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GENDERED DIMENSIONS OF CLIMATE CHANGE ADAPTATION PRACTICES AND LIVELIHOOD SUSTAINABILITY OF SMALLHOLDER FARMING HOUSEHOLDS IN THE GOROMONZI DISTRICT OF ZIMBABWE

BY

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DECLARATION

I hereby declare that this thesis is the result of my independent investigation undertaken with meticulous supervision. I have consulted and used other scholarly works which have been duly acknowledged. I confirm that this thesis is original and has never been submitted, in part or whole, to the University of Ghana or any other institution for the award of an academic degree.

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ABSTRACT

The global climate crisis is causing devastating effects across different facets of human life, including agriculture. Zimbabwe is among the countries dealing with extreme weather events, including droughts, cyclones, crop diseases, and erratic rainfall, all of which have severely impacted the smallholder agriculture sector. Despite the economic importance of this sector in the country, its vulnerability has been further worsened by economic decline and political instability. These circumstances have endangered the viability and sustenance of smallholder farmers' livelihoods in the country. Smallholder farmers have been actively implementing measures to counteract the adverse effects of climate change and safeguard their livelihoods. However, several factors impede the adaptation process, including inequalities related to resource access and control as well as decision-making power between men and women farmers. While existing research has explored climate change adaptation, it falls short in addressing the gendered dimensions of climate change adaptation. Focusing on the gendered dynamics of adaptation is crucial because varied adaptation measures result in varied outcomes for men and women farmers and male-headed and female-headed households. The adaptation outcomes also contribute to the livelihood sustainability of farming households, which is also overlooked in adaptation research. This study adopts a mixed-method approach and integrates concepts from the feminist political ecology and the sustainable livelihood framework to examine how gender related factors influence climate change adaptation and livelihood sustainability in smallholder farming households in Zimbabwe, specifically focusing on Ward 11 in the Goromonzi District. With the aim of contributing to existing knowledge in development studies, the study examined the differentiated climate change perceptions among smallholder farmers in Ward 11, asset ownership patterns in male-headed and female-headed smallholder households and their influence on the adaptation behaviours and livelihood sustainability of these households. A household survey was used to obtain quantitative data

from 256 smallholder households using the computer-assisted personal interviewing tool (CAPI). For the qualitative data, thirteen in-depth interviews with household heads (seven males and six females) and six key informant interviews from extension officers (1), Environmental Management Agency officers (2), Farmer's Union representatives (1) and village headmen (2) were used. The quantitative data analysis used STATA version 14.0 and involved descriptive statistics (frequencies and chi-square tests) and the Poisson and Ordinary Least Square regressions (OLS) for count and continuous variables, respectively. The qualitative data underwent thematic analysis to identify and analyse patterns within the data. The findings highlighted that while climate change perceptions were consistent across all smallholder farmer groups in Ward 11, the experiences of the phenomenon differed based on household attributes such as gender and age. The study revealed that smallholder households had physical, natural, social, human, and financial capital at their disposal, but the ownership patterns differed between male-headed and female-headed households. Three household categories were identified based on asset endowment; low-asset, medium-asset and high-asset households. Predominantly, households categorised as low-asset comprised both male-headed and female-headed households, those headed by elderly farmers (60+ years), extended households, and households with heads who had no formal education. Moreover, the study identified various strategies employed by smallholder households in Ward 11 to manage climate change effects on their livelihoods. However, the implementation of these strategies varied by the gender and age category of the household head, and asset endowment of the household. The intensity of households' implementation of adaptation strategies was determined by household size, physical capital, financial capital, the age category of the household head, community involvement, indigenous knowledge and access to extension services, as shown by the Poisson regression results. Furthermore, the results from an OLS regression revealed that implemented adaptation strategies are strong predictors of household

livelihood sustainability, as measured by a composite livelihood sustainability index. Other determinants of household livelihood sustainability in the study area included household per capita income, presence of children dependents (6-17 years), households' migration status and household type (nuclear or extended). Notably, adaptation strategies dominant in male-headed and female-headed households contributed to their livelihood sustainability. The study has therefore highlighted the linkages between asset ownership, adaptation, and livelihood sustainability in male-headed and female-headed smallholder farming households. It has highlighted the role of gender in shaping these dynamics and has shown that asset ownership, adaptation behaviours and livelihood sustainability are gendered in Ward 11 of the Goromonzi district. Based on the findings, recommendations are suggested that the government, in collaboration with other stakeholders such as the Farmers' Union, the Agriculture Technical and Extension Services Department, and local non-governmental organisations support both male and female farmers, with alternative and sustainable income-generating opportunities and other resources to stimulate their adaptive capacities and bridge gender disparities. Tailoring adaptation strategies to suit the unique characteristics of households can enhance their capacities and contribute to improved livelihood sustainability.

DEDICATION

To God Almighty and my family

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LIST OF ABBREVIATIONS

AGRITEX	Agriculture Technical and Extension Services
AER	Agroecological Regions
CAPI	Computer-Assisted Personal Interviewing
CLSI	Composite Livelihood Sustainability Index
DFID	Department for International Development
FTLRP	Fast Track Land Reform Programme
FPE	Feminist Political Ecology
FAO	Food and Agriculture Organisation
GoZ	Government of Zimbabwe
IPCC	Intergovernmental Panel on Climate Change
LSCFs	Large-Scale Commercial Farms
NGOs	Non-Governmental Organisations
OLS	Ordinary Least Square regression
ORAs	Old Resettlement Areas/Schemes
PCA	Principal Component Analysis
SSCFs	Small-Scale Commercial Farms
SDGs	Sustainable Development Goals
SLF	Sustainable Livelihood Framework
WCED	World Commission on Environment and Development
ZDHS	Zimbabwe Demographic and Health Survey
ZimStat	Zimbabwe National Statistics Agency
ZRP	Zimbabwe Republic Police
ZSAPS	Zimbabwe Smallholder Agriculture Productivity Survey
ZimVac	Zimbabwe Vulnerability Assessment Committee

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Climate change is undoubtedly one of humanity's greatest threats, with devastating consequences. The phenomenon has affected countries and regions around the world differently, with some developing countries in Africa, Asia, and Latin America being the most affected (Intergovernmental Panel on Climate Change (IPCC), 2014; 2007). Zimbabwe is no exception, climate predictions for the country show a temperature increase of 2.5 degrees Celsius by 2070, accompanied by a decrease in rainfall of about six per cent (Zimbabwe Statistical Services, Zimstat, 2018). The E1 Nino Southern Oscillation (ENSO) conditions in the Pacific Ocean have been associated with the droughts, climate variability, and other extreme weather conditions experienced in the country (Brown et al., 2012; Frischen et al., 2020; Hulme et al., 2001; Tadross et al., 2005). The E1 Nino is a periodic inter-annual oscillation in the tropical Pacific's sea surface temperature (SST) and sea level air pressure (Nicholls, 2015).

According to historical data, the climate in Zimbabwe showed a warmer trend at the close of the twentieth century (Chamaillé-Jammes et al., 2007; Government of Zimbabwe GoZ [Ministry of Environment Water and Climate], 2015; Hulme et al., 2001; Ndlovu & Mjimba, 2021). Hulme et al. (2001) suggest that the dry seasons have witnessed the most significant warming. Researchers have pointed out that Zimbabwe is a drought-prone country, and its vulnerability is increasing with drought occurring every two to three years (Chagutah, 2010; Chamaillé-Jammes et al., 2007; Hulme et al., 2001; Obert Jiri et al., 2017; Mazvimavi, 2010; Mutekwa, 2009; Muzari et al., 2014; Ndlovu & Mjimba, 2021). The number of climate-related natural disasters, including droughts, floods, storms and pests and diseases, continue to increase

(Frischen et al., 2020; World Bank, 2019). In particular, the Fall Army Worm and Tuta Absoluta (South American tomato pinworm) outbreaks have increased and caused great damage to crops and livestock (GoZ [Ministry of Lands, Agriculture & Rural Resettlement], 2018).

The droughts experienced in the country, with particular reference to the 2015/16 and 2018/19 cropping seasons, left many Zimbabweans impoverished (Zimbabwe National Statistics Agency (Zimstat), 2019). Tropical cyclone Idai, which hit Zimbabwe and other Southern African countries in 2019, worsened the situation. Government records indicate that around 2.8 million people experienced food insecurity due to the disaster. Agricultural output decreased by five per cent, resulting in food shortages (Zimstat, 2019). Scholars have argued that crop failures, for example, have occurred in three out of every five years in the semi-arid areas of the country, which aligns with drought predictions (Chagutah, 2010; Hulme et al., 2001).

Smallholder farmers have been particularly affected as a result of their over-reliance on rain-fed agriculture (Zimstat, 2019). Zimbabwean smallholder farmers are those farmers in communal areas, resettled small-scale areas and small-scale commercial areas who own less than thirty-five hectares of land (Mutami, 2015). These farmers account for nearly all of the country's farmers (Brown et al., 2012; Zimstat, 2019) and mainly engage in a traditional mixed crop-livestock production (Wani et al., 2009). Available statistics show that there are approximately 1.3 million smallholder farmers countrywide (Scoones et al., 2011) who occupy almost 70 per cent of agricultural land after the inception of the land redistribution programme (Zimstat, 2019).

The smallholder sector in Zimbabwe is widely recognised as a key contributor to the country's economy (Zimstat, 2012). Given that nearly 61 per cent of Zimbabwe's population lives in

rural areas and derives its livelihoods from agriculture and other natural resources, this raises questions about food security and sustainability of livelihoods (Brown et al., 2012; Zimstat, 2022). Climate change impacts on smallholder agriculture warrant adaptation to counteract the negative effects and safeguard livelihoods. The Inter-governmental Panel on Climate Change (IPCC, 2007) recognises adaptation as "adjustments in ecological, social, and economic systems in response to existing or anticipated climatic stimuli, and their effects or impacts, which mitigates harm or exploits advantageous possibilities". The changes or adjustments adopted are expected to reduce regions, communities and household vulnerability to the impacts of climate change and build resilience (IPCC, 2007; Mwasha & Robinson, 2021).

In Zimbabwe, climate change adaptation and livelihood sustainability have been hampered by unfavourable socioeconomic conditions that have prevailed in the last two decades. Financial bottlenecks such as high inflation and severe exchange rate volatility have contributed to the country's vulnerability (GoZ, 2018). Additional social inequalities, gender relations and roles, and land tenure and inheritance systems have compounded the vulnerability of smallholder farmers in the country, limiting their ability to adjust to the effects of climate change and build resilience (Brown et al., 2012; GoZ, 2018).

Growing research has shown that the adaptation process is gendered and yields different outcomes for male and female farmers (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Assan et al., 2020; Mersha & Van Laerhoven, 2016; Wrigley-Asante et al., 2017). This is because men and women can experience climate change differently, resulting in varied response strategies. This underscores the importance of gender analysis in climate change adaptation and livelihoods sustainability. Gender analysis, as an analytical framework, incorporates information about males and females regarding their roles, responsibilities, access to and control of resources, and opportunities, along with the power structures that govern their

relationships (Diiro et al., 2016). It also encompasses other social variables such as ethnicity, social class, and age (A. Ahmed et al., 2016). Gender constructions tend to influence males' and females' access to critical resources necessary for their development, leading to gendered vulnerabilities.

Researchers have argued that often, the two groups have varying levels of access to and control over the resources necessary for managing climate change due to gender relations, ingrained cultural norms and beliefs and political discrimination (S. Ahmed & Kiester, 2021; Mersha & Van Laerhoven, 2016; Vincent & Cull, 2010; Wrigley-Asante et al., 2017). For example, some studies have established that in many African countries, women farmers have fewer resources than male farmers in terms of land and other productive resources, which has contributed to their vulnerability and limited adaptive capacities (Assan et al., 2020; Autio et al., 2021; Azong et al., 2018; Goh, 2012; Jost et al., 2016; Mersha & Van Laerhoven, 2016; Nyantakyi-Frimpong, 2020; Yaro et al., 2015). The different responsibilities and roles of men and women farmers influence how vulnerable their activities and households are to climate change impacts and how they respond.

Climate change impacts may aggravate already existing gender inequalities. Therefore, understanding the gendered dimensions of adaptation and livelihood sustainability is critical. To begin with, taking gender into account is essential for developing initiatives to address gender disparities in climate change management, particularly within different farming households (Assan et al., 2018; Codjoe & Owusu, 2011; Yaro, 2013). Also, women are increasingly assuming household headship in most developing countries, and they have different access to and control over resources than male-headed households (Nelson, 2011), which results in differing adaptation preferences and arrangements at the household

level and consequently, different livelihood outcomes (Carr & Thompson, 2014; Mersha & Van Laerhoven, 2016).

Acknowledging and addressing the gendered dimensions of climate adaptation can contribute towards livelihood resilience and, ultimately, the attainment of the United Nation's Sustainable Development Goals (SDGs) (United Nations Climate Change Secretariat, 2017). This is true because adaptation and livelihood sustainability are interlinked. Farming households that adopt climate-resilient practices and diversify income are more likely to withstand climate change impacts and maintain sustainable livelihoods.

1.2 Problem Statement

Despite the significant contribution of the smallholder farming sector to economic growth and food security in Zimbabwe, it has been facing increasing impacts from climate change, necessitating adaptation (Zimstat, 2019). However, the adaptation process is constrained by various factors related to resource access, institutional support and cultural prescriptions among others (S. Ahmed & Kiester, 2021; Mersha & Van Laerhoven, 2016). Moreover, the sector's vulnerability has been exacerbated by political instability, a struggling economy and the long-standing HIV/AIDS pandemic (Zimstat, 2019). Climate change adaptation is critical in ensuring livelihood sustainability and achieving positive outcomes such as food security, improved well-being, and increased income for farmers. However, social inequalities related to resource access, land tenure and inheritance systems, gender roles and relations (Brown et al., 2012; GoZ, 2018) pose challenges for male and female farmers in effectively managing climate change impacts and securing their livelihoods.

So far, existing studies in smallholder communities have primarily focused on climate perceptions, and adaptation practices, exploring the linkages between climate change impacts,

vulnerability, and adaptation practices. These studies have been conducted in various countries, including Ethiopia, Nigeria, Zimbabwe, Kenya, Mali, Tanzania, and the Democratic Republic of Congo (Abidoye et al., 2017; Ayal & Leal Filho, 2017; Balasha et al., 2023; Diarra et al., 2021; Faisal et al., 2021; Funk et al., 2020; Habtemariam et al., 2016; Issa et al., 2015; Kaganzi et al., 2021; Mafongoya P, 2015; Musakwa et al., 2020; Mutandwa et al., 2019). The researchers examined perceptions of climate change and variability, its negative effects on farming portfolios specifically, crop and livestock production, and the factors influencing these perceptions. They also explored how climate change perceptions inform adaptation decisions and behaviours.

Other studies on climate change adaptation have largely focused on adaptation measures implemented by smallholder farmers to counteract climate change impacts on their livelihoods but did not necessarily focus on the gendered dimensions (e.g. Asante et al., 2021; Atube et al., 2021; Autio et al., 2021; Diarra et al., 2021; Dick-Sagoe et al., 2022; Eyasmin et al., 2021; Kalele et al., 2021; Yiridomoh et al., 2020). In Zimbabwe, research in this field has also been largely on climate change adaptation (e.g. Asare-Nuamah et al., 2022; Chingombe & Musarandega, 2021; Dube et al., 2018; Makuvaro et al., 2018; Mushore et al., 2021; Mutandwa et al., 2019) without much attention to gendered adaptation and livelihood sustainability. While some of the research has incorporated a gender analysis (e.g. Adzawla et al., 2019; S. Ahmed & Kiester, 2021; Antwi-Agyei & Nyantakyi-Frimpong, 2021; Assan et al., 2018; Mensah et al., 2022; Wrigley-Asante et al., 2017), it often falls short in explaining how gendered adaptation influences livelihood sustainability. There is a need to go beyond exploring gender perspectives and adaptation strategies to understand the outcomes of gendered adaptation in relation to livelihood sustainability.

In terms of farmers' livelihood sustainability, the available studies have predominantly been carried out in Asian countries such as China, India, Bangladesh, and Nepal (e.g. Ahmadpour et al., 2020; He & Ahmed, 2022; C. Zhang & Fang, 2020; Q. Zhang et al., 2019) with limited attention given to smallholder farmers in sub-Saharan Africa. Livelihood sustainability is important for consideration because strengthening farmers' livelihoods is key to achieving sustainable development. Also, gendered adaptation is critical to development and livelihood sustainability, necessitating further research to advance knowledge in this field. Such research should consider the outcomes of gendered adaptation strategies and their implications for farmers' overall well-being and sustainable livelihoods.

Therefore, this study contributes to existing scholarship by examining the gendered nature of climate change adaptation and livelihood sustainability prospects in smallholder farming households in the Goromonzi district of Zimbabwe. The study seeks to expand on current research by exploring the relationship between asset ownership, adaptation strategies and livelihood sustainability in male-headed and female-headed farming households. It recognises the importance of understanding how gender influences access to and utilisation of assets and the implications of these gendered dynamics on households' ability to adapt to climate change and achieve sustainable livelihoods.

1.3 Significance of the Study

This research is significant in the context of rural Zimbabwe, where over 60 per cent of the population lives, and engages in various livelihood activities (Zimbabwe Vulnerability Assessment Committee (ZimVac), 2020). The study focuses on the gendered dimensions of climate change adaptation for sustainable livelihoods in Zimbabwe's smallholder agricultural sector. This study's findings are expected to significantly contribute to gender, climate change adaptation and livelihood sustainability scholarship.

Overall, the study seeks to make two major contributions. The findings from this study have the potential to generate academic debates by analysing gender in the context of climate change, adding to the increasing body of knowledge in development studies. This could lead to a more nuanced understanding and appreciation of the complex relationship and interactions between gender, climate change adaptation and sustainable livelihoods. This move will once again bring to light the various manifestations of and reasons for gender disparities in climate change adaptation, as well as the implications for sustainable livelihoods.

Climate change's long-term effects are likely to negatively affect livelihoods, quality of life, and environmental sustainability directly and indirectly (Bob & Babugura, 2014). Boosting smallholder farmers' capacities for enhanced agricultural productivity and long-term livelihoods aligns with the Sustainable Development Goals (SDGs) and Agenda 2063 (The Africa, We Want). These two initiatives provide countries with frameworks for development to improve quality of life, inclusive growth, and long-term development. Of particular significance are SDGs 1 (No Poverty), 2 (Zero Hunger) and 5, (Achieve gender equality and empower all women and girls) and Agenda 2063 goal 17 (full gender equality in all spheres of life), which seeks to achieve gender equality and empower all women and girls with equal access to economic resources, ownership and control over land and other forms of property, financial services, inheritance, and natural resources in accordance with national laws to achieve accelerated sustainable development. In developing countries like Zimbabwe, the attainment of SDGs 1, 2 and 5 and Agenda 2063 goal 17 is critical for sustainable development. This study's findings can provide a basis for governments to develop programmes and strategies to address gender inequality, improve food security and promote women's empowerment by considering them as key agents and leaders of development initiatives.

Additionally, findings from this study could provide relevant information to policymakers by highlighting the various ways in which climate change affects individuals and social groups. This could help drive evidence-based micro level-interventions to aid climate change adaptation and enhance food security and sustainable livelihoods in Zimbabwe and Africa.

1.4 Main Research Question

How does gendered adaptation influence the sustainability of livelihoods in smallholder households in the Goromonzi District of Zimbabwe?

1.4.1 Specific Research Questions

- What are smallholder farmers' perceptions and experiences of the vulnerability context?

The sub-questions explored under this were: What signs of climate change have smallholder farmers observed in the last five to ten years? Are these perceptions differentiated by gender? How have the observed climate change signs affected farmers' livelihoods and household well-being? Are these effects gendered?

- What is the asset ownership patterns in smallholder farming households?

The explored sub-questions were: What assets do smallholder farming households have? Is the ownership of these assets differentiated by the gender of the household head?

- What is the relationship between adaptation systems and the sustainability of smallholder households' livelihoods?

