A. (2016). Climate change and saltwater intrusion in the province of Zeeland, the Netherlands: Assessing the impacts on agriculture. Agriculture and Human Values, 33(3), 651-664.

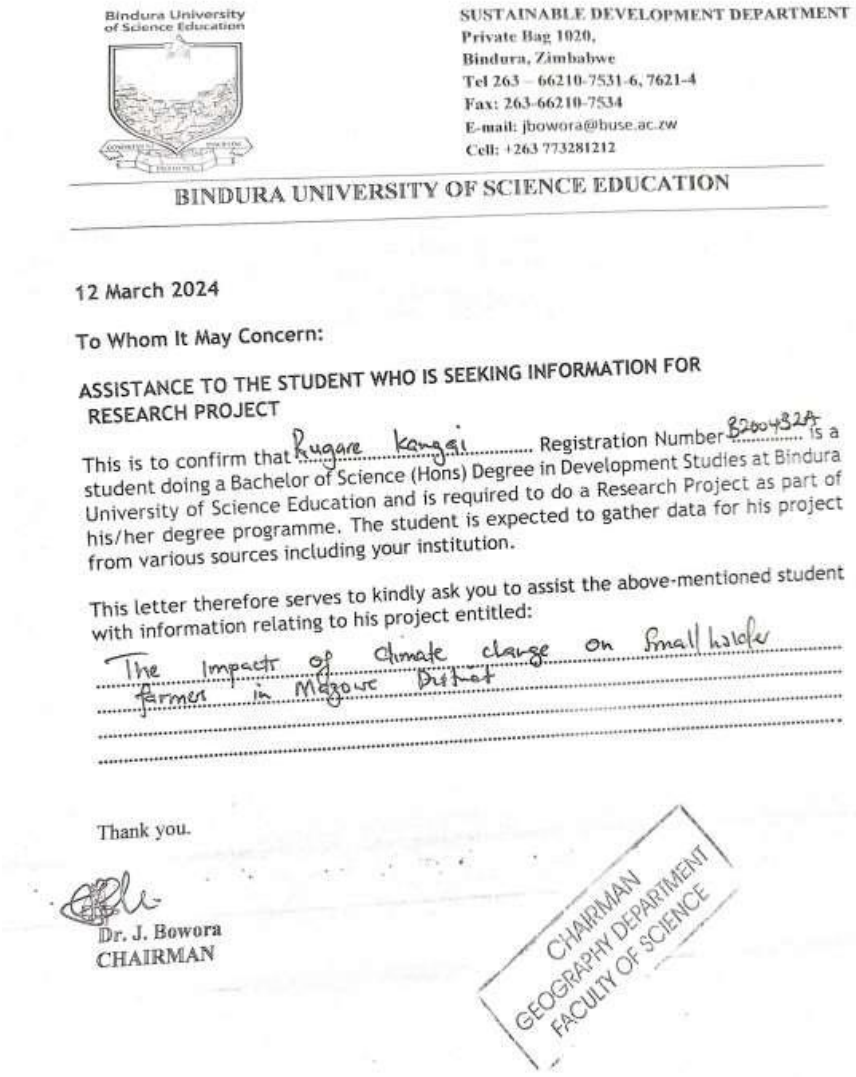
Van der Sluis, S., van der Meulen, S., & van den Brink, A. (2018). *Saltwater intrusion in the coastal province of Zeeland, the Netherlands*: Farmers' adaptation strategies and policy implications. Land Use Policy, 77, 12-21.

Ward, D., Kotze, I., & Engelbrecht, F. (2016). *The drivers of deforestation and degradation in the South African lowveld*: Stakeholder perspectives on policy and legislation. Land Use Policy, 57, 124-133.

Zhao Y, Fan J, Liang B, & Zhang L. *Evaluation of Sustainable Livelihoods in the Context of Disaster Vulnerability:* A Case Study of Shenzha County in Tibet, China. Sustainability, 11(10), 2874. https://doi.org/10.3390/su11102874

Zvinorova, P. I., et al. (2019). *Effects of Climate Change on Forage Availability and Utilization in Smallholder Livestock Systems in Zimbabwe*. Climate, 7(2), 30.