These sub-questions were asked under this broad question: What adaptation practices are smallholder farming households implementing? How is the implementation of these practices gendered? What are the outcomes of the selected adaptation practices in male-headed and female-headed households? How do these adaptation practices influence the sustainability of livelihoods in farming households?

1.5 Main Research Objective

The overarching objective of the research is to explore the gendered character of climate change adaptation and the sustainability of smallholder farming households in the Goromonzi district of Zimbabwe. This would expand knowledge and contribute to discussions of policy alternatives and interventions that enhance the sustainability of smallholder livelihoods.

1.5.1 Specific Objectives

- To understand the differentiated climate change perceptions in male-headed and female-headed smallholder farming households.
- To ascertain asset ownership patterns in male-headed and female-headed smallholder households.
- To examine smallholder farmers' adaptation practices and their implications for the long-term livelihood sustainability of their households

1.6 Operational Definitions

Gender: Refers to norms, behaviours and roles that cultures and societies consider appropriate for men and women and boys and girls.

Gendered adaptation: In this context, refers to the different ways in which male and female heads of farming households cope with and adapt to climate change effects on their livelihoods and is shaped by gender norms, resource access and differential climate change impacts.

Male heads of farming households: These are adult males, who are single or married/cohabiting, or are widowed and serve as the main decision-makers in the household.

Female heads of farming households: These are adult females who are single or married/cohabiting (with husband/partners absent for most of the calendar year) or are widowed and serve as the main decision-makers of the farming household.

Livelihood sustainability: The ability of farming households to adapt to or cope with climate change effects in order to enhance/secure their human, natural, physical, financial and social assets.

Household: Is defined according to the Zimbabwe Demographic and Health Survey as a person or group of related and unrelated persons, who live together in the same dwelling unit(s), acknowledge one adult male or female as the head of the household, share the same housekeeping arrangements, and are considered a single unit (Zimbabwe National Statistics Agency [Zimstat], 2016).

1.7 Structure of Thesis

This chapter has set the context by providing a brief background on climate change impacts, adaptation, and livelihood sustainability. The problem under inquiry, including the research questions and objectives of the study, were presented. In Chapter Two literature review and theoretical approaches that explain climate change perceptions, adaptation decisions and behaviours and livelihood sustainability are presented. The chapter provides a comprehensive overview of existing studies and theoretical frameworks that contribute to understanding the gendered nature of climate change adaptation practices and livelihood sustainability of smallholder households in Zimbabwe. The chapter introduces and discusses two theoretical frameworks that underpin the study; the Sustainable Livelihood Framework (SLF) and feminist political ecology theory (FPE). The chapter concludes by presenting the conceptual framework, which integrates the SLF and FPE theory and offers concluding remarks.

Chapter Three presents the methodological approach for the study. It begins by briefly describing the study area, emphasising its appropriateness and relevance for the research. The research approach, sampling and sample size, and methods of data collection and analysis are detailed. A discussion on ethical considerations follows, highlighting the steps taken to ensure

the rights and well-being of study respondents. The last section of the chapter explains the problems encountered in the field and how they were addressed.

Chapter Four presents the empirical findings on farmers' experiences and perceptions of climate change in Ward Eleven of the Goromonzi District. The chapter begins by presenting the sociodemographic characteristics of the studied farming households. Farmers' awareness of climate change is discussed, followed by attributed causes and effects on farming households' livelihoods to set the tone for the need for adaptation. Finally, the chapter provides conclusions with key insights drawn from the chapter.

Chapter Five profiles assets and ownership patterns in male-headed and female-headed households. The discussion on asset ownership is structured around the SLF's livelihood pentagon of capitals (human, natural, financial, physical, and social) necessary for livelihood sustainability. Subsequently, the farming households are characterised and classified into three groups referred to as low, medium, and high asset endowed households. The chapter concludes by summarising and synthesising the findings.

Chapter Six discusses adaptation practices prevailing in male-headed and female-headed households, the constraints farmers face and the determinants of farmers' adaptation decisions and behaviours. This is followed by a discussion on livelihood sustainability, particularly focusing on significant livelihood outcomes such as food security and household income. Households are assessed on their performance based on a Composite Livelihood Sustainability Index (CLSI) developed by the researcher in line with methods by other researchers. The determinants of livelihood sustainability in the study area are assessed, with implemented adaptations, food security and household income as key independent variables. The last section of the chapter offers conclusions in light of the chapter's findings and discussions.

Chapter Seven serves as the concluding chapter of the thesis, summarising the entire research. It provides an overview of the theoretical relevance, methodological approach, findings, concluding remarks, recommendations, and contribution of the thesis to knowledge. The last section of the chapter suggests potential areas for further research.

CHAPTER TWO

LITERATURE REVIEW, THEORETICAL CONSIDERATIONS AND CONCEPTUAL FRAMEWORK

2.1 Introduction

The examination of literature within the context of climate change is presented in this chapter. The chapter begins with a section on farmers' perspectives on climate change focusing specifically on awareness, experienced shocks and stressors, sources of climate information and causal attribution. The key question in this section is; Are climate change perspectives differentiated by gender and other socioeconomic variables such as age and education level? Next, empirical evidence on the debates about gendered vulnerability and adaptation is presented, taking into account the adaptation pathways and resources. This is followed by a discussion on constraints, highlighting issues relating to access, use and control over resources necessary for adaptation. Attention is then shifted to the question of livelihood sustainability, its measurement and applicability in ascertaining the sustainability of farming households. The literature review ends with a section on the study's theoretical foundations. The FPE and SLF are discussed, and a conceptual framework is offered, along with its suitability and relevance to the study. Lastly, a summary and conclusions are provided for the chapter.

2.2 Farmers' Perceptions and Experiences of Climate Change

Farmers' behaviours and attitudes towards climate change are influenced and shaped by their perceptions of the phenomenon. These perceptions have long been linked to implementing mitigative strategies to counteract the adverse effects of climate change and variability (Asrat & Simane, 2017; Deressa et al., 2009; Maddison, 2007). Hasan and Kumar (2019) assert that several questions are worth reflecting on when considering how farmers or other individuals

perceive climate change. Can farmers, for instance, actually be able to witness or monitor climate change? How do individuals react to climate-related (formal or informal) investigations, given the long-term manifestation of the phenomenon, while they may only have short-term experiences? Lastly, given that atmospheric change is a long process that can only be observed with meteorological apparatus, can people notice environmental changes based solely on memories? Thinking and reflecting on these questions has offered researchers an entry point to understanding how farmers perceive, interpret and manage climate change.

Research has shown that perceptions of climate change by farmers matter in shaping their adaptation decisions and behaviours (Asante et al., 2021; Baffour-Ata et al., 2021; Diarra et al., 2021; Dick-Sagoe et al., 2022; Faisal et al., 2021; Hassan & Nhemachena, 2008; Mafongoya P, 2015; Mensah et al., 2022; Mutandwa et al., 2019; Rishikesh Pandey, 2020; Teye et al., 2015; Yiridomoh et al., 2020). Farmers are at the centre of perception debates for a number of reasons; first, their primary source of income is innately vulnerable to climate-related changes, making them more concerned about the issue than non-farmers (Niles & Mueller, 2016). Second, they are also more likely to notice local changes and effects (Howe & Leiserowitz, 2013) because they closely interact with day-to-day weather conditions. This makes their perceptions crucial and provides the motivation to take action in the fight against climate change (Leiserowitz, 2006; Mafongoya P, 2015).

Even though farmers are at the centre of perception studies, evidence shows that not all farmers will perceive and comprehend climate change similarly (Mutandwa et al., 2019; Onwuemele, 2018; Rishikesh Pandey, 2020). Nonetheless, studies in Zimbabwe, Ghana, and Mali have shown that farmers are highly acclimatised to the local climate (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Balasha et al., 2023; Diarra et al., 2021; Mensah et al., 2022; Mutandwa et al., 2019). Mensah et al. (2022) observed that male and female farmers in their study area in

Ghana were well aware of climate change and its impacts on their livelihoods. Conversely, other studies (Onwuemele, 2018) detailed a lack of comprehension and awareness of climate change among farmers. Such evidence from research is significant because it shows that farmers' initiation of adaptive measures hinge on their ability to recognise that the climate has changed (Hassan & Nhemachena, 2008; Mafongoya P, 2015).

Researchers have linked several socioeconomic, demographic, and institutional factors, including gender, age and education, to how farmers perceive, comprehend and interpret climate change (Asante et al., 2021; Assan et al., 2020; Dang et al., 2019; Kaganzi et al., 2021; Rishikesh Pandey, 2020; Teye et al., 2015). In terms of gender, arguments about how it shapes perceptions have emanated from various viewpoints. Liu et al. (2014) believe that men are more attuned to the scientific dimensions of society, while women concern themselves with environmental issues that threaten their families and communities, accounting for the differences in climate change perceptions. Notwithstanding its plausibility, this idea must be treated cautiously because it feminises environmental issues. Women are increasingly getting exposed to the scientific community due to technological advancements and other developments. This has led to an increase in their capacity to contribute to discussions about climate change, suggesting that gender as a variable in analysing climate change perceptions may be irrelevant.

Regardless of these arguments, the role of gender in shaping climate change perceptions remains debated, as some studies have found significant links while others did not. For example, studies by Diarra et al. (2021) and Pandey (2020) in Mali and Nepal, respectively, found that the gender of the farmer had no significant links with the construction of climate change perceptions. Other studies equally reported no gender differences in the observed patterns of climate change (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Asante et al., 2021;

Assan et al., 2020; Chidakwa et al., 2020; Diarra et al., 2021; Mensah et al., 2022; Rishikesh Pandey, 2020). In these studies, male and female farmers noticed similar trends in weather patterns. These studies seem to suggest that perceptions of patterns of change do not necessarily differ between male and female farmers, although the impacts experienced by each group may differ considerably. The ability of both genders to identify similar indicators of change suggests that these changes are the main drivers altering their major livelihood activity (Pandey, 2020).

Divergent views from other studies (e.g. Teye et al., 2015) have suggested a relationship between the gender of the farmer and climate change awareness. The main argument for this is that there is unequal distribution of labour between the sexes in farming households in terms of the activities they engage in which results in differing perceptions (Teye et al., 2015). In Northern Ghana, Teye et al. (2015) found that men were more likely than women to observe changes in the climate. According to the researchers, even though both genders farmed, some women considered farming a secondary activity, making them less interested in climate change (Teye et al., 2015).

The patterns of change often observed by farmers vary and may occur over a period of time. Recent observations in Ghana, Lesotho, Kenya, the Democratic Republic of Congo and Zimbabwe highlight several patterns of climate change often reported by farmers. The changes include rainfall variations (decreased rainfall, early or late cessation, delayed onset of rainy seasons), temperature changes (high and low), frequent droughts, strong winds, reduced vegetation cover, the loss of wetlands, increased disease and pest infestations, water stress and declines in wild animal and migratory bird populations (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Asante et al., 2021; Assan et al., 2020; Baffour-Ata et al., 2021; Balasha et al., 2023; Diarra et al., 2021; Dick-Sagoe et al., 2022; Faisal et al., 2021; Issa et al., 2015; Kalele et al.,

2021; Makuvaro et al., 2018; Mensah et al., 2022; Mutandwa et al., 2019; Rishikesh Pandey, 2020; Teye et al., 2015; Yaro, 2013; Yiridomoh et al., 2020). These observed climate change events provide substantial evidence that farmers are indeed noticing changes in the climate across different countries, which have shaped their adaptation trajectories. Moreover, many of the observed changes align with scientific evidence (Hasan & Kumar, 2019; Teye et al., 2015) and their validity can be verified using national and global climate change data.

2.2.1 Perceptions about the Effects of Climate Change on Farmers' Livelihoods

Farmers may construct climate change perceptions based on the impacts they have experienced on their livelihoods. These impacts affect farming households' ability to fight climate change and sustain desirable well-being, including food security and poverty alleviation (Issa et al., 2015; Teye et al., 2015). The dependency of farmers on rain-fed agriculture and other natural resources will render them more vulnerable. Several researchers have contributed to the literature on the effects of climate change, specifically focusing on how they have affected farmers' livelihoods (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Assan et al., 2020; Baffour-Ata et al., 2021; Dick-Sagoe et al., 2022; Issa et al., 2015; Mafongoya P, 2015; Mutandwa et al., 2019; Teye et al., 2015; Yiridomoh et al., 2020). The effects include direct and indirect impacts such as on general household welfare and crop and animal production.

Indirect climate change impacts highlighted in the literature include inability to cater for basic household needs such education and food, poor health and poverty (Assan et al., 2020; Dube et al., 2018; Magalhães et al., 2022; Muzari et al., 2014). Assan et al. (2020) studied smallholder farmers in Ghana and noted that their well-being was impacted by food scarcity and decreased income, which resulted in fewer daily meals, poor health among household members, and an inability to fund children's education owing to the effects of climate change. In this vein, Makuvaro et al. (2018) assert that farmers' well-being would be significantly

impacted by climate change, leading to an increase in poverty, hunger, and starvation as well as an increase in the prevalence of diseases.

Other direct climate change impacts including, reduced crop yield, crop failure, increased pests and diseases, high post-harvest losses, reduced soil fertility, poor seed germination, food insecurity, bushfires, famine, flooding, water stress, livestock deaths and a lack of fodder have also been reported in farming communities in Ghana, Zimbabwe, Kenya, Lesotho and the Democratic Republic of Congo (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Asante et al., 2021; Assan et al., 2020; Baffour-Ata et al., 2021; Balasha et al., 2023; Dick-Sagoe et al., 2022; Dube et al., 2018; Kalele et al., 2021; Makuvaro et al., 2018; Mensah et al., 2022; Musakwa et al., 2020). Evidence from a study by Dick-Sagoe et al. (2022) in Lesotho shows that smallholder farmers experienced significant direct climate change impacts on crop and animal production. Smallholder farmers in the studied villages mainly attributed declining crop yields to soil infertility, prolonged droughts, and heavy rainfall (Dick-Sagoe et al. (2022). A reduction in crop yield could mean poor crop performance, translating into low household income. The direct climate change impacts undermine both the quality and quantity of output (Dick-Sagoe et al., 2022). Consequently, these impacts lead to food insecurity, notably reduced access and availability.

Climate change, though often associated with negative consequences can positively impact farmers' livelihoods. However, research in this area is somewhat limited. Muzari et al. (2014) attempted to highlight the potential positive effects of climate change on the smallholder farming sector in Zimbabwe. According to their findings, the aftermath of excessive rains increased fruit production, which met the consumption needs of farming households, but also served as a valuable source of income when sold. Additionally, their study pointed out that climate change impacts led to an increase in environmental-induced migration, which bolstered

remittances to farming communities. These remittances, they argued, played a pivotal role in enhancing the standard of living of farming households.

The gender debates on climate change impacts on farmers' livelihoods are inconclusive on how male and female farmers are affected. Some studies have reported similar impacts for men and women (Balasha et al., 2023; Issa et al., 2015; Mensah et al., 2022), while others have reported varied effects (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Assan et al., 2020). In a study in two agroecological zones in Nigeria (North-Central & North-West), Issa et al. (2015) observed no gender disparities in the perception of the negative impacts of climate change. In their study, both gender groups alluded that erratic rainfall, in particular, impacted overall farm productivity. Balasha et al. (2023) observed no significant differences in climate change effects between male and female farmers in the Democratic Republic of Congo. Yet a study in Ghana's northern region revealed some gendered impacts (Antwi-Agyei & Nyantakyi-Frimpong, 2021). Despite both men and women experiencing increased diseases and reduced crop yield, the researchers noticed disproportionate impacts on women farmers, who had to travel far to fetch water for household use and to find water points for livestock.

The findings by Antwi-Agyei and Nyantakyi-Frimpong (2021) support the notion that women often undertake caregiving and domestic work making them more vulnerable to the impacts of climate change. Pandey (2020) points out that women are at a higher risk of experiencing these impacts because extreme weather alters their daily activities. For example, when they have to wait long periods to fetch water, they would feel the impact of drought, or when they miss out on working days on the farm due to the care burden of the household, they would feel the shift in the seasons. Conversely, men may not see these issues in the same light because they may be detached from these responsibilities. Pandey (2020) points out that these differences in

perceptions emanate from the differences in productive, reproductive and community roles and responsibilities between men and women.

The literature analysis has provided evidence that smallholder farmers in developing countries are fully aware of the consequences of climate change on crop and animal production as well as other livelihood activities. The substantial implications on food production posed by these observed impacts impede farmers' capacity to adapt and their ability to maintain livelihoods (Baffour-Ata et al., 2021). This makes smallholder farmers' livelihoods generally vulnerable, as Carney (1998) described that livelihoods are vulnerable when exposed to the physical harm brought on by climate variability.

2.2.2 Climate Information Sources

Understanding the prerequisites for smallholder farmers' acceptance of climate information makes it easier to effectively implement adaptive measures (Sanga & Elia, 2020). Opinions on climate change in a global context are frequently expressed on social media and by experts in the field (Weber, 2010). Farmers form their ideas on the changing climate within local contexts based on personal experiences (Krosnick et al., 2006). To some extent, climate change perceptions are determined by access to information, individual differences in cognitive abilities and other economic, environmental, cultural and political conditions that may interfere with perceptions (Weber, 2010). Access to climate information gives farming populations in sub-Saharan Africa a chance to manage the risks posed by climate change and aid adaptation interventions (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Harvey et al., 2014; Henriksson et al., 2021; Chandni Singh et al., 2018). Farmers can make informed decisions on adaptation if they have access to climate information. Even beyond adaptation, access to climate information is crucial in determining how resilient farmers may become (Balasha et al., 2023).

For climate information to be used more often and effectively, it must be deemed reliable, understandable, and timely (Chandni Singh et al., 2018). Therefore, highlighting ways to access climate information is critical to enhancing farmers' perceptions about climate change. Existing research has identified the various information sources utilised by farmers to acquire climate knowledge. Information mediums such as the radio, phone messages, internet, extension officers, farmers groups, televisions, and personal observation emerged from the studies conducted across farming communities in the developing world (Assan et al., 2020; Diouf et al., 2019; Dube et al., 2018; Henriksson et al., 2021; Kaganzi et al., 2021; Mutandwa et al., 2019; Sanga & Elia, 2020; Teye et al., 2015). Among all these sources, the radio remains the most widely used channel for receiving climate information across farming communities in sub-Saharan Africa, and existing research supports this (Assan et al., 2020; Diouf et al., 2019; Dube et al., 2018; Henriksson et al., 2021; Issa et al., 2015; Teye et al., 2015). For example, Henriksson et al. (2021) recognised the radio as a strategic medium of climate change information in their study on smallholder farmers in Malawi. Similarly, Diouf et al. (2019) discovered that both male and female farmers in Senegal mostly preferred the radio as a source of information about climate change.

The radio is favoured for several reasons, including the widespread dissemination of information in local languages, making it more accessible (Diouf et al., 2019). Second, the radio is portable and has reasonable transmission costs (Khanal et al., 2018). Finally, radio promotes dialogue in rural areas, especially among women (McOmber et al., 2013). These qualities make radio an appealing medium for sharing information as opposed to television and the Internet, which farmers consider costly (Dube et al., 2018). Other information sources, such as personal observation and extension officers, have been widely reported as valued communication avenues (Diouf et al., 2019; Henriksson et al., 2021; Sanga & Elia, 2020). For example, based on the research findings by Henriksson et al. (2021), in addition to community

leaders and non-governmental organisations (NGOs), extension officers were Malawi's second most preferred source of weather forecasts. This is plausible because farmers frequently trust information from these sources because of familiarity and shared understanding. Personal experience is an additional source also frequently cited by farmers (Henriksson et al., 2021; Issa et al., 2015; Kaganzi et al., 2021).

Farmers' information sources and access differ, making it very important to figure out the source of the variation. How farmers access climate information is primarily determined by gender, age, educational background, location, and other socioeconomic characteristics. The gendered dimension of climate information access has particularly drawn scholarly attention (Assan et al., 2020; Balasha et al., 2023; Diouf et al., 2019; Henriksson et al., 2021) because of the critical role it plays in equitable adaptation and benefits (Dube et al., 2018). Researchers have suggested that gender inequalities in information access and sharing have been caused by male dominance in climate information access (Jost et al., 2016; Ngigi et al., 2017).

Studies highlighting the gendered nature of climate information access include Assan et al. (2020), who noted evident gender differences in Ghana. Female farmers favoured indigenous knowledge and social networks (friends and family) for climate information, while male farmers primarily relied on the radio and extension officers (Assan et al., 2020). Women's preference for indigenous knowledge for forecasting information has favourable opportunities that prevent them from spending money to access climate information, which can lead to better investments in other activities to enhance household welfare. This has increased women's preference for indigenous knowledge. In the Democratic Republic of Congo, Balasha et al. (2023) also found that female farmers favoured indigenous knowledge as a source of climate information in the Democratic Republic of Congo.

Male farmers tend to invest in more technological sources of information, such as the Internet and mobile phones. The use of these technologies (newspapers, SMS, WhatsApp) among male farmers has been linked to high literacy rates (Diouf et al., 2019; Henriksson et al., 2021). This was found to be the case in Senegal, where Diouf et al. (2019) observed that due to high level of education, male farmers preferred the internet and cell phones as sources of information, compared to female farmers who accessed information mostly from producer organisations such as NGOs and social networks. Female farmers' preference for NGOs and extension officers could be associated with the willingness of NGOs and extension agents to accommodate the informational needs of various farmer groups. Given this, NGOs and extension agents tend to accommodate disadvantaged populations such as women, the less educated and the elderly (Kakota et al., 2015). The age of the farmer is equally important when assessing access to climate information (Dube et al., 2018; Henriksson et al., 2021; Sanga & Elia, 2020). Age as a determinant of climate information depicts the different needs of farmers of varying age groups. Elderly farmers also seem to favour information from extension officers because they are deemed reliable (Sanga & Elia, 2020).

Indigenous knowledge also serves as an important source of climate information for farmers. Also referred to as local or traditional knowledge, it is essential for understanding and predicting climate change. Indigenous knowledge is a body of ideologies, traditions, and knowledge about how a community engages with its agroecosystem (Gyampoh et al., 2009; O. Jiri et al., 2015; Nyadzi et al., 2021). It includes understanding local plants, techniques for conserving food, seed selection to prevent famine, and livestock disease prevention (Odero, 2011). These attributes of traditional knowledge enable farmers to predict weather and impending threats in order to sustain agriculture. Weather forecasting based on locally acquired knowledge systems allows farmers to plan their operations and implement adaptation mechanisms to avert climate change shocks. This is because the knowledge can be used to

forecasts short-term, daily, weekly and seasonal weather patterns that support farmers to engage in certain farming activities at specific times in the cropping season (Chandni Singh et al., 2018).

The use of traditional ecological in climate change management is an important aspect of sustainable adaptation. Several studies conducted in Zimbabwe, Ghana, China, Nigeria and Kenya have documented how local communities utilise traditional knowledge to make informed decisions related agricultural activities and adapt to changing weather patterns (Assan et al., 2020; Baffour-Ata et al., 2021; Dube et al., 2016; Gbangou et al., 2021; O. Jiri et al., 2015; Nkuba et al., 2020; Onwuemele, 2018; Siambombe et al., 2018; Sibanda & Sibanda, 2021; Sullo et al., 2020; Van Huynh et al., 2020). Some of the traditional knowledge indicators identified include meteorological, animal behaviour, plant phenology, and celestial indicators. Farmers have accumulated knowledge about these indicators and use them to predict hunger, droughts, and rainfall. Baffour-Ata et al. (2021) highlighted how smallholder farmers in the Upper East region of Ghana effectively used local knowledge to predict weather patterns and plan their seasonal agricultural activities. This demonstrates the practicality and relevance of traditional knowledge in climate change adaptation.

Specifically, farmers observe wind direction, cloud type and colour, the appearance and disappearance of animals (e.g. frogs, cattle egret, hornbill, red ants fireflies etc.) and the fruiting patterns of local trees (e.g. shea nut, baobab, *dawadawa*) to foretell the timing, duration and quantity of rainfall, droughts and floods among other indicators (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Assan et al., 2020; Baffour-Ata et al., 2021; O. Jiri et al., 2015; Siambombe et al., 2018; Sibanda & Sibanda, 2021). In Zimbabwe, for example, Siambombe et al. (2018) found that the BaTonga farmers in the Binga district used celestial (moon's encirclement, red clouds, wind direction), animal (termites, birds, and pests), and plant (baobab and tamarind

fruits) indicators to forecast seasonal change and prepare for planting activities. The farmers pointed out that shining fireflies at night during the rainy season signify more rainfall, whereas an abundance of baobab and tamarind fruits signals starvation and poor rainfall.

The use of traditional knowledge in climate change management has shown both potential benefits and challenges. On one hand, as demonstrated by literature indigenous knowledge has proved helpful for farmers in sustainably preparing farming activities and mitigating risks such as droughts and floods (Nyadzi et al., 2021; Siambombe et al., 2018). Not only is traditional knowledge important for weather predictions, farmers can also hinge on it to make decisions and implement adaptation practices. However, there have been notable setbacks associated with the use of local indigenous knowledge in climate change adaptation. One significant challenge is the unpredictability nature of local indigenous knowledge (Balasha et al., 2023). . As the climate becomes erratic, traditional knowledge may become less reliable, making it difficult for farmers to accurately forecast weather patterns and plan agricultural activities (Nyahunda & Tirivangasi, 2019). The concerns raised by farmers in the study by Nyahunda and Tirivangasi (2019) in Zimbabwe highlight the doubts and hesitations that can arise when relying on indigenous knowledge for weather forecasting. This unpredictability can lead to risks and uncertainties in agriculture, which can exacerbate food scarcity and increase farmers' vulnerability to climate change (Assan et al., 2020).

2.2.3 Causal Attribution to Climate Change

In recent years, researchers have paid attention to farmers' perceptions of the causes of climate change. Farmers' awareness of the causal elements of climate change will likely motivate them to take action to arrest the situation. Farmers largely believe that specific actions or inactions cause climate variations and their impacts (Teye et al., 2015). Research has documented deforestation, bushfires, natural occurrence, God's will, population growth, angry deities,

depletion of sacred places as factors associated with climate change by farmers (Assan et al., 2020; Ayal & Leal Filho, 2017; Mensah et al., 2022; Mnimbo et al., 2016; Teye et al., 2015). These causal factors can be categorised into human, economic, supernatural, and divine causes (Assan et al., 2020; Ayal & Leal Filho, 2017)

Farmers' adaptation choices and willingness to take action to cope with climate variability-related risk reflect their perceptions of the causes (Ayal & Leal Filho, 2017). Some scholars have argued that when the perception of the cause of climate change is backed by science, it might lead to adopting multiple adaptation techniques than when the impact is attributed to supernatural or divine sources. For example, citing the degradation of biophysical conditions, political problems, and resource mismanagement as causing climate change and variability will influence rational actions to address the effects (Ayal & Leal Filho, 2017).

Farmers have demonstrated awareness of their role in climate change, particularly the natural and human causes. For example, elements such as bushfires, burning of fossil fuels, deforestation and population growth are attributed to the extreme weather events affecting farming communities (Assan et al., 2020; Ayal & Leal Filho, 2017; Mensah et al., 2022; Mnimbo et al., 2016; Teye et al., 2015). In Ghana, smallholder farmers studied by Assan et al. (2020) mentioned indiscriminate tree-cutting and bushfires as the leading causes of the observed changes in the climate. The researchers disaggregated the causal factors by the gender of the farmers. They found that men's uncontrolled burning during game hunting was the primary cause of bushfires, whereas tree cutting by women for firewood and other actors such as constructors was blamed for deforestation and loss of vegetative cover (Assan et al., 2020).

Research has shown that violation of traditional norms, depletion of sacred sites, angry deities, sin, indiscriminate shedding of blood and God's will are some of the supernatural and divine attributes of climate change (Assan et al., 2020; Ayal & Leal Filho, 2017; Mnimbo et al., 2016;

Teye et al., 2015). For instance, Assan et al. (2020) found that farmers in their study area in Ghana ascribed the negative effects of climate change to angry deities and ancestors. Female farmers, in particular, are thought to be more likely to connect spiritual or divine elements to the adverse effects of climate change (Assan et al., 2020; Mnimbo et al., 2016). Ayal and Leal Filho (2017) point out that associating economic and human causes with climate change demonstrates rational thinking and aligns with scientific knowledge. Rationality may however fall short in totally explaining the causes of climate change because in some ways spiritual or divine elements often identify and deter antisocial or problematic practices that affect the climate. Many farmers in Africa still have long held mythical beliefs about the causes of climate change and variability and have no problem linking observed changes in the climate to religious transgressions or other supernatural elements. This is despite arguments by some scholars including Kuruppu and Liverman (2011) that this line of reasoning restricts efficient adaptation to climate change-related risks because the divine attribution often implies that risk is inevitable and unavoidable.

Several elements have emerged crucial in shaping farmers' climate change perceptions. These elements include awareness of the changing climate, observed indicators of change, sources of information and perceived causal attributes of climate change. Other factors such as gender, age and education play a role in climate change perceptions. Knowing how farmers perceive climate change makes it possible to identify and prioritise their concerns leading to better climate change management based on tailor-made and context-specific interventions.

2.3 Gender Debates in Climate Change Vulnerability

Climate change vulnerability is complex, multifaceted and shaped by several environmental and socioeconomic inequities (Bhadwal et al., 2019). Coirolo and Rahman (2014) point out that vulnerability outcomes are varied because of the intersections of several factors, such as

the larger political economy (access to and control of resources) and power dynamics at the household and community levels, among others. As a result, a system's vulnerability is dynamic and ever-changing (Djoudi et al., 2016). According to the IPCC (2007), vulnerability results from a system's exposure to climatic distresses, sensitivity to them, and capacity to adapt and cope with changes. Indicators of vulnerability to climate change effects depend on the types of hazards individuals are exposed to and the measures required to lessen the impacts. Coirolo and Rahman (2014) argue that the smallholder sector is especially vulnerable to climate change because of its heavy reliance on rain-fed agriculture and limited access to productive resources. Farmers in this sector experience varied climatic and non-climatic risks, such as extreme weather events, pests and diseases, economic shocks, and environmental stresses, such as land degradation and soil erosion.

Debates on vulnerability have brought attention to the ways in which social categorisations such as gender, age, and poverty, among other factors, create inequalities that either include or exclude individuals (Kaijser & Kronsell, 2014). These debates have given rise to gendered vulnerability scholarship in the context of climate change, with arguments focusing on gender specificity and gender neutrality.

2.3.1 Debates about Gender Specificity and Gender Neutrality

Some studies hypothesise that women and men are differently affected by the impacts of climate change, resulting in differentiated vulnerability (Balikoowa et al., 2019; Bob & Babugura, 2014; Chandra et al., 2017; Kakota et al., 2011; Ume et al., 2021). Gendered vulnerability is dynamic and changes in space and time, as men's and women's traditional roles also evolve with time. Men and women's vulnerability is shaped by the roles and responsibilities established in households and communities, the types of risks induced by climate change and other socioeconomic characteristics that present varying challenges (Goh,

2012; Musiyiwa, 2014; Rao et al., 2019). Moser (1998) argues that the disparity in vulnerability may be explained by the fact that women tend to possess fewer assets and opportunities than men, which reflects in the households they head. This notion confirms arguments by some scholars that vulnerability bifurcates along the gender of the household head (Balikoowa et al., 2019; Rao et al., 2019; Ravera et al., 2016). Abebe (2014) also asserts that climate change does not affect an entire population equally but disproportionately affects women. This has led to claims by some scholars that women's vulnerability to climate change impacts is higher than men (Abebe, 2014; Balikoowa et al., 2019; Bhadwal et al., 2019; Bob & Babugura, 2014; Chandra et al., 2017; Goh, 2012; Phan et al., 2019). Also, households headed by women are argued to be more vulnerable compared to those headed by men (Balikoowa et al., 2019; Ume et al., 2021).

Other scholars, notably Djoudi et al. (2016) and Arora-Jonsson (2011), have questioned this argument and disputed the feminisation of vulnerability. They argue that the singling out of women as climate victims or labelling women as victims or stewards is a flawed conclusion. This is because vulnerability is heterogeneous. Shackleton et al., 2015 also argue that it is not always true that women or households headed by females are more vulnerable than male-headed households. In fact, a study among farmers in Uganda found the difference in climate change vulnerability between male-headed and female-headed households to be less pronounced than usually suggested by the literature, based on a calculated vulnerability index (Balikoowa et al., 2019).

Likewise, Ravera et al. (2016) theorise that women's creativity and proactiveness in addressing climate change through individual or collective innovative approaches aid them in developing resilience. Research conducted by Andersen et al. (2017) in Brazil, Peru and Mexico supported this assertion. Their findings established that despite having lower educational levels than

male-headed households, households with female heads were more resilient and less vulnerable in all three nations. This is because women's use of social capital amplifies their agency as a result of their participation in both formal and informal networks (Phan et al., 2019). Some emerging studies are reporting high vulnerability in male-headed households compared to female-headed households (Ume et al., 2021).

Based on a vulnerability index, Ume et al. (2021) found male-headed households in their study area in Nigeria to be more vulnerable than female-headed households. They associated this with female farmers being more experienced and best adapted to climate change because of their early introduction to farming at a young age. Female-headed households only showed greater vulnerability in the off-farm income indicator, which according to the authors, was due to their low participation in off-farm income-generating activities (Ume et al., 2021). The inter-household vulnerability analysis has, however, been questioned by Doss (2015), who argues that female versus male-headed household comparisons fail to account for the status of females in male-headed households and, in particular, oversimplify the nature of households with couples (mostly male-headed). Research can thus benefit from intra and inter-household gender analysis to paint a better picture of the gendered vulnerability.

The binary conceptualisation of gender as men and women tend to distort our understanding of vulnerability. The intersections of gender, class, age, and income within the context of social norms and culture determine vulnerability (Djoudi et al., 2016). In the context of intersectionality, there is the argument that differences may not exist between gender categories but will exist within groups because neither men nor women constitute homogeneous units (Arora-Jonsson, 2011; Jost et al., 2016; Sultana, 2014). This underscores the importance of understanding complex intersectionalities and how they influence vulnerability (Bhadwal et al., 2019).

Several studies, including those by Wrigley-Asante et al. (2017), Djoudi et al. (2016), (Fisher and Carr (2015), Garai (2016) and Arora-Jonsson (2011), have established that even though gender is a determinant of vulnerability, it is not the only factor. These scholars argue that men and women are not a homogenous group, therefore, emphasise the intersectionality of gender and other individual attributes, such as age, economic status, and political affiliation, among other variables in assessing gendered vulnerabilities. For example, while studying gender-specific vulnerabilities to climate change in Bangladesh's coastal areas, Garai (2016) found that both men and women studied were vulnerable due to their different roles and responsibilities. This vulnerability is amplified by gendered norms in decision-making and other social markers, such as poverty and social status, which profoundly influence climate change vulnerability (Djoudi et al., 2016; Goh, 2012).

Similarly, Assan et al. (2020) found that male and female farmers in the Upper West region of Ghana were vulnerable to climate change impacts. Nonetheless, the farmers' capacity to diversify their livelihood activities determined the extent of their vulnerability (Assan et al., 2020). Other studies, for example, Bhadwal et al. (2019), also documented the intersectionalities of vulnerabilities. In a study on how ethnicity, poverty, and political identity shape gender vulnerabilities in the Eastern Himalayas, Bhadwal et al. (2019) found that men were more exposed to climatic shocks and were more burdened with workload because they were responsible for grazing animals in high-altitude areas. On the other hand, women were directly affected by flooding and flash floods in low-elevation areas. The authors established that both men and women in their study were vulnerable to climate change effects. These studies have confirmed that gender and other categories of social differentiation influence the extent of farmers' vulnerability to climate change impacts. Farmers of both sexes are vulnerable to climate change effects, even though varying circumstances may lead one gender to be more highly impacted than the other.

2.4 Debates about Gendered Adaptation

Adaptation and coping have become two key concepts in the literature on climate change. Its roots are in development studies scholarship, specifically the sustainable livelihoods framework (Ellis, 2000). Coping methods are quick actions farmers take to lessen the harmful effects of climate change (Eriksen et al., 2005). Farmers use coping strategies to reduce their exposure to the potential of income loss and food insecurity brought on by climatic and non-climatic stresses (Davies, 1996). In his analysis of rural livelihoods, Ellis (2000) identified five main coping strategies, which can be listed in the order in which they are most likely to occur; looking for new sources of income, drawing upon reciprocal obligations (sharing resources like seed and labour), temporarily relocating to reduce the size of the household, decreasing the size of movable assets (e.g., livestock), and selling fixed assets (e.g., land). He further points out that permanent distress migration is often the last resort after all other coping mechanisms have been explored (Ellis, 2000).

Adaptation, however, is a more advanced kind of coping. It is defined as adjustments in natural or human systems in response to present or anticipated climatic stimuli or their impacts, which moderates harm or exploits beneficial opportunities (IPCC, 2007). Adaptation to counteract adverse climate change effects is necessary because failure to adapt could lead to dire consequences, including loss of livelihood, social conflicts and displacement, and even death (Diiro et al., 2016). Several researchers note that adaptation is implemented to manage climatic shocks and other non-ecological stressors and varies from activities that are undertaken on the farm and off the farm (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Hassan & Nhemachena, 2008; Obert Jiri & Mafongoya, 2020; Ylipaa et al., 2019).

According to available research on adaptation, smallholder farmers have employed several strategies to safeguard their livelihoods against the negative effects of climate change

encompassing on-farm and off-farm activities. Literature is rife with examples of on-farm adaptation practices implemented by farmers. These include soil conservation (zero tillage), manure and fertiliser application, mixed farming, crop rotation, intercropping, mulching, agro-forestry, use of hybrid crop and animal species, adjusting planting dates, crop staggering, water harvesting and irrigation, among others (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Asante et al., 2021; Asare-Nuamah et al., 2022; Atube et al., 2021; Autio et al., 2021; Diarra et al., 2021; Dick-Sagoe et al., 2022; Dube et al., 2018; Eyasmin et al., 2021; Kalele et al., 2021; Makuvaro et al., 2018; Mushore et al., 2021; Mutandwa et al., 2019).

The off-farm livelihood diversification practices highlighted in the literature include trading, craftwork, commercial driving, running small businesses (hairdressing, dressmaking, grinding mill), skilled work such as carpentry, masonry, foraging for wild fruits, herbs and vegetables and migration (Asante et al., 2021; Asare-Nuamah et al., 2022; Mushore et al., 2021; Mutandwa et al., 2019). Off-farm activities are vital because farmers face greater risks as a result of climate variability, making it challenging to rely primarily on agricultural production. The adaptation strategies identified in the literature follow Scoones's (1998a) rural livelihood strategies, namely agricultural intensification or extensification, livelihood diversification and migration. Scoones (1998) posited that households could gain more from agriculture through more capital and labour investments (intensification) or increasing the size of land under cultivation (extensification) or by, diversifying into various off-farm income-generating activities, or migrating temporarily or permanently to seek alternative livelihoods.

Even though additional research is needed to document the gendered patterns of climate change adaptation, some studies have shown that adaptation is gendered (Adzawla et al., 2019; S. Ahmed & Kiester, 2021; Antwi-Agyei & Nyantakyi-Frimpong, 2021; Assan et al., 2018; Mensah et al., 2022; Wrigley-Asante et al., 2019). Table 2.1 presents the prevailing adaptation

practices, highlighting some of the few studies that have explored gender differences in adaptation in recent years. Gender dimensions of climate change adaptation are particularly crucial because they could support the development of initiatives to address gender disparities in climate change adaptation in different farming households (Assan et al., 2018; Codjoe & Owusu, 2011; Yaro, 2013). Additionally, because women are increasingly assuming household headship in most developing countries, it is crucial to establish gender-sensitive adaptation procedures for inclusivity (Nelson, 2011).