APPENDIX 1: LETTER FROM THE DEPARTMENT OF SUSTAINABLE DEVELOPMENT-BUSE



Bindura University of Science Education

SUSTAINABLE DEVELOPMENT DEPARTMENT
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BINDURA UNIVERSITY OF SCIENCE EDUCATION

12 March 2024

To Whom It May Concern:

ASSISTANCE TO THE STUDENT WHO IS SEEKING INFORMATION FOR RESEARCH PROJECT

This is to confirm that Rugare Kangai Registration Number B200432A is a student doing a Bachelor of Science (Hons) Degree in Development Studies at Bindura University of Science Education and is required to do a Research Project as part of his/her degree programme. The student is expected to gather data for his project from various sources including your institution.

This letter therefore serves to kindly ask you to assist the above-mentioned student with information relating to his project entitled:

The Impact of climate change on small holder farmers in Mazowe District

Thank you.

Dr. J. Bowora
CHAIRMAN

CHAIRMAN
GEOGRAPHY DEPARTMENT
FACULTY OF SCIENCE

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APPENDIX 2: HOUSEHOLD QUESTIONNAIRE FOR SMALLHOLDER FARMERS IN MAZOWE DISTRICT WARDS 8, 10 AND 12

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF SUSTAINABLE DEVELOPMENT

Dear respondent

Good morning/ afternoon, I am RUGARE KANGAI, an undergraduate student at Bindura University of Science Education pursuing towards attainment of a Bachelor of Science with Honors Degree in Sustainable Development. I am conducting a research on the **THE IMPACTS OF CLIMATE CHANGE ON SMALLHOLDER FARMERS IN MAZOWE DISTRICT, MASHONALAND CENTRAL PROVINCE, ZIMBABWE.** The study also hopes to provide information on best practices for the community, various stakeholders, and policymakers during this period of climate variability and change. You are warmly invited to voluntarily engage in this study. The information you enter is totally confidential, and your

personal details will be kept anonymous and secure. You may withdraw from this interview at any moment. May I ask you some few questions?

STUDY QUESTIONS

SECTION A: HOUSEHOLD CHARACTERISTICS

1. **Sex of Respondent**

   a) Female ☐ b) Male ☐

2. **Age in years**

   a) 18-24 ☐ b) 25-34 ☐ c) 35-44 ☐

   d) 45-54 ☐ e) 55-64 ☐ f) Above ☐

3.

Household status	**Response**
Husband	
Wife	
Daughter	
Son	
Grand	

4. How long have you been residing in this village? (Tick where applicable)

Period of stay	**Response**
0-10 years	
11-20 years	

21-30 years

31+ years

5. Family Size

a) 0-4 ☐ b) 11-12 ☐ c) 21-30 ☐

d) 9-10 ☐ e) Above 10 ☐

6. Age in years of family members. Please indicate number of members in given age group

a) 0-10 ——— b) 11-18 ——— c) 19-30 ———

d) 31-40 ——— e) 41-50 ——— f) Above 50 ———

SECTION B: CAUSES OF CLIMATE CHANGE IN WARD 12, MAZOWE DISTRICT

7. In your area what are the causes of climate change. Number them in order of importance in your household.

a) Deforestation ☐ b) burning of grass ☐ c) emission of gas ☐

d) Overgrazing ☐ e) lack of knowledge ☐

SECTION C: EFFECTS OF CLIMATE CHANGE IN WARD 12, MAZOWE DISTRICT

8. What do you think are the effects of climate change in your area?

a) Water scarcity ☐ b) low yield ☐ c) hunger ☐

d) Poverty ☐ e) Loss ☐ f) High temperatures ☐

g) Change of precipitation ☐

9. What do you think can be done to reduce the effects of climate change? ----------

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SECTION D: CHALLENGES TO ADAPT TO THE EFFECTS OF CLIMATE CHANGE BY SMALLHOLDER FARMERS.

10. What could be the challenges faced in adapting to the effects of climate change?

a) Lack of resources ☐ b) limited knowledge ☐

c) Lack of policy and institutional support ☐ d) ignorance ☐

11. what do you think can be done for smallholder farmers to overcome the challenges?-------
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12. What do you think is the role of the Ministry of Agriculture for smallholders to adapt to the climate change impacts?

The community members should ----------

The government should----------

The NGOs should----------

Others (please specify) ----------

APPENDIX 3: KEY INFORMANT INTERVIEW FOR AGRITEX OFFICERS IN MAZOWE DISTRICT WARDS 8, 10 AND 12

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF SUSTAINABLE DEVELOPMENT

Dear participant

Good morning/ afternoon, I am RUGARE KANGAI, an undergraduate student at Bindura University of Science Education studying towards attainment of a Bachelor of Science, Honors Degree in Development. I am carrying out a research on the **THE IMPACTS OF CLIMATE CHANGE ON SMALLHOLDER FARMERS IN MAZOWE DISTRICT, MASHONALAND CENTRAL PROVINCE, ZIMBABWE.** The research also intends to help the community, various stakeholders and policy-makers with information on best practices in this time of climate variability and change. You are kindly asked to freely

participate in this study. The information you provide is strictly confidential and your personal details will remain anonymous and protected. You are free to withdraw your participation from this interview at any time when you so wish. May I ask you some few questions?