The central argument for gendered adaptation is that gender relations, sociocultural norms and power relations influence access to and control over crucial adaptation resources between men and women (S. Ahmed & Kiester, 2021; Assan et al., 2020; Mersha & Van Laerhoven, 2016; Vincent & Cull, 2010; Wrigley-Asante et al., 2019). These differences may impact how vulnerable men and women are to climate change shocks and how they adjust to counteract them, which varies between the genders leading to different priorities and preferences for adaptation based on resources available (time, labour, inputs), crops grown, and skills needed to implement strategies. For instance, Wrigley-Asante et al. (2019) found that male and female farmers in their study in Ghana prioritised and used different farming practices. Female farmers largely implemented early harvesting, crop staggering, mixed cropping and engaged in petty trading, most likely to secure household food security. Conversely, male farmers were more involved in cultivating hybrid crop varieties and typically migrated in pursuit of better livelihood conditions. Similar adaptation differences between male and female farmers were observed by S. Ahmed & Kiester (2021), Adzawla et al. (2019) and Mensah et al. (2022) in Bangladesh and Ghana respectively.

Table 2.1: Identified Adaptation Strategies by Researchers and Country of Study

Authors/Study	Identified Adaptation Strategies
Adzawla et al., 2019 Ghana	zero-tillage[1]*, intercropping* mixed farming**, hybrid varieties**, row planting** changing planting dates***
Ahmed & Kiester, 2021 Bangladesh	shifting planting dates***, changing crops*** changing cropping patterns* reducing farm size**, change in occupation**, migration**
Antwi-Agyei & Nyantakyi-Frimpong, 2021 Ghana	land and soil management ***, crop diversification*** shifting planting dates***, hybrid varieties***, use of IKS***, off-farm activities***, irrigation intensification***
Wrigley-Asante et al., 2019 Ghana	early planting***, intensification of livestock*** use of fertiliser**, hybrid varieties** off-farm (migration) ** early harvesting*, crop staggering*, mixed cropping* off-farm (petty trading) *
Mutandwa et al., 2019 Zimbabwe	zero-tillage, varying planting dates, mulching, change of fertiliser; migration, agro-forestry, crop diversification
Autio et al., 2021 Kenya	zero-tillage, manure application, agro-forestry, mulching intercropping, crop rotation, early planting, terracing
Asare-Nuamah et al., 2022 Zimbabwe	mixed farming, crop staggering, hybrid varieties, off-farm activities
Asante et al. 2021 Ghana	Non-farm activities, Crop diversification, Change in farm location; Migration, Irrigation, agro-chemical application
Diarra et al., 2021 Mali	Shifting planting dates, Hybrid varieties, Manure application Contour farming, Tree planting, Mulching, Crop rotation Mixed farming
Dick-Sagoe et al., 2022 Lesotho	use of fertiliser, conservation farming, tree planting use of IKS, crop diversification, rainwater harvesting shifting planting dates
Atube et al., 2021 Uganda	hybrid varieties; tree planting; fallowing; use of insecticides use of chemical fertiliser; tree planting
Kalele et al., 2021 Kenya	shifting planting dates; crop diversification; hybrid varieties manure application; water conservation; water harvesting
Mushore et al., 2021 Zimbabwe	hybrid varieties; multiple cropping; livelihood diversification dry planting; early planting; barter trading
Makuvaro et al., 2018 Zimbabwe	zero-tillage, mulching, fertiliser application water conservation, irrigation, hybrid seed varieties growing small grains, supplement grazing with animal feed
Dube et al., 2018 Zimbabwe	zero-tillage, growing small grains, rainwater harvesting stream bank cultivation, hybrid seed varieties, irrigation transhumance (seasonal movement of livestock)
Eyasmin et al., 2021 Bangladesh	crop diversification, hybrid varieties, fertiliser application irrigation, shifting planting dates, manure application
Assan et al., 2018 Ghana	shifting planting dates***, crop diversification*** soil fertility improvement***, hybrid varieties*** tree planting***, off-farm activities***
Mensah et al., 2022 Ghana	off-farm jobs* migration** shifting planting dates***, crop diversification ***
Yiridomoh et al., 2020 Ghana	livelihood diversification, hybrid varieties, shifting planting dates, terracing, animal and plant residue application consulting rain gods

Source: Author's construct from literature, 2022; Note: ***=adaptation strategies by both male and female farmers; **=adaptation strategies dominated by male farmers; *=adaptation strategies dominated by female farmers

[1] Zero-tillage is a conservation agriculture technique that refrain from disturbing or turning of the soil over, thus preserving moisture and organic matter. In the study area, it was used synonymously with the concept of *'pfumvudza',* this according to the Extension Officer is because with zero-tillage, seeds are broadcasted without tilling but because farmers dig holes for seeds, the terminology migrated to *'pfumvudza'*.

Research also suggests that men are more successful at implementing complex strategies than women (Wrigley-Asante et al., 2017). As a result, whereas women typically focus on less costly adaptation activities for household consumption, men pursue adaptation techniques that require more inputs and are primarily motivated by profit. This supports claims by Wrigley-Asante et al. (2019) that women are unlikely to compromise household food security since it is a priority to them. Gendered off-farm adaptation also includes activities that are in some cases considered culturally appropriate for different categories, such as petty trading of household items and consumables for women and migration (both internal and external), work on daily wage, selling of non-farm assets and burning charcoal for men as found in two studies in Ghana (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Wrigley-Asante et al., 2019).

Adaptation intensity differs between male-headed and female-headed households, also based on the availability of key resources needed for adaptation, which influence the number of strategies a household implements at any given time. In general, it has been observed that male farmers have a higher adaptation intensity than female farmers (Adzawla et al., 2019; Assan et al., 2018, 2020; Diarra et al., 2021; Mensah et al., 2022). Thus, even though male and female farmers may implement similar strategies, as Adzawla et al. (2019) found in Ghana, their adoption intensity may vary. Several scholars (S. Ahmed & Kiester, 2021; Assan et al., 2020; Mensah et al., 2022; Mersha & Van Laerhoven, 2016) point out that the observed higher adaptation intensity in male-headed households than in female-headed households is likely due to varied ownership and control over basic physical and financial resources crucial for livelihood resilience.

Additional significance of adaptation outcomes in terms of increased output has been reported. Researchers found evidence that when adaptation is effectively implemented, the outcome tends to be positive for households in terms of improved yield and food security (Diallo et al.,

2020; Mafongoya P, 2015). The reverse has also been reported showing that improved crop, influences adaptation behaviours positively (Diallo et al., 2020; Mafongoya P, 2015). Smallholder farmers in Ghana studied by Asante et al. (2021) rated their implemented strategies as effective in managing climate change impacts. Specifically, the farmers rated non-farm diversification, migration, and agrochemical application as the most effective strategies. The discussion on gendered adaptation has shown that male and female farmers have diverse knowledge and agency that they draw upon to lessen their vulnerability to the negative effects of climate change.

2.4.1 Resources for Adaptation

Various factors influence the ability of male and female farmers to adapt. A system's adaptive capacity, including adjustments in behaviours, resources, and technologies, determines how well it can respond to climate variability and change (IPCC, 2007). These behaviours and resources are critical in influencing smallholder farmers' livelihoods, sustainability, and food security (Chiweshe, 2015) and vary to include financial, human, natural, social and physical assets (Chambers & Conway, 1992; Department for International Development (DFID), 2000; Scoones, 1998) as well as other factors such as indigenous knowledge and cultural norms and customs. Assets are critical in pursuing livelihood and adaptation activities and influence outcomes in terms of food security and general household well-being and resilience (Funk et al., 2020; Hassan & Nhemachena, 2008; Obert Jiri et al., 2017; Chiweshe, 2015). The capacity of men and women farmers to withstand climate change is stimulated by the ability to access assets or resources without compromise. However, gender dynamics and power relations profoundly influence male and female farmers' ability to access and control such critical productive resources.

2.4.1.1 Human

Human resources are central to farmers' livelihoods and essential to climate change adaptation (Kuang et al., 2019; Li et al., 2020). Human capital variables, including gender, age, education level, household size, use of labour, farmers' climate change perceptions, and farming experience, have all been identified as crucial components of the adaptation process (S. Ahmed & Kiester, 2021; Asante et al., 2021; Atube et al., 2021; Belachew & Ababu, 2021; Belay & Fekadu, 2021; Chipenda, 2018; Diarra et al., 2021; Faisal et al., 2021; Garcia et al., 2020; Kalele et al., 2021; Mutandwa et al., 2019; Saptutyningsih et al., 2020; Ume et al., 2021). However, research is not conclusive on the role of gender in influencing adaptation behaviours and practices. There are several studies showing different adaptation capacities and preferences for male and female farmers. While some studies found that the gender of the household head or farmer increased the probability of high adoption (Adzawla et al., 2019; S. Ahmed & Kiester, 2021; Asante et al., 2021; Deressa et al., 2009), other studies failed to make this connection (Asare-Nuamah et al., 2022; Autio et al., 2021; Dick-Sagoe et al., 2022; Kalele et al., 2021; Makuvaro et al., 2018; Mushore et al., 2021; Mutandwa et al., 2019; Yiridomoh et al., 2020).

In terms generational differences older farmers are perceived to have more experience and are thus best suited to initiate and implement adaptation mechanisms to counter the adverse effects of climate change than younger farmers. In Mali, for example, Diarra et al. (2021) observed that aged farmers were more likely to implement adaptation strategies than younger ones. Ageing comes with acquired experience and a better understanding of the changes in the climate and agricultural practices over time. This is directly related to farming experience as a factor in adaptability. Several studies have shown that farmers with more years of farming experience are better adapters than those with less farming experience (Atube et al., 2021; Muriithi et al., 2018; Ume et al., 2021). For example, a study in Uganda found that farmers with more farming experience were more likely to adopt improved farming techniques (Atube

et al., 2021). This hinges on the idea that experienced farmers have a wealth of indigenous knowledge and information about climatic changes and possess the best agronomic practices to adapt (Nhemachena & Hassan, 2007).

Other studies have found a relationship between household size and climate change adaptation (Atube et al., 2021; Belachew & Ababu, 2021; Belay & Fekadu, 2021; Faisal et al., 2021). This is more likely because household size is a proxy for labour availability, enabling farmers to take labour-intensive adaptive measures on their farms. The studies cited above in Ethiopia, Uganda, Nigeria, and Pakistan found that households with more productive members tend to adapt to climate change better than small households with less productive members. Typically, hiring labour tends to be minimal when a household is large and has active members. Although necessary, hiring labour incurs additional costs for the household. Addison (2019) points out that employing permanent labour has financial obligations because salaries must be given to employees each month or at a predetermined interval. This means that households with more resources can comfortably engage labour, and male-headed households dominate based on evidence from the literature. Chipenda (2018) found this to be the case in Zimbabwe's Goromonzi district, where more male farmers than females used hired labour due to their significant farm investments. Conversely, the lack of resources, particularly cash, can make it challenging to hire labour (Addison, 2019; Garcia et al., 2020).

2.4.1.2 Natural

Natural capital variables, particularly land, have been identified as central resources that facilitate adaptation. Land is so essential to livelihoods that its possession by farmers provides better livelihood outcomes, notably, food security and improved well-being (Autio et al., 2021; Garcia et al., 2020; Mersha & Van Laerhoven, 2016; Shinbrot et al., 2019; Kaganzi et al., 2021; Mensah et al., 2022; Murken & Gornott, 2022). However, some barriers exist in terms of

access, use, and control of land resources, particularly for women. These barriers are ingrained in the prevailing social norms, unequal social relations, and power dynamics (Vercillo, 2021). The Food and Agriculture Organisation (FAO) (2016) points out that women own less than 20% of the land despite their significant contribution to agricultural production. This is an issue of concern for researchers and policymakers.

Discriminatory inheritance customs and land titling are some of the contributing causes (Autio et al., 2021; Azong et al., 2018; Chiweshe, 2015; Vercillo, 2021). Under these circumstances, women are deprived of their land rights, putting them in danger and diminishing their ability to adjust. One such condition is the customary inheritance which may exclude women from access to land and ownership. Widowhood is a typical example which often leads to women losing their rights to utilise land at the onset of widowhood (Muchacha & Mushunje, 2019; Nguthi, 2007). This increases women's vulnerability to the effects of climate change. Studies by A. Ahmed et al. (2016) and Ume et al. (2021) identified patriarchal local customs and institutions and deep-rooted cultural systems as factors contributing to differential adaptation between men and women in Ghana and Nigeria, respectively. Culturally, marriage, male kin and chiefs remain women's most important avenues to land access (Azong et al., 2018; Ingwani, 2021; Tsikata & Yaro, 2014; Vercillo, 2021).

Based on these circumstances, women are believed to lack access to and ownership of land and, as such, have been tagged as labourers and not land owners (Garcia et al., 2020; Shrestha et al., 2019; Wrigley-Asante et al., 2019). For example, in Cameroon, Azong et al. (2018) reported that most women they studied had user access to land through male kin but did not own the land. In Uganda, female-headed households owned less land relative to male-headed households (Balikoowa et al., 2019). While investigating gender differences and gender-specific adaptation strategies in Ghana, Mensah et al. (2022) observed a significant relationship

between land ownership and adaptation. Sadly, they found that the patrilineal system of inheritance and succession disadvantaged female farmers in land ownership and property rights leading to reduced adaptive capacities (Mensah et al., 2022). This suggests that men can better adapt to climate change impacts because they have better access to land than women, who have limited or no access to land. Decision-making in matters concerning land, its access, use and ownership at the household level are within the domain of husbands and other male adults in the family (Vercillo, 2021; Wrigley-Asante et al., 2019). This results in limited land access and ownership among groups such as women.

Even when women's access to land is guaranteed, this may still not be enough to support their adaptation behaviours. This is because other additional concerns regarding the structure of land tenure, particularly titling, can worsen women's land dispossession and constrain their adaptation practices, as reported by Autio et al. (2021) in Kenya. In their study on adopting climate-smart practices among smallholder farmers, the researchers found that women rarely held land titles, which complicated their investment in new technologies. Similarly, Ume et al. (2021) observed that a greater population of women farmers lacked proper land ownership titles, translating into more male farmers' accessing and owning land in Nigeria.

A lack of land titles can impede climate change adaptation and other investments that could improve household welfare. This is because land titles provide land security and can guarantee credit access. Chandra et al. (2017) point out that the outcome of men's dominance in land governance leaves women with smaller plots, often less fertile and tenure insecurity. Smaller plots imply limited adaptation. Some studies (Ume et al., 2021) have established linkages between large plot sizes and a higher likelihood of adaptation, thus highlighting the importance of land security in adaptation. Mutandwa et al. (2019) pointed out that households in Zimbabwe's communal areas were more likely to implement adaptation strategies than those

in resettlement areas. Their conclusion suggested that the land tenure structure significantly affects how land is used, how many resources are invested, and how well farmers adapt to climate change.

2.4.1.3 Financial

Financial resources in terms of credit, savings and income, among other variables, have emerged in adaptation literature as playing a pivotal role in boosting the levels of adaptation and sustainable land-use practices (Atube et al., 2021; Mensah et al., 2022; Ojo & Baiyegunhi, 2020a; Sekyi et al., 2020; Ume et al., 2021). Access to credit has been credited for enhancing smallholder farmers' adaptive capacities by creating opportunities for diverse and multiple implementations of adaptation strategies (Assan et al., 2018; Mensah et al., 2022; Sekyi et al., 2020; Ume et al., 2021). This is because farmers' credit access minimises cash constraints and enables the purchase of farm inputs and labour, stimulating productivity (Sekyi et al., 2020). In support of this, Atube et al. (2021) found a strong positive correlation between access to credit and climate change adaptation among studied smallholder farmers in Uganda. Decisions about which adaptation techniques to implement hinge on farmers' capacity to borrow credit formally or informally (Palanisami et al., 2015). Farmers, therefore, frame their decisions to adapt or not based on the cost of adaptation (Dube et al., 2018; Mushore et al., 2021). The financial cost of adaptation can be offset by households' off-farm income, which emerged as a critical determinant of adaptation among rice farmers in South-West Nigeria (Ojo & Baiyegunhi, 2020b). This suggests that access to credit has a significant relationship with climate change adaptation.

Evidently, having access to credit and other financial resources allows the gender with the advantage to consider more adaptation options, including engaging in off-farm activities. In most cases, female farmers or female-headed households are identified as being under-

resourced financially, which restricts their ability to increase agricultural investment to build resilience against the effects of climate change (Nabikolo & Bashaasha, 2012). While exploring coping and climate adaptation by smallholder farmers in Ghana, Assan (2018) observed how female-headed households borrowed from village savings and loan groups to fund adaptation activities. Male heads of households in the same study obtained cash for adaptation activities from the sale of livestock. In Uganda, women's adaptation strategies were induced by the availability of liquid household assets, while men's decisions were influenced by real estate, most notably land (Nabikolo & Bashaasha, 2012). Disparities in opportunities for off-farm work between men and women imply that men can potentially earn more income than their female counterparts. Kakota et al. (2011) observed that male heads of households in Malawi had greater influence over household income and were worth more money per head than women due to their higher levels of education and more opportunities for off-farm work.

It is true that when women or female heads of households have access to credit, they can make better investments in adaptation to improve household welfare (Ume et al., 2021; Wrigley-Asante et al., 2019). Female farmers who are financially independent as a result of their engagement in off-farm work are more likely to participate in household decision-making. According to the findings from a study by Wrigley-Asante et al. (2019) in Ghana, women's participation in non-farm activities had a favourable impact on their socioeconomic status and ability to make decisions for the household, which boosted their resilience and capacity to adapt to climate change. In this regard, Shackleton et al. (2015) argue that women's access to productive resources is an advantage in their adaptation to environmental change. The empirical evidence presented implies that financial resources, including access to credit, can positively influence adaptation.

2.4.1.4 Physical

Physical assets are considered important in promoting climate change adaptation as they mirror the household endowment (Kuang et al., 2019). Physical capital refers to the means of production, including infrastructure (roads, dams, animal houses etc.) and material equipment (farm equipment, livestock, household items etc.) that support and maintain farmers' livelihoods (Liu et al., 2018; Yang et al., 2021). Such assets can be converted into income that can stimulate agricultural productivity, livelihood diversification and adaptation practices (Faisal et al., 2021; Knowler & Bradshaw, 2007; Moser & Felton, 2007; He & Ahmed, 2022). Ownership of farm equipment, household items, livestock and crop stocks can directly or indirectly influence production capacity and adaptation behaviours as these assets can be sold or used directly to pursue adaptation (Kuang et al., 2019).

Possessions such as agricultural implements and livestock improve production and support the adoption of strategies to counter the negative effects of climate change. As a result, a household's level of physical capital can indicate its overall income and capacity for subsistence. Kuang et al. (2019) affirmed this in their study in China, where they found that physical capital positively influenced farmers' adaptation decisions. Nonetheless, limited physical capital can lead to increased vulnerability, as observed by Zhang and Fang (2020) Nepal's Koshi basin, where households with poor physical capital had higher vulnerability than those with higher physical capital.

2.4.1.5 Social

Social capital is another important resource necessary for adaptation. It encompasses social resources, including networks, social claims, affiliations, associations and social relations (DFID, 2000; Kollmair & Gamper, 2002; Scoones, 1998). Existing research has established a strong link between social capital variables such as group membership, extension services and

climate change adaptation. Social capital promotes climate change adaptation through shared knowledge, skills and support (Belay & Fekadu, 2021; Diarra et al., 2021; Kuang et al., 2019; Nyahunda & Tirivangasi, 2021; Omolo & Mafongoya, 2019; Saptutyningsih et al., 2020). In particular, group membership facilitates resource sharing and problem sharing, most importantly, labour requirements for adaptation.

Group services such as collective labour have been found to offset labour demands in farming communities (Mersha & Van Laerhoven, 2016; Nyahunda & Tirivangasi, 2021). For example, Mersha and Van Laerhoven (2016) identified a community labour system called *'ofera'* or *'jigie'* practised by farmers in their study area in Ethiopia to support each other. Women and older people benefited more from this system because they lacked draught power. A similar system was observed in Zimbabwe, where a collective labour system called *'nhimbe'* or *'humwe'* played a major role in the execution of farming activities (Nyahunda & Tirivangasi, 2021). In general, belonging to and participating in groups facilitates resource coordination (sharing of seeds, fertiliser, and labour), information exchange, and knowledge mobilisation (new technologies, etc.) (Nyahunda & Tirivangasi, 2021). This is especially true for extension services and dissemination of climate information.

The main argument for extension services proposed by researchers has been that farmers tend to adapt more effectively when extension services are availed as a result of the knowledge and skills acquired to manage the effects of climate change (Atube et al., 2021; Belachew & Ababu, 2021; Makate et al., 2016; Mensah et al., 2022; Mutandwa et al., 2019; Muzamhindo et al., 2015; Mwololo et al., 2019; Zamasiya et al., 2017). For example, Mwololo et al. (2019) discovered that access to extension services, both public and private, enhanced total farm diversity in their study area in Kenya. This emphasises how critical extension services and information sharing are in helping farmers develop their capacity to adjust to the negative

effects of climate change. Climate information also includes indigenous knowledge, which is critical in adaptation (Antwi-Agyei & Nyantakyi-Frimpong, 2021; O. Jiri et al., 2015; Nkuba et al., 2020; Nyadzi et al., 2021).

Some studies, though few, have documented gendered access to social capital, including climate information and extension services (Ngigi et al., 2017; Phan et al., 2019). Gendered patterns of group participation influence the diversity and quality of information for each gender. For example, Ngigi et al. (2017) discovered that men in Kenya had greater access to extension services and information about agriculture and livestock than women, negatively impacting women's ability to adapt. Phan et al. (2019) established that in Vietnam, women in their study participated in small, less formal, and flexible organisations while men were involved with bigger, more organised, and structured groups. Regardless of the type of group men and women participate in, the key outcome is that the involvement stimulates collective decision-making, which enhances the adaptive capacities of those involved.

2.4.2 Barriers to Adaptation

In recent years, debates on adaptation have broadened their scope to include barriers to adaptation (Kalele et al., 2021; Mersha & Van Laerhoven, 2016). The IPCC) (2014, p. 1758) defines barriers as factors that make planning and implementing adaptation action difficult. These obstacles affect smallholder farmers as they strive to safeguard their livelihoods. While the IPCC (2014) identified eight distinct types of barriers (physical, biological, economic, financial, human resource, social and cultural, governance and institutional, knowledge, awareness and technology), scholarly studies have also documented adaptation barriers faced by farmers due to climate change. These studies have identified the different barriers to adaptation and demonstrated that they are context-specific and vary across time and space.

The identified barriers include sociocultural (lack of climate information, land tenure, labour constraints, poor institutional support), financial (limited or lack of markets, high cost of farm implements) and ecological barriers (extreme climatic events (pests and diseases, high temperatures and floods) (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Asare-Nuamah et al., 2022; Chingombe & Musarandega, 2021; Dube et al., 2018; Garcia et al., 2020; Makate et al., 2017; Mushore et al., 2021; Nyahunda & Tirivangasi, 2019; Phuong et al., 2018; C Singh et al., 2016; Ume et al., 2021).

Asare-Nuamah et al. (2022), Chingombe and Musarandega (2021) and Mushore et al. (2021) observed climatic barriers, including rainfall shortage, climate variability and climate stress as factors impeding adaptation in smallholder communities in Zimbabwe. Climate variability functions as a dynamic pressure that triggers droughts and other extreme weather events, which worsens farmers' vulnerability. Autio et al. (2021) reported crop failure, pests, and disease infestation as barriers to effective adaptation in Kenya, while Antwi-Agyei and Nyantakyi-Frimpong (2021), Chingombe and Musarandega (2021), Mushore et al. (2021) and Nyahunda and Tirivangasi (2019) identified financial barriers in Ghana and Zimbabwe. These researchers argue that financial constraints render it challenging to manage irrigation systems and purchase farm equipment for production.

Poverty, which is strongly linked to financial challenges, is another setback that aggravates climate change effects and the adaptive capacities of farming households. Mersha and Van Laerhoven (2016) showed that cultural, social, financial, and institutional barriers hampered adaptation practices at the household level in Ethiopia. According to researchers these barriers do not act in isolation but rather interact to hamper the effectiveness of various adaptation and coping mechanisms (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Mersha & Van Laerhoven, 2016). Mersha and Van Laerhoven (2016) argue that when barriers interact, they result in

differentiated impacts upon different actors. For example, a confluence of social and cultural barriers may limit the adaptation behaviours of specific population groups, such as women, while simultaneously enabling adequate adaptation by certain population groups, such as men.

Adaptation literature has highlighted the gendered nature of constraints to adaptation as a result of gender relations, roles and obligations (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Assan et al., 2020). This is because gender reveals the linkages between different barriers and how these links affect female and male farmers' adaptation decisions and practices (Mersha & Van Laerhoven, 2016). Marimo et al. (2021) note that gender roles and expectations may impede smallholder households' ability to participate in on-farm and off-farm adaptation activities. This suggests that adaptation needs and constraining factors will likely differ for males, females, and other social groups depending on prevailing livelihood activities and the roles each performs in their households and communities (Marimo et al., 2021). For example, Antwi-Agyei and Nyantakyi-Frimpong (2021) found female farmers more burdened in Ghana. Their most significant challenges in implementing adaptation and coping strategies were labour shortages, insufficient markets, a lack of irrigation facilities, and land tenure instability.

Regarding the issue of labour, Assan et al. (2020) argue that labour shortages often emanate from the exodus of the youth and other able-bodied persons as well as low-income farming households. As a result, households with the elderly, female-headed households and those with fewer active household members tend to have an increased labour burden (Antwi-Agyei & Nyantakyi-Frimpong, 2021). Again, poor participation in income-generating activities can result in labour shortages as a result of a lack of money to hire labour (Assan et al., 2020). This leaves female farmers "less able" to act, adapt and protect their families (Garcia et al., 2020). Fisher and Carr (2015) assert that differences in adaptation behaviours between male-headed and female-headed households are a result of constraints in decision-making and productive

resources necessary for livelihood improvement. Thus, farmers' constraints in resource access should be accounted for when initiating sustainable adaptation interventions.

2.5 Livelihood Sustainability and Measurement

Smallholder farmers' livelihood sustainability has come under threat from climate change effects. These threats have undermined farmers' well-being and the economy leading to increased poverty (IPCC, 2014). Therefore, a well-devised livelihood sustainability approach is needed to create a positive synergy between the natural, physical, human, financial and social assets (Cetinkaya et al., 2014). Such a strategy has the potential to fully preserve the natural resource base for the present and future generations as well as to eradicate poverty. In recent years, rural development thinking has seen a significant transition with a greater emphasis on rural poverty reduction (Ellis & Biggs, 2001). Consequently, the sustainable livelihood approach has gained popularity and has been widely used for analysing smallholder farmers' livelihoods (Eyasmin et al., 2021; He & Ahmed, 2022; Li et al., 2020; Nguthi, 2007). The SLF emphasises sustainability through access to various livelihood resources in the five capitals (Chambers & Conway, 1992; Ellis, 2000; Scoones, 1998). In addition, the emphasis on livelihood outcomes, individual and community empowerment, and the connection between people, the government and non-government institutions have made the sustainable livelihood approach more viable for achieving sustainability (Sherbinin et al., 2008).

The linkage between farmers' livelihood capitals and their livelihood sustainability has garnered attention in research, with various indices developed to measure sustainability. Li et al. (2020) have elaborated on the contribution of livelihood assets in gauging smallholder farmers' sustainable development. Given the significance of assets in livelihood sustainability, Zhang and Fang (2020) used a capital-based sustainable livelihood index to evaluate livelihood vulnerability and sustainability for Nepal's Koshi River basin community, Eyasmin et al.

(2021) assessed livelihood adaptation indices and the sustainability of rice farmers in Bangladesh. He and Ahmed (2022) also examined the impacts of livelihood capital on the sustainability of farmers' livelihood strategies in China, while Ahmadpour et al. (2020) investigated factors influencing the sustainable livelihood of female household heads in rural Iran. In Malaysia, Kamaruddin and Samsudin (2014) proposed a sustainable livelihood index to assess the ability and preparedness of rural people in receiving entrepreneurial projects. Marulanda et al. (2020) assessed the livelihood sustainability of cattle ranchers and small-scale family farmers in deforested landscapes of Colombian Amazonia, and De and Das (2021) provided a tool for measuring livelihood sustainability using Principal Component Analysis (PCA) in Indian Sundarbans.

These studies used livelihood assets (human, financial, physical, social, natural) to measure sustainability at different levels (micro and macro) based on the sustainable livelihood approaches. Kamaruddin and Samsudin (2014) comprehensively measured micro-level livelihood sustainability using a sustainable livelihood index. This index was created using 22 livelihood assets broadly grouped under human, natural, physical, financial, and social capital. Their investigation revealed that the sustainability of livelihoods in the region was relatively low since more than half of the farming households had sustainable livelihood scores below 0.5. Another micro-level assessment of livelihood sustainability was carried out by Marulanda et al. (2020), who used the Sustainable Rural Livelihood Framework to identify key variables under the natural, financial, human, social and physical capital to create a sustainable livelihood index. According to their research findings, among cattle ranchers in the Colombian Amazonia, financial capital had the greatest impact on sustainability, followed by human, physical, natural, and social capital, whereas, among small-scale family farmers, human capital had the greatest impact on sustainability, followed by natural, social, physical, and financial capital. In contrast to Marulanda et al. (2020), who found that financial capital contributed most to

sustainable livelihoods, Ibrahim et al. (2018) noted that financial and physical assets had the lowest scores on the livelihood asset index in Malaysia.

Scholars have suggested that a lack of financial assets prevents infrastructure development, agricultural productivity, and livelihood diversification (Ibrahim et al., 2018; Kamaruddin & Samsudin, 2014). Kamaruddin and Samsudin (2014) established that income, a key measurement of poverty, moved in tandem with their sustainable livelihood index, such that when income increased, the SLI increased and vice versa when they assessed livelihood sustainability and the preparedness of rural people in receiving entrepreneurial projects. Scholars have also adopted indices constructed using the five-livelihood capital to measure macro-level livelihood sustainability, mainly to inform policy-driven interventions. For example, De and Das (2021) identified 35 indicators which they grouped into natural, human, physical and socioeconomic capital to measure livelihood sustainability in India. Through their analysis, the authors ranked 19 blocks in the Indian Sundarbans according to their performance on the composite livelihood sustainability index and offered recommendations for livelihood enhancement in the study area.

2.5.1 Factors Influencing Livelihood Sustainability

Researchers have identified several factors that influence livelihood sustainability. These variables include cultural beliefs, farm size, credit access, extension service access, household type (extended or nuclear), dependency ratio, food security, access to land, remittances and income and personality (Ahmadpour et al., 2020; M. Ahmed et al., 2018; Eyasmin et al., 2021; Kamaruddin & Samsudin, 2014). For example, in an investigation on livelihood sustainability, Eyasmin et al. (2021) reported that education level, farm size, credit access and extension services positively improved the livelihood sustainability of rice farming households in Bangladesh. They also observed that adaptation strategies such as crop diversification, off-

farm activities and hybrid seed varieties were strongly linked with the three dimensions of sustainability (economic, social and environmental) explored in the study. Ahmadpour et al. (2020) also noted that farmers' personalities, average income, and assets had a favourable and significant influence on women's sustainable livelihoods in Iran. For example, remittances contributed significantly to household income, as found by M. Ahmed et al. (2018) in Bangladesh when they studied the factors affecting livelihood diversification.

The other determinant of household livelihood sustainability is the number of dependents (dependency ratio). Researchers (e.g. M. Ahmed et al., 2018) note that an increased number of dependents reduces the ability of the household to meet its basic need due to increased pressure on the available resources which could otherwise be invested in securing livelihoods. This conversely impacts the household's capability to sustain its livelihoods. While studying farmers in Bangladesh M. Ahmed et al. (2018) discovered that dependency ratio negatively impacted household's livelihood diversification such that households that had a higher dependency ratio were constrained in livelihood diversification.

2.5.2 Livelihood Outcomes

The SLF indicates food security, improved income and well-being, reduced vulnerability and sustainable use of natural resources as key outcomes of sustainable livelihoods (Ellis, 2000; Scoones, 1998). These outcomes are possible if farming households can cope with and recover from stressors and shocks and maintain their capabilities and assets without undermining the natural resources upon which it depends (Scoones, 1998). Recent studies have documented food security and income as key outcomes that contribute to the sustainability of households (Etale & Simatele, 2021; Mushore et al., 2021; Mutea et al., 2019).

While studying livelihood and food security in Kenya, Mutea et al. (2019) found that food insecurity was a problem because more than half of their studied households were food insecure. The researchers identified ownership of productive hand tools, off-farm income, agro-ecological zone, farm income and infestation of crops by pests and diseases as determinants of food security in the surveyed households. It has been argued that income makes a considerable contribution to a household's food security because the two variables have been shown to move in tandem (Kamaruddin & Samsudin, 2014; Mutea et al., 2019). This is because income provides a household with physical access to food through purchasing, especially when it cannot meet its food needs through production. Income constraints can undermine households' food security, leading to poor nutrition and hunger. Mushore et al. (2021) demonstrated that the inability to secure food led many farming households to reduce their meals from three a day to two or even one in some instances. This situation can be worse for women farmers, in particular, who, due to lack of access to land, may suffer high levels of food insecurity (Etale & Simatele, 2021). In Bangladesh, Wright et al. (2012) established a linkage between food security and asset ownership. Their study reported that food secure households had more assets, compared to food insecure households. The sustainable livelihood approach recognises food security as one of the outcomes contributing to livelihood sustainability.

2.6 Theoretical Considerations

This section discusses the proposed theoretical frameworks underpinning gendered climate change adaptation and sustainability of livelihoods. Theoretical frameworks enhance our understanding of the various dimensions and complexities of the research problem, provide linkages to extant research, and motivate ideas about the research subject (Neuman, 2006). The Sustainable Livelihood Framework and the Feminist Political Ecology, as well as their applicability and suitability in addressing the research problem, are discussed.

2.6.1 The Sustainable Livelihoods Framework (SLF) (DFID, 2000)

Sustainable livelihoods as a concept originated with the work of the World Commission on Environment and Development (WCED) as a vehicle for achieving rural development (Chambers & Conway, 1992). One of the leading models of sustainable livelihoods is the Sustainable Livelihoods Framework (SLF), which has become popular in development programmes, especially in the global south. The framework was developed to examine and understand fully the sustainability of rural livelihoods that were dependent on the favourability of the weather or environment. In this framework, a livelihood comprises the capabilities, assets and activities required for living. Consequently, a livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (DFID, 2000; Scoones, 1998). The SLF consists of several key elements: vulnerability context, livelihood assets, policies, institutions and processes, livelihood activities and outcomes.

The SLF views individuals or households as existing in a vulnerability context where their survival and development are impacted by the external environment (DFID, 2000; Ellis, 2000; Sherbinin et al., 2008). The vulnerability context includes trends, shocks, and seasonality, with shocks being sudden and extreme changes like disasters and conflicts. Trends are more predictable and long-term, while seasonality involves fluctuations in prices, employment, and resources due to seasonal factors. Vulnerability, in this context, arises when people cannot cope with or respond appropriately to threats and shocks.

In order to cope or adapt, households deploy assets (human, physical, natural, social and financial) at their disposal to pursue livelihood strategies that best provide them with livelihood outcomes (D. Carney, 1998; Ellis, 2000; Scoones, 1998). Livelihood activities are activities and decisions people make to attain their livelihood goals. The policies, institutions and

processes mediate access to assets, the pursuit of livelihood strategies and how the vulnerability context impacts people or households (DFID, 2000). Kollmair and Gamper (2002) note that people or households need a variety of assets to attain positive livelihood outcomes. The livelihood outcomes constitute the accomplishments and benefits (food security, the sustainable use of natural resources, enhanced well-being and increased income) that individuals anticipate by implementing specific activities and strategies (Ellis, 2000; Scoones, 1998). These outcomes enhance individual or household livelihood sustainability.

The SLF is not without criticism, despite its widespread acceptance and usefulness. Some issues regarding its suitability in specific contexts have been raised. One issue of concern not addressed by the framework is the importance of significant explanatory variables such as culture, power and power relations and historical factors in influencing individual choices and livelihood outcomes (Adato & Meizen-Dick, 2002). Although there may be no clear linkages between culture and socioeconomic outcomes, it does influence people's lives and well-being. Additionally, power relations inherent in gender relations are critical in resource access and use and ultimately influence livelihood outcomes. To address the problem of gender relations and power in climate change adaptation and livelihood sustainability, it is necessary to incorporate the Feminist Political Ecology theory.

2.6.2 Feminist Political Ecology (FPE)

FPE is a contemporary approach that stems from the broader field of feminism and is situated within the of political ecology. It differs from certain branches of ecofeminism by rejecting the essentialist relationship between women and the environment. FPE also highlights the need to examine the everyday micro-politics that significantly shape human relationships, which it argues is lacking in traditional political ecology. Political ecology as a theory recognises that "the human struggle for resources and healthy environments is strongly influenced by how

much power societies and individuals hold and how they use it" (Batterbury, 2018, p. 439). Early debates on political ecology did not adequately capture the complexities of conflicts, struggles and everyday politics and how they influence human interactions with the environment (J. Carney & Watts, 1990). These limitations prompted the emergence of FPE in the 1990s, aiming to address the gaps in both ecofeminism and political ecology by integrating feminist perspectives and emphasising the nuanced dynamics of power, gender, and the environment. Therefore, FPE examines how gender influences an individual's access to resources and different forms of power (Rocheleau et al., 1996).

The theory recognises gender as a "critical variable that shapes resource access, control" (Rocheleau et al., 1996, p.4) and power dynamics (Nightingale, 2006). Gender helps to elucidate how decision-making processes and socio-political factors influence environmental laws, including access to and control over resources. Therefore, FPE theorists argue then that culturally defined gender roles determine each gender's interaction with the natural environment around them. While feminist scholarship primarily considers gender as key, it does not see the gender-environment (man-nature) relationship as universal. Instead, it emphasises plurality, complexity and intricate interactions embedded in their connectedness (Jarosz, 2011). Gender and gender relations are conceived as lived experiences under circumstances that shape men's and women's fortunes in ways that may be beyond their control.

Additionally, by interrogating power relations within human interactions, feminist political ecologists advocate for the equitable distribution and access to land and other resources (Wangari, 1999). Overall, FPE emphasises that gender, along with other social factors, determines individuals' opportunities and constraints regarding resource utilisation and decision-making power (Sato & Soto Alarcón, 2019). Other social categories, such as class,

race, culture and ethnicity, are equally important in FPE (Elmhirst, 2011). This is because they play a role in shaping the "processes of ecological change and the struggle of men and women to sustain ecologically viable livelihoods and the prospects of any community for sustainable development" (Rocheleau et al., 1996, p.4).

The FPE theory offers a relevant and appropriate framework for understanding and theorising climate change adaptation and livelihood sustainability by recognising the intersection of gender and political ecology. Given that gendered climate change adaptation and livelihood sustainability have ecological and political dimensions, the FPE approach offers a suitable framework for analysis. The FPE lens makes it possible to analyse the vulnerabilities of male-headed and female-headed smallholder farming households to climate change impacts and how they navigate and adapt to these challenges in their daily lives, given the resources available to them.

2.6.3 Suitability and Application of the SLF and FPE Theory to the Study

The SLF holds potential for application in various areas beyond livelihood thinking alone. The framework integrates insights from other current theoretical approaches, making it adaptive and flexible for development research and projects in diverse contexts. Moreover, gendering the framework enhances its usefulness by providing a lens to understand access to assets, their deployment in pursuing livelihood strategies, and how these strategies contribute to livelihood sustainability in male-headed and female-headed farming households. In this study, the SLF is employed to analyse the connections between access to assets and livelihood outcomes, mainly because SLF portrays the use of various forms of assets by the farming household to generate strategies for sustainable livelihoods.

The FPE, on the other hand, can be used as a tool for examining climate change adaptation and livelihood sustainability within a context where male-headed and female-headed farming households have differential access to resources. By integrating the FPE theory into climate change adaptation, we understand the gendered nature of vulnerability, recognise women's agency in the adaptation processes and work toward more equitable and inclusive strategies that address the needs of all farmers. The combination of the SLF and FPE theory in this study is aimed at providing clarity on the intricate relationship between gender, access to assets and livelihood sustainability in smallholder farming households in the Goromonzi district of Zimbabwe. The frameworks provide insights into how gender dynamics influence the ability of farming households to access and utilise various assets and how this, in turn, impacts their livelihoods.