1. What is your age?
2. How long have you been staying in the village?
3. What is your understanding of climate change concepts?
4. What do you think are the causes of climate change in the District?
5. What do you think are the effects of climate change to the smallholder farmers?
6. What are the challenges of smallholder farmers to adapt to the effects of climate change?
7. What are the improved strategies that can be done by stallholder farmers to adapt to the effects of climate change?

APPENDIX 4: KEY INFORMANT INTERVIEW FOR WEATHER STATION OFFICERS

Dear participant

Good morning/ afternoon, I am RUGARE KANGAI, an undergraduate student at Bindura University of Science Education studying towards attainment of a Bachelor of Science, Honors Degree in Development. I am carrying out a research on the **THE IMPACTS OF CLIMATE CHANGE ON SMALLHOLDER FARMERS IN MAZOWE DISTRICT, MASHONALAND CENTRAL PROVINCE, ZIMBABWE.** The research also intends to help the community, various stakeholders and policy-makers with information on best practices in this time of climate variability and change. You are kindly asked to freely participate in this study. The information you provide is strictly confidential and your personal details will remain anonymous and protected. You are free to withdraw your participation from this interview at any time when you so wish. May I ask you some few questions?

1. What are your understanding of climate change concepts?
2. Is there any climate change taking place in ward 12 of Mazowe District?
3. What do you think are the cause of climate change in the District?
4. What are the effects of climate change to the smallholder farmers?
5. What are the challenges of smallholder farmers to adapt to climate change effects?
6. What are the improved strategies?

APPENDIX 5: AN INTERVIEW GUIDE FOR MINISTRY OF AGICULTURE OFFICERS

Dear participant

Good morning/ afternoon, I am RUGARE KANGAI, an undergraduate student at Bindura University of Science Education studying towards attainment of a Bachelor of Science, Honors Degree in Development. I am carrying out a research on the **THE IMPACTS OF CLIMATE CHANGE ON SMALLHOLDER FARMERS IN MAZOWE DISTRICT, MASHONALAND CENTRAL PROVINCE, ZIMBABWE.** The research also intends to help the community, various stakeholders and policy-makers with information on best practices in this time of climate variability and change. You are kindly asked to freely participate in this study. The information you provide is strictly confidential and your personal details will remain anonymous and protected. You are free to withdraw your participation from this interview at any time when you so wish. May I ask you some few questions?

1. What is the role of department in terms of climate change for smallholder farmers?
2. What are the officers understanding of the concept of climate change?
3. What do you think are the causes of climate change in the District?
4. What are the effects of climate change to smallholder farmers?
5. What are the challenges of smallholder farmers to adapt to climate change effects?
6. What are the improved strategies that can be done by smallholder farmers to adapt to the effects of climate change?

APPENDIX 6: AN INTERVIEW GUIDE FOR FOCUS GROUP DISCUSSION FOR SMALLHOLDER FARMERS

Dear participant

Good morning/ afternoon, I am RUGARE KANGAI, an undergraduate student at Bindura University of Science Education studying towards attainment of a Bachelor of Science, Honors Degree in Development. I am carrying out a research on the **THE IMPACTS OF CLIMATE CHANGE ON SMALLHOLDER FARMERS IN MAZOWE DISTRICT, MASHONALAND CENTRAL PROVINCE, ZIMBABWE.** The research also intends to help the community, various stakeholders and policy-makers with information on best practices in this time of climate variability and change. You are kindly asked to freely participate in this study. The information you provide is strictly confidential and your personal details will remain anonymous and protected. You are free to withdraw your participation from this interview at any time when you so wish. May I ask you some few questions?

1. What is your age?
2. What is your duration of stay in the village?
3. What is your understanding of climate change concepts?
4. What do you think are the causes of climate change in the District?
5. What do you think are the effects of climate change to the smallholder farmers?
6. What are the challenges of smallholder farmers to adapt to the effects of climate change?
7. What are the improved strategies that can be done by stallholder farmers to adapt to the effects of climate change?