2.7 Conceptual Framework for the Study

The conceptual framework presented in Figure 2.1 is grounded in the FPE and the SLF. It aims to explain the linkages between the vulnerability context, power structures, household assets, climate change adaptation and livelihood sustainability in farming households. At the centre of the framework is the farming household, which exists in a vulnerability context characterised by various climatic shocks and stressors such as droughts, extreme heat, erratic rainfall, pests, and diseases. These climate-related challenges pose threats to the livelihoods that the households rely on for their survival. To secure their livelihoods, households utilise the assets available to them, including human, physical, natural, financial, and social. The level of asset endowment within the household determines the intensity of the adaptation strategies they can implement to counteract climate change impacts.

The adaptation and survival strategies within households are impacted by household characteristics such as the size, gender, and education level of the household head, as well as

external elements. In this framework, the external factors encompass power structures and the institutional context (Agriculture Technical and Extension Services (AGRITEX) and government policies on climate change). The power structures dictate decision-making authority, gender roles and relationships in the community These power structures determine who has access to what resources and when. The decision-making processes determine who has the authority to make decisions regarding resource allocation and livelihood strategies.

Additionally, gender roles and relations dictate the distribution of resources and the division of labour within the community and the household, which has implications for livelihood outcomes. Gender dynamics are important for consideration because gender differentiation is pervasive in many farming communities and has a significant impact on the vulnerability of households and how they manage climate change impacts. The institutional context, including extension services and policies, can facilitate households' climate change management and livelihood sustainability by providing resources. For example, initiatives such as the Command Agriculture and '*Pfumvudza'*[2] offer agricultural inputs and subsidies to farmers in order to intensify agricultural production and ensure food security.

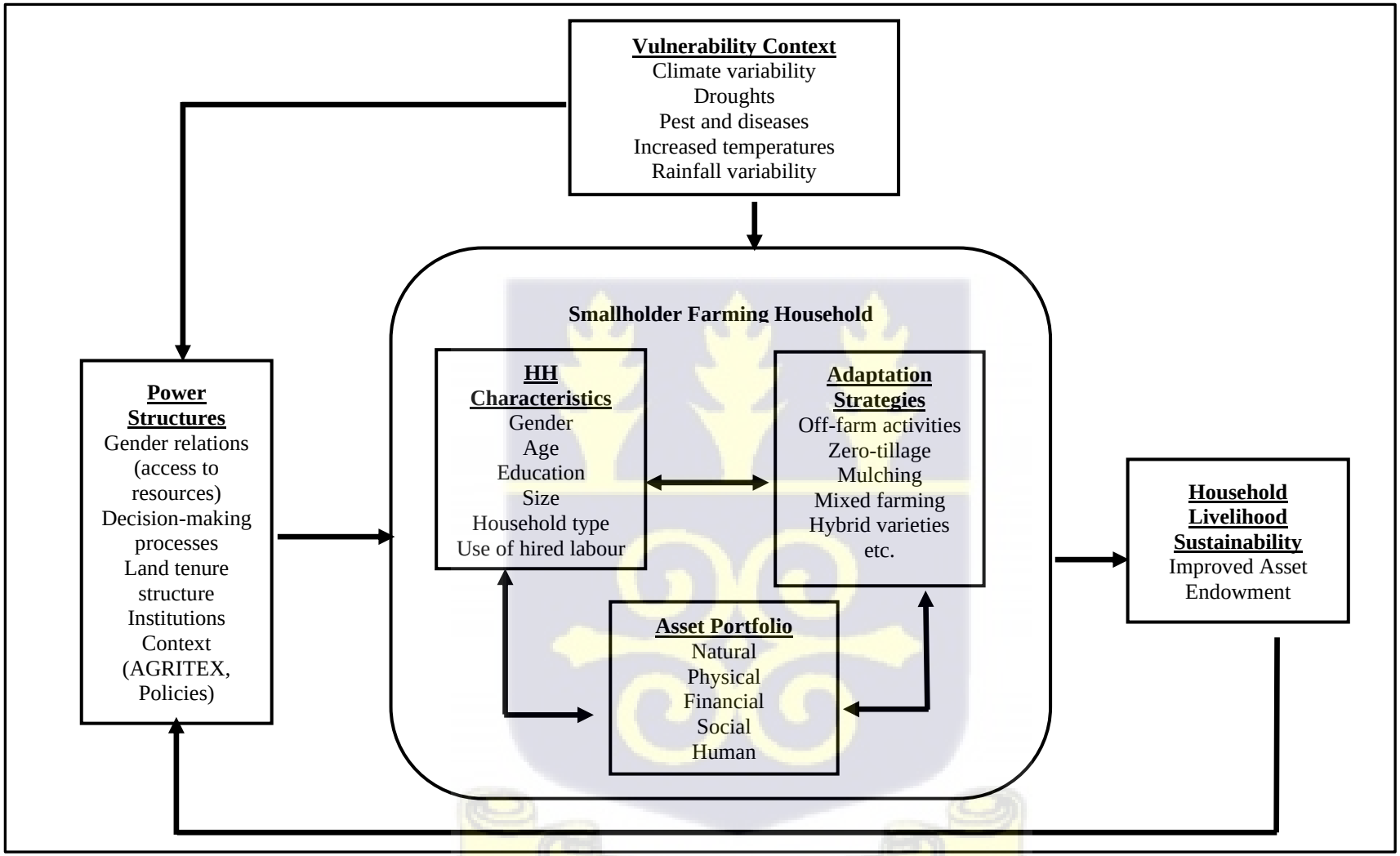
The power structures and institutional context (extension services and policies) are pivotal in shaping how households access resources, adapt and achieve livelihood outcomes. The livelihood outcomes can either enhance or reduce the sustainability of the household's livelihood. Prudent investments and effectively deploying assets can lead to positive livelihood outcomes, ultimately stimulating livelihood sustainability. Sustaining livelihoods over time strengthens the institutional context and power structures which boosts households' assets and reduces its vulnerability to future climate-related and other non-climatic risks and shocks.

[2] '*Pfumvudza'* is a Shona word which literally means the blooming of new leaves during spring indicating the beginning of new farming season. This suggests a new way of farming that maximises productivity. In the study area it has been used to refer to zero-tillage (a conservation agriculture technique).

Conversely, compromised livelihood sustainability increases the household's susceptibility to climate change impacts, creating a continuous cycle of heightened vulnerability.

Figure 2.1

Conceptual framework of vulnerability, adaptation, and livelihood sustainability in smallholder farming households



Note: Conceptual Framework adopted from Nguthi 2007 and modified by author using theoretical concepts

2.8 Summary and Conclusions

The literature has provided a comprehensive exploration of climate change perspectives, adaptation, and livelihood sustainability. It has shed light on several key points that are important to note. First, the literature emphasises that adaptation behaviours and practices hinge on climate change. These perceptions are based on smallholder farmers' awareness of climate change and the perceived effects on their livelihoods. Second, the literature highlights smallholder farmers' vulnerability to climate change, adaptation practices, and challenges. However, there is no conclusive evidence or consensus regarding gendered vulnerability. The literature does not provide sufficient support for the idea that one gender is more vulnerable to the effects of climate change than the other. It is, however, important to recognise that vulnerability to climate change is complex and depends on multiple factors, including socioeconomic, cultural, and political contexts.

The literature has also underscored the gendered nature of climate perceptions and adaptation decisions and behaviours. It has shown that both male and female farmers recognise climate change and take actions to militate its effects on their livelihoods. However, the complexities of adaptation emerge as a result of the interplay of various factors in the household's political, economic, social, and environmental contexts. These conditions lead to differential outcomes for female and male smallholder farmers. Additionally, the literature discussed various pathways for farmers' livelihood sustainability. It has explored the different strategies, approaches and resources that can contribute to the long-term well-being and resilience of farming households. These measures encompass diversification of income sources and food security. Third, the literature discussed pathways for farmers' livelihood sustainability.

The literature has identified a gap in research regarding livelihood sustainability in the context of gender and gender relations in smallholder farming communities, particularly in sub-

Saharan Africa. Most of the studies conducted on this theme have been focused on Asian countries such as Bangladesh, China, Nepal, Iran, and India. This opens an avenue to explore livelihood sustainability in sub-Saharan Africa and examine how smallholder farmers in this region have been able to secure their livelihoods in the face of increasing climate change impacts. The review of available literature has served as a starting point for further investigation into the gendered nature of climate change adaptation and livelihood sustainability. It has highlighted the need to explore whether there are differences in adaptation practices and how they contribute to livelihood sustainability prospects in male-headed and female-headed households. Addressing these important questions will contribute valuable knowledge to development studies, especially considering the continuous and devastating climate change impacts on the agriculture sector. The next chapter describes the study area and the methodological approach for the study.

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.1 Introduction

This chapter presents a description of the study area and the methodological approaches used for the study. It lays out the philosophical foundations of the study and how this informed the study methods and tools of data collection. Other aspects of the research process are discussed, including sampling methods and data analysis. The chapter also details the challenges encountered during the fieldwork and how they were resolved. To conclude the chapter, a discussion of the ethical considerations for the study is presented.

3.2 Study Area

The discussion under the study area focuses on several sections, the first of which discusses climate change and agriculture in Zimbabwe. It focuses, particularly, on climate change trends over time and how these changes have affected agriculture. The next discussion zooms on Mashonaland East province, specifically, the Goromonzi district where the study was conducted. The last section presents the study sites from where the data for this study was collected.

3.2.1 Country Profile

Zimbabwe is a semi-arid and landlocked country in Southern Africa, with a population of about 15.1 million of which 61.4 per cent reside in the rural areas. Forty-eight per cent (7,289,558) of the population is male, while females constitute 52 per cent (7,889,421). The average household size in the country is 4.0. The country covers an area of 390,757 square kilometres (Zimbabwe National Statistics Agency (Zimstat), 2022). The country's neighbours are

Mozambique to the East, South Africa to the South, Botswana to the West and Zambia to the North and North-west. The Zambezi River to the north and the Limpopo River to the south form Zimbabwe's borders with Zambia and South Africa, respectively (Government of Zimbabwe [Ministry of Environment Water and Climate], 2015.). There are ten provinces in Zimbabwe and sixty-one administrative districts, which are further divided into municipal wards.

The subtropical climate in Zimbabwe features four distinct seasons: the cool and dry season, which lasts from mid-May to August; the hot and dry season, lasting from September to mid-November; the major rainy season, which lasts from mid-November to mid-March; and the post-rainy season, which lasts from March to mid-May. Temperatures vary and range from a mean of 15^0 Celsius in July to 24^0 Celsius in November. The lowest minimum temperatures (7^0 C) and highest maximum temperatures (29^0 C), respectively, are recorded in June or July and in October or November or if the rains are delayed (GoZ [Ministry of Environment Water and Climate], 2015).

Zimbabwe is divided into five agroecological regions (AER I-V) based on soil type, rainfall pattern, temperature, and other climatic factors (Government of Zimbabwe, 2018; Moyo, 2000). Agriculture is primarily undertaken in AER I, II and III because the climate is more suited for intensive crop and animal farming. However, extensive livestock production and crop irrigation, mainly sugarcane, is suitable in AER IV and V (GoZ, 2018). Table 3.1 summarises the agroecological zones in Zimbabwe based on rainfall patterns. It is estimated that about 74 per cent of communal lands and 43 per cent of old resettlement lands are situated in AER IV and V, the regions with the least agricultural viability (Chimhowu et al., 2009).

Table 3.1: Natural/Ecological Regions in Zimbabwe

Ecological Region	Defining rainfall features	Type of agriculture practised
Region 1	More than 1000mm per year	Specialised and diversified farming, suitable for dairy farming, tea, coffee, fruit and maize production
Region 2	700-1050mm per year	Ideal for intensive farming of maize, tobacco, cotton and livestock
Region 3	500-800mm per year	Semi-intensive farming, suitable for livestock production, fodder crops and cash crops (under good farm management
Region 4	450-650mm per year	Semi-extensive farming, suitable for livestock production and resistant fodder crops. Forestry and wildlife
Region 5	Less than 450mm per year	Extensive farming region suitable for cattle ranching, forestry and wildlife

Source: Moyo (2000) & Government of Zimbabwe (National Agricultural Policy Framework) (2018)

Agricultural productivity in the smallholder sector reduces from AER I to AER V, owing to average rainfall fluctuations and soil differences. Rainfall and temperatures differ from AER I to V, with the low-lying Limpopo Valley (AER V) having a mean annual rainfall of 300mm, while AER I like the Eastern highlands have a mean yearly rainfall of over 1000mm. A climate change profile of Zimbabwe based on topography reveals that most parts of Zimbabwe enjoy normal inter-annual rainfall variability. Other locations at lower altitudes, such as the Limpopo River, have significant inter-annual rainfall variability, while areas in the northern parts of the Zambezi have lower inter-annual variability but more rainfall (Warner, 2018). The yearly average temperature in the AER I around October ranges from less than 15°C to more than 30°C. In the AER V average annual temperature is between 23°C and 40+°C (Chagutah, 2010; GoZ [Ministry of Environment Water and Climate], 2015).

The agriculture sector is predominated by smallholder farmers who till an average of one Ha per household (GoZ, 2018). These farmers depend on rainfed agriculture for their livelihoods and food security (Zimstat, 2019). Several studies confirmed that climate variability and change have affected agriculture and compromised agricultural productivity in the country (Brown et al., 2012; Chagutah, 2010; Dube et al., 2017; Dube & Phiri, 2013; Frischen et al., 2020; Mafongoya P, 2015; Zimstat, 2019).

3.2.2 Land Tenure Arrangements

Land tenure defines land access, rights to use, control and transfer of land within societies (Matondi & Dekker, 2011). In Zimbabwe, there are several types of land tenure arrangements each with its own attributes. These arrangements include Freehold, Leasehold, Customary, Permit regime, Statutory and Licence regimes (Shivji et al., 1998). The Freehold tenure pertains to land owned by private individuals or institutions documented and authorised through a title deed. This tenure arrangement is often associated with large-scale commercial farms (LSCFs), mining companies and multinational corporations. Land under the Leasehold tenure is occupied based on a lease agreement with the owner, who can either be the state, a public body, or a private individual. Customary tenure constitutes land and land rights acquired and held according to customary law reflecting traditional practices and norms. The Permit tenurial regime governs land occupancy based on permits issued by the state. Statutory tenure applies to state-owned land held under specific legal or statutory provisions. These lands encompass national parks, national forests, and game reserves. Lastly, the Licence tenurial regime constitutes all state lands occupied by any individual under a contractual license issued by the state. This arrangement includes lands used for safari and trophy hunting (Matondi & Dekker, 2011; Shivji et al., 1998).

Several sub-sectors exist under these land tenure arrangements, including the Large Scale Commercial Farms (LSCFs), Small Scale Commercial Farms (SSCF), Old Resettlement Schemes (ORA), A1 and A2 Farmers, and Communal Lands (Zimstat, 2019). The LSCF sector consists of farmers, mainly white families and individuals and a few indigenes who own land under the Freehold tenure arrangement. These farmers are financially secure and engage in crop and livestock production and extensive horticulture. However, the land occupied by large-scale commercial farmers has been reduced over time due to the government's land reform programme. The SSCFs which account for about four per cent of all the country's land, are

owned under the Freehold and Leasehold tenure structures and are given to individual farmers to undertake crop and livestock production. Farmers who have fully paid for the land to the government have title deeds, while those who have not finished paying are leasing the land from the state. It is estimated that there is a total of 9 655 SSCFs in Zimbabwe, with an average land size of 148 hectares per farmer (Zimstat, 2019). Farmers occupying land in the ORAs were resettled during the initial land redistribution programme. Between 1982 and 2010, the government acquired land from the LSCF sector through a willing buyer, willing seller approach. This land was then used to resettle farmers from communal lands (Matondi & Dekker, 2011; Zimstat, 2019). The land allocation was carried out under the Permit tenurial regime, and the resettlement followed five models as outlined in Table 3.2. While the resettlement allowed land-constrained Zimbabweans to access and occupy land, researchers have highlighted a notable gender disparity. Several scholars have pointed out that women did not benefit as significantly from the redistribution programme compared to men (Bhatasara & Chiweshe, 2017; Gaidzanwa, 2011; Matondi & Dekker, 2011; Mutopo et al., 2014).

Table 3.2: Resettlement Models in Zimbabwe

Model	Characteristic
A	The individual family holding is five hectares plus common grazing land for livestock. The homesteads are in villages, and fields are in designated areas.
B	Members of a co-operative were given an area to operate as a unit, though some of the co-operatives are now defunct, and the members currently operate individually. Two Model Bs now exist; B1 - still a cooperative, and B2 - individualised.
C	Farmers from Communal Lands were given additional land in the neighbouring large-scale commercial area where they operate as a cooperative. This model was operational in two districts of Manicaland province but no longer exists.
D	Farmers were resettled in cattle ranching areas. This model was mainly found in Matabeleland South province but no longer exists.
E	These are Self-Contained Units where farmers were resettled, similar to the SSCFs, where an individual has a farm for crop and livestock production. The average farm size is 50 hectares.

Source: Zimbabwe Smallholder Agricultural Productivity Survey (2019).
Note: All these lands were occupied under the permit tenurial arrangement, with farmers given permits to occupy land by the state

The A1 and A2 Farms were established as a result of the accelerated land reform programme in the early 2000s. As part of this initiative, the government acquired farms from LSCFs and relocated farmers from urban areas and CLs into two accelerated resettlement models, A1 and

A2 Farms. A1 farms were designed as communal areas, and landholders were allocated land under the Permit tenurial arrangement. Landholders received offer letters from the state as evidence of ownership of the farms. The issuance of offer letters has, however, been critiqued as not providing enough tenure security since the state can withdraw the offers at any time. In terms of structure, these farms have a common grazing area for livestock and at least six hectares of land (depending on the AER) allocated to individual families. In this scheme, households are located a distance from the allotted fields in villages.

The A2 Farms are commercial models where individual farmers are allocated plots of various sizes depending on the AER for crop and livestock production. The state allocated the farms under the Leasehold tenure for lease agreements lasting 99 years. While, both men and women, were issued farms either jointly or individually, Matondi and Dekker (2011) argue that the number of women owning A1 and A2 farms remained relatively low.

All communal lands in Zimbabwe are governed by Customary tenure, regulated by the Tribal Trust Land Act and the Communal Land Act, with the administrative authority vested in the President. Landholders in the communal areas live in villages and share access to collective pastures. Agricultural production is mainly for staple consumption, with any surplus for income. Farmers in CLs account for about 51% of Zimbabwe's total population and occupy nearly 42% of the nation’s total land area (Zimstat, 2019). Land allocation in communal areas is directed toward male lineage members who are customarily recognised as the holders of the land. Village headmen under the authority of the chiefs oversee land allocations (Gaidzanwa, 1994). Women’s land access in the communal areas is through marriage, inheritance or other male relations (Gaidzanwa, 1994).

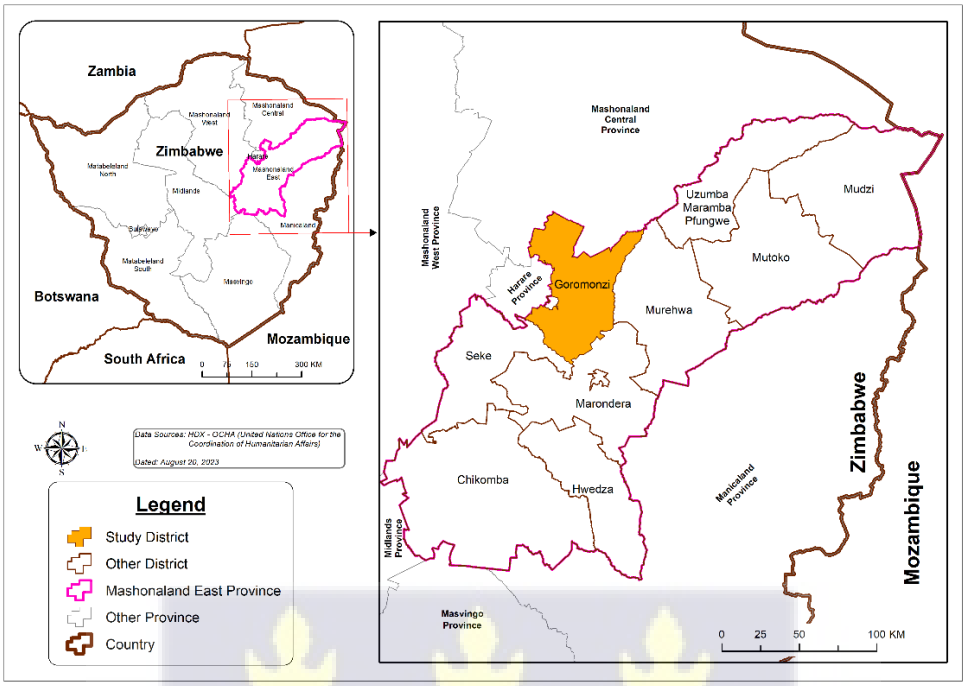
3.2.3 Goromonzi District, Mashonaland East Province, Zimbabwe

Goromonzi district, is located in Mashonaland East province, 32 km out of the capital city, Harare (Fig. 3.1). This district was selected because it has the largest communal land area under chiefs, Chikwaka, Chinyika, and Chinhamora, compared to other districts. As a result, it is home to many smallholder farmers concentrated in these communal areas (Zimstat, 2019). Official records identify four smallholder farming sectors in the districts: communal lands, small-scale commercial farming areas, ORAs, and A1 farmers (Zimstat, 2019). However, this study focuses on smallholder farmers in communal lands, excluding the resettled A1 and small-scale commercial smallholder sectors.

The district's size is 2 559 km² and covers 234 072 hectares (Zimstat, 2012). Demographically, the district has a population of 386, 199 representing 2.5 per cent of the national population. There are more women than men in the district, with corresponding figures of 199,006 (52%) and 187, 193 (48%), respectively. Goromonzi district is predominantly rural, with 75 per cent of the population residing in rural areas and only 25 per cent living in urban areas. There are approximately One hundred and two thousand (102,000) households with an average family size of 3.8 in the district (Zimstat, 2022).

Figure 3.1

Map of the Study Site



Map created by Mr J. Tetteh (PhD Candidate) Department of Geography and Resource Development

Goromonzi district is located in the country's Natural Region II. It is acknowledged as having some of the most fertile soils in the country. For this reason, it is considered one of the best agroecological zones. The district receives a high annual rainfall of between1,000-1,200 mm, making it suitable for rain-fed crop production. It has different soil types, including deep sandy, sandy loamy and red clay soils, suited for different crops and agricultural activities. Statistics show that of the twenty-five million, four hundred and seven thousand, two hundred (25 407 200) hectares of land in the area, twenty million and seven thousand (20, 007, 000) are arable (http://www.goromonzirdc.org). The average temperature varies between 15^0 and 20^0 Celsius. The two major seasons are summer (October-March) and winter (April-September). Summers are generally hot and wet, while winters are cold and dry (Zimstat, 2013).

In terms of geographical location, the district is bordered by Marondera to the east, Harare to the west, Manyame to the south and Murehwa and Domboshava to the North. Administratively,

the district has twenty-five (25) municipal wards (13 for commercial agriculture, 11 communal areas, and one Ward for small-scale farming). Compared to Ward 11 (Gutu) which is located in Chikwaka communal lands about 67 kilometres from Harare, other Wards particularly Ruwa, Bromley and Chishawasha are in close proximity to Harare and likely to be peri urbanised. For example, wards such as Domboshava, which is about 29 kilometres and Ruwa, 24 kilometres from Harare have seen considerable urbanisation in recent times with a scramble for land by city workers, even though this remains controversial since communal lands are not for sale. These Wards are also noted for vegetable production due to their close proximity to markets in Harare.

Land tenure arrangements in the district comprises Customary tenure, Freehold (LSCFs and SCCFs), Leasehold (SSCFs) and Permit tenure (A1 farms). The communal areas, which are the focus of this study are governed under the Customary tenure and regulated by the Tribal Trust Land Act and the Communal Land Act, with the administrative authority vested in the President. The lands in these areas are tribal lands for the indigenes. Many of the black Zimbabwean families live in the communal areas. Three chieftainships, namely the Chikwaka, Chinyika and Chinhamora, oversee the communal lands in the district (Makura-Paradza, 2010). These chiefs manage land allocation through the various village headmen. Land allocation in the district's communal areas mirrors distribution patterns in the country's communal areas where land is given to male members of the family, in particular male heads of the household. Women can access land through marriage, inheritance, or male kin.

Agricultural production in the district was predominantly undertaken by LSCFs prior to the Fast Track Land Reform Programme (FTLRP). Communal farmers and SSCFs engaged in production on a much smaller scale. In recent times, most LSCFs have since been replaced by A1 and A2 farms. Although Goromonzi district is known for its prominent agricultural sector,

this has been affected by the drastic fall of the country's economy and constant droughts. Official reports show that maize, tobacco, soya beans and groundnuts are the major crops in the district for food and cash and are supplemented by livestock production. Consequently, households heavily rely on their production for income. Even though the district covers prime agricultural land and is considered food secure, there are variations in the population's ability to meet food needs (Zimstat, 2013). There seem to be no available data on the gendered dynamics of crop and animal production in the district.

3.2.4 Research Sites

This study was conducted in Gutu Ward 11. It is the largest of the eleven municipal wards in the Communal Areas in the district. According to official records, Ward 11 has fifty villages, even though the Agriculture Technical and Extension Service department (AGRITEX) register for the 'Pfumvudza' Agriculture Programme only lists 42 villages. Ward eleven's population according to the 2022 census report is 9,643 and the total number of households is 2,568. The average household size is 3.8 (Zimstat, 2022). Data were collected from 15 villages namely, Gore, Chikodzonga, Timuri, Maendesa, Zavare, Mambera, Chiwhape, Cheuka, Ngoshi, Mavhaza, Chiringa, Maonera, Mavhudzi, Bungu and Mabreza. The village headmen and the Village Development Committee manage the affairs of the villages. Table 3.3 shows a list of these villages.

Table 3.3: List of Study Villages in Ward 11

Study Villages	
Gore	Ngoshi
Chikodzonga	Mavhaza
Timuri	Chiringa
Maendesa	Maonera
Zavare	Mavhudzi
Mambera	Bungu
Chiwhape	Mabreza
Cheuka	

3.3 The Philosophical Underpinning

The philosophical underpinning of this study is pragmatism. Pragmatism is more action-oriented and emphasises the utility of knowledge and its outcomes (Creswell & Plano-Clark, 2011; Morgan, 2014). The pragmatic philosophy adopts a dual stance between positivist and interpretivist ontologies (Goles & Hirschheim, 2000). In contrast to positivism and interpretivism, the pragmatic philosophical paradigm rejects the idea of "one system of philosophy and reality" (Creswell, 2007, p.23). In this view, the philosophy maintains that there are different ways of interpreting the world and doing research to investigate reality. Therefore, blending different approaches may provide a broader understanding of the phenomena under investigation. This encompasses applying multiple methods, techniques and procedures best suited to solve the research problem (Creswell, 2007).

It is, therefore, accurate to describe pragmatism as a paradigm that frees the researcher from the conceptual and practical constraints imposed by positivism and constructivism and thus allows the researcher to employ the methods that yield the most favourable outcomes (Creswell & Plano-Clark 2011; Shannon-Baker, 2016; Morgan, 2014). The researcher can therefore conduct his or her research study inventively to actively address the defined research question (Shannon-Baker, 2016; Morgan, 2014). Morgan (2007) points out that “it is not the abstract seeking of knowledge through inquiry that is central to a pragmatic approach but rather the attempt to gain knowledge in the pursuit of desired ends” (p. 69). This makes a pragmatic researcher both subjective in his or her reflections on research and objective throughout the research process, including data collection and analysis (Shannon-Baker, 2016) These attributes make pragmatism applicable and flexible in diverse research contexts, making it an ideal paradigm of choice for this study.

In this study, pragmatism was the ideal paradigm for a variety of reasons. Firstly, the philosophy coincides naturally with my position as a researcher, as I do not believe that there is a single better methodological tradition for research. Consequently, a pragmatic worldview enabled me as a researcher to find the depth and breadth necessary to understand gendered dimensions of climate change adaptation practices and their influence on farming households' livelihood sustainability in Zimbabwe. Secondly, the research problem required adopting both qualitative and quantitative approaches (mixed method) to provide a thorough understanding of the phenomenon in Zimbabwe by capturing multiple dimensions of how the phenomenon plays out. Scholars have argued that pragmatism embodies several assumptions underpinning the mixed-method research approach (Morgan, 2007; Denscombe, 2008; Onwuegbuzie, 2014; Creswell & Plano-Clark, 2011).

3.4 Research Approach

This study adopts the mixed method research design. Mixed method approaches are advocated by pragmatism. Given that the study has its philosophical foundation within the pragmatic research paradigm, a mixed method is the best approach to inquiry, as it would present a complete picture of the research problem by combining information from complementary kinds of data (Creswell & Plano Clark, 2011; Onwuegbuzie & Collins, 2007). Additionally, the mixed method approach is favoured by feminist scholars who embrace the plurality of methods in conducting research (Hesse-Biber & Yaiser, 2004). Mixing methods harmonises the strengths of qualitative and quantitative methods (Morgan, 2017).

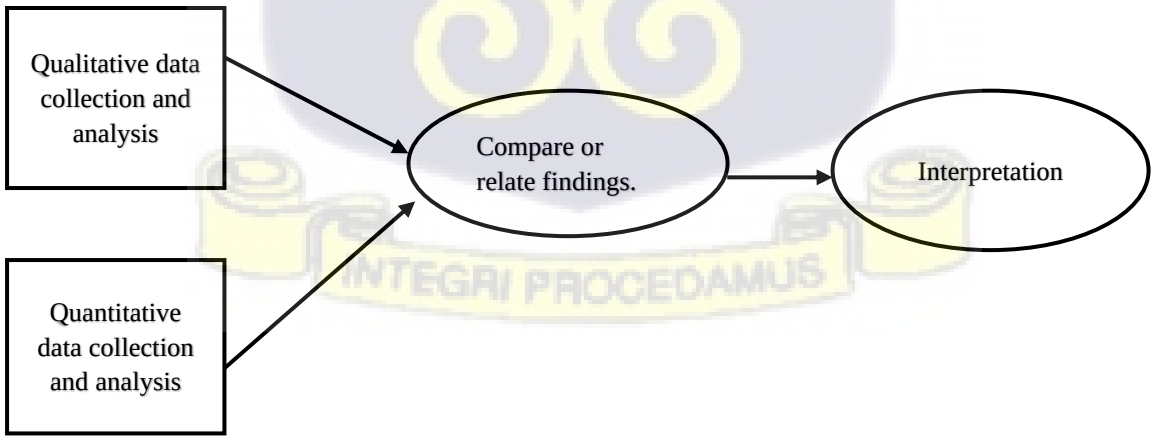
I used the mixed method approach in this study to explain the quantitative findings with the qualitative data (Bryman, 2006), in order to provide a comprehensive understanding of gendered adaptation practices in the context of climate change (Bryman, 2006; Teddlie & Yu, 2019). As a result, the qualitative and quantitative findings provided a more nuanced

understanding of the relationships between gender, climate change adaptation, and livelihood sustainability in the smallholder agricultural sector in Goromonzi District, Zimbabwe.

Specifically, the study followed the convergence parallel design (Creswell & Plano Clark, 2011) or parallel study (Tashakkori et al., 1998) (Fig 3.2). The study's quantitative and qualitative primary data were collected during the same phase of the research, analysed separately, and the results synthesised at interpretation (Creswell & Plano-Clark, 2011) (Fig 3.2). The convergence parallel design was appropriate in this instance because the researcher needed to collect the data and depart the field before election campaigning began for the country's approaching parliamentary and local government by-elections. Thus, while conducting fieldwork between March and April, in-depth interviews, key informant interviews and the household survey were all conducted simultaneously. The use of a concurrent technique of data collection made it possible to quickly gather all the data before I returned to Ghana to do the analysis. The two data sets (quantitative and qualitative) helped to shed light on and answer the research problem.

Figure 3.2

Convergent Parallel Mixed Methods Design



Note: Source: Creswell & Plano-Clark, 2011

3.5 Quantitative Approach and Sampling

A household survey was used for the quantitative element of the study. Enumerated households were randomly selected from a village register. As gatekeepers, the extension officer, a teacher, and the village headmen ensured I could access the study site.

3.5.1 Orientation Phase

Before the main fieldwork, I conducted a reconnaissance visit to the study site in May 2021. The objectives of this visit were to explore the study area to gain general insights into climate change, adaptation, and outcomes and to establish contacts with key informants on the ground. I met the district Extension Officer at the Goromonzi district AGRITEX office. I also met and engaged village heads and smallholder farming households to get information about how climate change affected their livelihoods and how they had been coping. I used the opportunity to enquire about community entry procedures to enable adequate preparation for the actual fieldwork. In March 2022, I returned to Zimbabwe for the actual fieldwork.

3.5.2 Sampling

Sampling was done at the province, district, ward, village, and household levels. Mashonaland East Province, Goromonzi District and Gutu Ward 11 were purposively selected. The Goromonzi district has 25 Wards consisting of Commercial Agriculture Areas (13), Small-Scale Farming Areas (1) and Communal Areas (11). Gutu Ward 11 was purposively selected from the eleven wards in the Communal Areas because it is the biggest Ward in terms of land size and population. Table 3.4 shows the sampling frame from which the villages and households were drawn. Fifteen out of the 42 villages in Ward 11 were selected from village registers obtained from the extension officer, using random sampling.

Table 3.4: Sampling Frame for the Study

Ward 11	Population	Sample Size
Village	42	15
Households	2100	336

Data Source: AGRITEX Records & the ZSAPS (2017)

According to official AGRITEX records, Ward eleven (11) has a total of 2,100 households. The 2,100 households formed the sample frame from which the sample size was drawn. This sample was calculated based on Yamane's method for estimating household survey samples (Yamane, 1967) expressed as:

$$n = \frac{N}{1 + N(e)^2}$$

Where 'n' is the sample size of the study, 'N' is the target population (total number of smallholder households in Ward 11) and 'e' is the precision of sampling error (0.05). The confidence interval indicates the margin of error assumed for the average responses. For instance, if 20% of the sample picks a response, we can be sure that if the entire population were to be asked the question, 15% (20%-5%) and 25% (20%+5%) would pick that answer. With a 95 per cent confidence level, a 5 per cent error margin was used to draw the sample of 336 smallholder households as shown below.

$$n = \frac{2100}{1 + 2100(0.05^2)} = \frac{2100}{6.25} = 336$$

Although the sample size calculator determined a sample of 336, a total of 256 households were eventually surveyed, resulting in a response rate of 76 percent. The discrepancy between the computed sample size and the actual number of households surveyed was due to an unforeseen circumstance that required truncating data collection. The commencement of the local government and parliamentary by-elections campaign led to restrictions on research and other activities deemed to interfere with the campaign leading to the early termination of the fieldwork.

The surveyed households were randomly selected from village registers of all the selected villages, obtained from the Extension Officer and confirmed through the village heads' and village secretaries' records. The selected 256 households constituted 147 (57%) male-headed and 109 (43%) female-headed households. The sample per village was aimed at 15 households with the condition that people are willing to participate. However, due to uncertainty on the field, the village samples varied in the end with some villages having more households selected than others (Appendix 1A). This was not an issue of concern since the Ward was considered as a single entity in the analyses, in addition to the fact that the villages in the Ward are homogenous and therefore selected households were a representation of the Ward.

Based on the sampling technique employed (random sampling) to select the households, the sample size derived is a representation of the target population (Ward 11 smallholder households). Given that the Ward was considered as an entity, findings from this study can be easily generalised to other Wards in the communal areas where households engage in small-scale farming in the Goromonzi District. In terms of validity, in the data collection and analysis procedures, the study utilised elements from established research instruments (e.g. Nguthi, 2007). This implies that other researchers can adopt the instrument developed for this study and replicate it in other smallholder communities.

3.5.3 The Household Survey

A household survey was used as the primary tool for collecting quantitative data. It was useful in capturing respondents' demographic characteristics and behaviours. I was particularly interested in capturing extensive disaggregated information on the gendered dimension of climate change adaptation in the Goromonzi district and how it influences livelihood sustainability in smallholder farming households. In the context of this study, a household is defined according to the Zimbabwe Demographic and Health Survey (ZDHS). It refers to a

person or group of related and unrelated persons who live together in the same dwelling unit(s), acknowledge one adult male or female as the head of the household, share the same housekeeping arrangements, and are considered a single unit (Zimbabwe National Statistics Agency [Zimstat], 2016). Because households are considered the primary institutions where resource sharing and exchange occurs, the household was chosen as the micro-level basic unit of analysis in this study (Bruce, 1995). The type of data collected was cross-sectional because households were surveyed at a particular time, with each observation about different households.

3.5.3.1 Survey Questionnaire Design and Administration

The survey instrument was designed in four major sections and under several themes. The sections were household assets, livelihoods and economic activities, household income and food security and climate change perspectives, adaptation practices and constraints. Table 3.5 summarises the sections and themes under which the questionnaire was constructed. After the questionnaire design, a Computer Assisted Personal Interviewing (CAPI) system was developed using the kobo collect tool. The assistance of the Agriculture and Technical Extension Officer and a teacher from the community high school, St. Charles Mavhudzi Secondary School, was enlisted to recruit and train enumerators. Ten fieldwork enumerators were engaged for the fieldwork. Before commencing the fieldwork, the enumerators were trained for 1.5 days. The training was necessary because the enumerators needed to understand the survey questions, translate them into the local language and be conversant with the tablet device used to collect data. The training also offered the enumerators the opportunity to learn the process of synching data to the server, which was done at the end of each fieldwork day.

Table 3.5: Questionnaire Sections and Themes

No.	Section Title	Themes
1	Household assets	human capital (household size, composition and structure; hired labour; in-migration; out-migration
		Natural capital (land size and use; water; fuel energy)
		Physical capital (farm equipment and household assets; livestock)
		Financial capital (bank savings and stores value; credit)
		Social capital (Group membership; social exclusion and inclusion)
2	Livelihood and major economic activities	Livelihood activities
		Crop and animal production
3	Household income and food security	Sources of income and income earned
		Household food security
4	Climate change perceptions and adaptation practices	Experiences of climate change- awareness, perceived indicators of changes, causes, impacts
		Specific adaptation arrangements
		On-going on-farm adaptation strategies
		On-going off-farm adaptation strategies
		Constraints to adaptation
		Climate change institutional context

Source: Author's construct

As the first point of contact, the Extension Officer introduced me to the Ward Councillor who facilitated my community entry linking me to the key individuals in the area, including village headmen and political leaders. These individuals acted as gatekeepers and facilitated the fieldwork process in different ways. They also represented the interests of villagers, communities and organisations in the district (Gallo et al., 2012). The gatekeepers also played a significant role in safeguarding the researcher's and the enumerators' safety during the data collection period, which was close to the by-elections for the parliament and local governments. I visited the district's Zimbabwe Republic Police (ZRP) office to submit relevant documentation and inform them of my presence and mission for security reasons. In each of the villages sampled, the first point of contact was the village headman, who authorised entry into households.

In many villages visited, the headmen required identity cards to know whose household I belonged including my father's and grandfather's names to establish rapport. This process and the presence of the extension officer on the team allowed for a smooth data collection process

because the villagers had trust in the enumerators and offered information freely. For each sampled household, I interviewed the household head. The household head served as a proxy for investigating gender differences that may exist in farming households' adaptation practices and livelihood sustainability. Focusing on only the household head, however, overlooks gender differences within households, because for example, women in female-headed households may not always have the same experiences as women in male-headed households (Doss & Morris, 2001). Despite this and taking into account the structure of farming households in Zimbabwe, a considerable contribution can still be made by contrasting male-headed and female-headed households.

3.5.3.2 Data Analysis and Interpretation

Creswell and Plano-Clark (2011) propose a data collection and analysis procedure using the convergent mixed method design. In this study, two data sets were collected (quantitative and qualitative) and analysed separately, then merged for interpretation. The quantitative data was managed before the analysis, taking care of outliers and some reported responses that needed clarifications with the help of the enumerators. The analysis was done using the STATA statistical tool and focused on descriptive statistics including frequency tables, cross tabulations, percentages, t-tests and chi-square tests. The chi-square tests examined the association between categorical variables at a 90% confidence interval. In addition to the descriptive statistics, inferential regression analyses were carried out to investigate the relationships between independent and dependent variables.

The inferential statistics encompassed the Poisson and Ordinary Least Square (OLS) regression models. The Poisson regression model examines the factors that influence smallholder farmers' adaptation practices (as stated in Objective Three), while the OLS regression model analyses the relationship between adaptation practices and the sustainability of smallholder households'

livelihoods (as stated in Objective Three). Details of these estimation techniques are described next.

3.5.3.3 Poisson Regression

The Poisson regression model was used to analyse the factors that determine the intensity of climate change adaptation (dependent variable) by the households measured as a count variable. Typically, count-based response variables (y) are best modelled using Poisson regression. The Poisson regression model specifies that each observation of the dependent variable (y_i) is drawn from a Poisson population with parameter (λ_i), which is related to the independent variables (x_i) (Greene, 2012). The general formula of the Poisson regression model is expressed as:

$$\Pr(Y = y \mid x_i) = \frac{e^{-\lambda_i} \lambda_i^{y_i}}{y_i!}, y_i = 0,1,2,... \qquad Eqn(1)$$

The parameter (λ_i) expressed as a log-linear model is related to the independent variables as:

$$\lambda_i = x_i^{'}\beta \qquad Eqn(2)$$

It can be shown from Equations (1) and (2) that the number of events per period is given by:

$$E[y_i \mid x_i] = Var[y_i \mid x_i] = \lambda_i = e^{x_i^{'}\beta} \qquad Eqn(3)$$

The key assumptions underlying the Poisson regression model are:

- The observations must be independent of one another.
- The mean of a Poisson random variable and its variance must be equal, as expressed in Equation (3).

Equation (3) can be re-written as:

$$E(y \mid x_1, x_2, ..., x_k) = \exp(\beta_0 + \beta_1 x_1 + ... + \beta_k x_k) \qquad Eqn(4)$$

The dependent variable (y_i) is the intensity of climate change adaptation (INCLAD) which is regressed on a vector of regressors (x_i). The empirical model is therefore expressed as:

$$INCLAD_i = \beta_0 + \beta_1 HHSIZE_i + \beta_2 PHYCAP_i + \beta_3 FINCAP_i + \beta_4 NATCAP_i + \beta_5 GENACC_i + \beta_6 HHSEX_i + \beta_7 HHAGE_i + \beta_8 HHEDU_i + \beta_9 COMENG_i + \beta_{10} INDKNOW_i + \beta_{11} ACCEXT_i + \mu_i \quad Eqn(5)$$

where, 'INCLAD' is the intensity of adaptation, 'HHSIZE' is the size of the households, 'PHYCAP' is the value of physical capital, 'FINCAP' denotes financial capital and is a measure of the average score of savings and access to credit in the past year, 'NATCAP' is a ratio of arable lands, 'GENACC' is gender access to farmlands, 'HHSEX' is the sex of the household head, 'HHAGE' is the age category of the household head, 'HHEDU' is the education level of the household head, 'ACCEXT' is farmers' access to extension services, 'COMENG' refers to community engagement and participation, 'INDKNOW' is indigenous knowledge of climate change, the symbol μ is the error term, β_0 is the constant term, and β_i are the parameter estimates of the model.

The variables used in the model were derived from the literature which established that household size, physical capital, financial capital, natural capital, gender, age, community engagement, indigenous knowledge and access to extension services influence adaptation decisions and behaviours (e.g. Atube et al., 2021; Belachew & Ababu, 2021; Belay & Fekadu, 2021; Diarra et al., 2021; Faisal et al., 2021; Nyahunda & Tirivangasi, 2021; Saptutyningsih et al., 2020; Zamasiya et al., 2017). A detailed description of the variables in the Poisson model is provided in Table 3.6 under Section 3.5.3.5.

3.5.3.4 Ordinary Least Square Regression (OLS)

OLS is a linear regression that describes the relationship between one or more independent quantitative variables and a dependent variable which is linear in relation to the regressors. The OLS method minimises the differences between the sum square of the observed and predicted

values (Greene, 2012). For the best linear unbiased estimators (BLUE) of the OLS model, certain assumptions must be met:

- The expected value of the error term should be equal to zero (constant).
- The error terms variance should be constant; in other words, they should be homoscedastic or equal to 0.
- There should be no autocorrelation or serial correlation between the error terms. The covariance of the error terms should be equal to 0.
- The explanatory variables and the error term should be uncorrelated. (They should be exogeneous of the error term).
- The regression model is linear in parameters.

The OLS regression model is thus specified as follows:

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n + \mu_i \qquad Eqn(6)$$

For the OLS model, the dependent variable (y_i) is the livelihood sustainability ($SUSTLIVE_i$) expressed as a function of the regressors (x_i). The factors influencing sustainable livelihood are derived from literature and conceptual framework and include climate change adaptation, household income, food security, access to extension services, migration, household type, dependency ratio (Berry et al., 2015; Eyasmin et al., 2021; Kamaruddin & Samsudin, 2014; Mishi, 2014; Samal, 2007; Xing, 2018). The empirical model for the study is therefore presented as follows:

$$SUSTLIVE_i = \beta_0 + \beta_1 INCLAD_i + \beta_2 INCOME\_PC_i + \beta_3 CHILD\_5_i + \beta_4 CHILD\_6\text{–}17_i + \beta_5 FS_i + \beta_6 HHSEX_i + \beta_7 ACCEXT_i + \beta_8 MIGRATE_i + \beta_9 HHTYPE_i + \varepsilon_i \qquad Eqn(7)$$

where, SUSTLIVE is the dependent variable representing livelihood sustainability, INCLAD is the intensity of adaptation, INCOME_PC is the log of household income per capita, CHILD_5 is the number of infants (0-5yrs), CHILD_6-17 is the number of children between the ages of 6 to 17 years, FS is the household food insecurity score, HHSEX is the gender of

the household head, ACCEXT is access to extension services, MIGRATE is the migration status of the household, HHTYPE is the household type (nuclear or extended), β_0 is the constant term, and β_i are the parameter estimates of the model and ε_i is the error term.

In addition to the main OLS model for the full sample, two other models were estimated to determine the effects of female-dominant and male-dominant adaptation strategies on households' livelihood sustainability. These models are specified in equations 8 and 9 below.

$$SUSTLIVE_i = \beta_0 + \beta_1 FEM\_STRAT_i + \beta_2 INCOME\_PC_i + \beta_3 CHILD\_5_i + \beta_4 CHILD\_6-17_i + \beta_5 FS_i + \beta_6 HHSEX_i + \beta_7 ACCEXT_i + \beta_8 MIGRATE_i + \beta_9 HHTYPE_i + \varepsilon_i \quad Eqn(8)$$

where, FEM_STRAT are the female-dominated adaptation strategies.

$$SUSTLIVE_i = \beta_0 + \beta_1 MALE\_STRAT_i + \beta_2 INCOME\_PC_i + \beta_3 CHILD\_5_i + \beta_4 CHILD\_6-17_i + \beta_5 FS_i + \beta_6 HHSEX_i + \beta_7 ACCEXT_i + \beta_8 MIGRATE_i + \beta_9 HHTYPE_i + \varepsilon_i \quad Eqn(9)$$

where, MALE_STRAT are the male-dominated adaptation strategies.

A detailed description of the variables in the OLS model is provided in Table 3.6 under Section 3.5.3.5.

3.5.3.5 Description of Variables and Measurements

Dependent Variables

The dependent variable in the Poisson regression model is the number of adaptation strategies employed, which reflects the intensity of climate change adaptation by the households. In the model, it is denoted by INCLAD. The intensity of adaptation variable denotes that the households' level of adaptation increases as more adaptation measures are implemented. In Gutu Ward 11, thirteen adaption practices were identified. These are; stopped-growing crops, shifting planting dates, crop staggering, crop rotation, intercropping, mulching, zero-tillage, irrigation, water harvesting, tree planting, mixed farming, off-farm activities and planting hybrid crop varieties.

Livelihood sustainability (SUSTLIVE) is the dependent variable in the OLS regression model. A composite livelihood sustainability index measures this variable and was developed using the techniques by (De & Das, 2021). The CLSI was constructed using the five livelihood capitals (human, physical, natural, financial, and social) as depicted in the SLF. The principal component analysis (PCA) method was used. Key features of the PCA like the Kaiser-Meyer-Olkin which asserts the reliability of an index are presented in Table 1B, Appendix 1. PCA is a systematic and reliable quantitative data reduction tool for measuring composite scores. In essence, PCA identifies new variables that are uncorrelated linear functions of the original dataset's variables that successively maximise variance (Jolliffe & Cadima, 2016).

Independent Variables

Conceptual and theoretical concepts and literature informed the choice of explanatory variables. Physical capital (PHYCAP) constituted the market value of household assets (e. g. furniture and household equipment), economic assets (e. g. farm equipment, business items), and livestock possessed by the households. These assets were valued at their current price in US$. The natural capital (NATCAP) variable was measured by the total lands in acres possessed by households. A household's financial capital (FINCAP) is a measure of the average score of savings and access to credit in the past year.

The demographic characteristics of the household constitute another category of independent variables. Household size (HHSIZE) was measured by the number of household members who share the same cooking arrangements and designated one member as the head. Other characteristics include the sex of the household head (HHSEX), which is measured as a dummy variable (male=0 and female=1); the age of the household head (HHAGE), which is measured as a categorical variable (18-35 years = 1; 36-60 years = 2; 60+ years = 3), household per capita income (INCOME_PC) which is a continuous variable derived by dividing the total annual

household income generated from farm and non-farm work by the household size, and presented in its log form and the two other continuous variables; (CHILD_5) which is the number of infants in the household and CHILD_6-17) representing the number of children between the ages of six and seventeen. The household type (HHTYPE), whether a household is nuclear or extended and migration status of the household (MIGRATE) were also included as binary variables. Household food insecurity (FS) is a continuous food insecurity scale calculated based on the nine severity questions in the Household Food Insecurity Access Score (HFIAS) (Coates et al., 2007).

The Poisson regression model had one other gender variable. Gender access to farmlands (GENACC) which illustrates the sex with the most access to community lands (men=0; women=1). Other independent variables used across the Poisson and OLS models are access to extension services (ACCEXT), a binary variable represented by yes=1 and no=0. Community engagement and participation (COMENG), also a binary variable of the household's ability to participate and engage in community activities, measured by yes=1 and no=0. Adaptation strategies (INCLAD) a count variable measuring adaptation intensity, male-dominated adaptation strategies (MALE_STRAT) and female-dominated strategies (FEM_STRAT) were used in the OLS models to measure households' livelihood sustainability. Finally, indigenous knowledge about climate change (INDKNOW) is a binary variable of whether the respondents had any knowledge of local indicators of climate change. The measurements of these variables and other variables mentioned in the preceding paragraphs are described in the summarised Table 3.6 below.

Table 3.6: Description of Research Variables

Variable Type	Variable Name	Variable form	Brief Description and Measurement
Dependent variables	INCLAD	Count	Intensity of climate change adaptation. It is measured by the number of strategies employed by a household
	SUSTLIVE	Continuous index	Livelihood sustainability of a household. It is measured by an asset index in a continuous form. The index was created using the PCA, which reduced the physical, financial, social, human and natural capital into one index.
Independent variables:	HHSIZE	Continuous	Household size. It is measured in the number of members in the household
	FEM_STRAT	Count	Adaptation strategies prevalent in FFHs
	MALE_STRAT	Count	Adaptation strategies prevalent in MHHs
	PHYCAP	Continuous (natural log)	Household physical capital measured by the total current valuation of economic assets, household assets, and livestock in US$.
	FINCAP	Continuous	Financial capital of the household. The variable was generated using as a simple average index of households who save and those with access to credit in the past year.
	NATCAP	Continuous	Household natural capital. It is measured by the ratio of arable land and the total land possessed by the household in acres with values 0-1.
	GENACC	Categorical (dummy)	Gender access to community lands. It establishes who has the most access to community farmlands. The values are men = 0 and women =1
	HHSEX	Categorical (dummy)	Sex of the household head, whether male =0 or female = 1
	HHAGE	Categorical	Age category of the household head. The categories are 18-35yrs =1; 36-60yrs = 2 and 60+yrs =3
	ACCEXT	Categorical (dummy)	Access to extension services. It measures whether households have access to extension services represented by Yes = 1 and No = 0
	COMENG	Categorical (dummy)	Community engagement and participation. It is measured by ascertaining whether the household participates in community activities Yes = 1 and No = 0
	INDKNOW	Categorical (dummy)	Indigenous knowledge about climate change, represented by Yes = 1 and Otherwise = 0
	INCOME_PC	Continuous	Household per capita income. This variable was generated by dividing the total annual household income by the household size. It is measured in US$.
	CHILD_5	Continuous	Number of infants in the household.
	CHILD_6-17	Continuous	Number of children in the household between the ages of six and seventeen
	FS	Continuous	Household food insecurity access score (HFIAS) measured by nine severity questions.
	MIGRATE	Categorical (dummy)	Migration. It was measured by asking whether any household member had migrated out of the household. Yes =1 or No = 0
	HHTYPE	Categorical (dummy)	Type of farming household. It was measured by whether a household is Nuclear = 0 or Extended = 1

Source: Fieldwork data

3.5.3.6 Index Categorisation

The Composite Livelihood Sustainable Index (CLSI) and human capital indices were categorised using equal intervals where the index was divided into equal parts (Basaraner & Cetinkaya, 2017). The following ranges were used in the classification: Category 1: 0.00-0.25 (low); Category 2: 0.26-0.75 (moderate); Category 3: 0.76-1.00 (high).

3.6 Qualitative Approaches

The qualitative component of the study utilised in-depth interviews (IDIs) and key informant interviews (KIIs) to obtain primary data on the gendered dimensions of climate change perceptions, adaptation practices and outcomes, constraints and livelihood sustainability. Participants for the KIIs and IDIs were purposively selected. Using purposive sampling allowed for the selection of rich-information cases to achieve an in-depth understanding (Patton, 2002) of gendered climate change adaptation and livelihood sustainability in smallholder farming households.

3.6.1 In-depth interviews

Interviewing is an important data collection tool that elicits information about people's experiences, thoughts, opinions, and attitudes using open-ended questions and probing (Patton, 2002). When conducting interviews, the researcher can probe into the participant's thoughts, feelings, and viewpoints (Bloor & Wood, 2006), and the participants can articulate their opinions on the topic at hand (Bernard, 2006). The interviews with smallholder farmers in Ward 11 entailed asking questions, listening and recording the answers and, where necessary, posing additional questions to clarify or expand specific points. I developed an open-ended guide with themes that complemented the household survey tool. As a result, participants could speak freely about their experiences with climate change, including its perceived causes and impacts, and implemented adaptation measures and outcomes. Sampling for the in-depth

interviews was purposive, and the sample size was determined by the principle of data saturation (Lincoln & Guba, 1985; Onwuegbuzie & Collins, 2007) and to make theoretical generalisations (Yin, 2013).

In-depth interviews with thirteen (13) smallholder farming households were conducted. The distribution of participants comprised seven (7) male heads and six (6) female heads of farming households. The participants' homes and farms were the locations of the interviews. A voice recording device was used to record the interviews for attentive listening, and a notebook was used for field notes. The audio recording was instrumental because it provided an accurate verbatim record of the interviews. The length of each interview ranged from forty to sixty minutes. Even though some participants assumed I was working with an organisation that would distribute goods and essentials in the future, most participants were open-minded and welcoming.

3.6.2 Key Informant Interviews

Key informant interviews entail interviewing individuals with unique insights on a topic. The aim is to interview a small group using an interview guide. Interviewers may build questions from a list of topics to explore in the guide, making the interviews unstructured and more like a casual conversation between friends (Patton, 2002). In this study, I considered key informants particularly important because they are knowledgeable about the study area and could provide insights and valuable information (Patton, 2002) to help me understand what has been happening concerning climate change and how smallholder farmers have responded. As a result, I recruited key informants that represented different demographic characteristics and value alignments by selecting from four categories: agricultural extension services, environmental management services, farmers' unions and village headmen.

The key informants helped to shed more light on the macro-level interventions and programmes available to farmers and their outcomes. I also inquired about climate change in the district, its impacts on smallholder farmers' livelihoods and the adaptation practices implemented. The breakdown of the key informants interviewed was Extension Officer (1), Environment Management Agency officers (2), one female Farmers' Union Representative for Ward 11 and two village headmen from Gore and Mambera villages. Of the two officers, one was a female District Forestry Commission Officer and the other a male Environment Management Monitor. In total, six (6) key informants participated in the study. These key informants were invited to participate in the study through a formal letter and follow-up calls to schedule an interview date, time, and location. The interviews with key informants were conducted using guides that varied depending on the group the informant represented. Interviews took place either at their place of work or their homes. All the interviews lasted between 40 and 60 minutes.

3.6.3 Secondary Data

In addition to the primary data, secondary data were obtained from the government of Zimbabwe's central statistics reports published by the Zimbabwe Statistical Services (Zimstat). The reports included the Zimbabwe National Census Report (2022), Zimbabwe Smallholder Agricultural Productivity Survey 2017 Report, Zimbabwe Vulnerability Assessment Committee 2020: Rural Livelihoods Assessment Report, The Food Poverty Atlas (2016) and the Zimbabwe Demographic and Health Survey (2016). These sources provided data on the profile of the study area, demographic characteristics, and the nature of agriculture and climate change in Zimbabwe.

3.7 Data Analysis and Interpretation

Qualitative data analysis occurred concurrently with quantitative data analysis. The qualitative data analysis was underpinned by Saldana's (2009) recommendations for qualitative data analysis and based on the objectives and research questions of the study. Saldana (2009) suggests that qualitative data analysis follows the first and second cycle coding. I transcribed the interviews verbatim and organised and stored the transcripts and field notes. I thoroughly read the transcripts, which enabled me to make sense of the data. This was followed by the first cycle coding, which involved assigning codes to chunks of data. I searched for patterns in the first cycle codes and combined similar codes. I then carried out the second cycle coding, which involved grouping the first cycle codes into smaller categories based on the identified patterns. I generated pattern codes by tying together data bits under broad categories and themes. These themes appear in the presentation alongside the quantitative results with supporting quotations.

3.8 Ethical Considerations

To ensure that the research was carried out in a manner consistent with internal standards, ethical approval to carry out the study was sought from the Ethics Committee for Humanities (ECH) at the University of Ghana. In Zimbabwe, permission to enter the study site was sought from the Ward Councillor and the ZRP Office in the district. This process involved sending letters of introduction, ethical clearance letters and personal identification documents. Confidentiality was guaranteed, respondents' approval was solicited verbally and in writing, and participants were urged to air their opinions without restraint. Although the research instrument's questions were non-political and did not require respondents to specify which political party they belonged to, several respondents nevertheless worried that the information they provided would be compromised. The country was just a few weeks away from holding by-elections to choose councillors for various wards, which was the leading cause of their

apprehension at the time. Respondents were reassured of confidentiality to address this concern, and voluntary participation was reaffirmed, ensuring that they knew they could withdraw from the study anytime they felt discomfort. Assurance of anonymity was given by eliminating the usage of identifying markers (Lofland et al., 2006) in the presentation of study findings.

Another ethical issue involved incentives. For example, households participating in the in-depth interviews were given 2kgs sugar and a soap bar. I considered these gifts culturally appropriate because of the prevailing economic situation in Zimbabwe at the time. A third ethical issue encountered involved the dilemma of wearing nose masks when approaching respondents. The fieldwork was carried out when nose mask-wearing was still mandatory in Zimbabwe. It was a dilemma because we were unsure how respondents would feel seeing enumerators approaching their households wearing nose masks with bottles of sanitisers on their backpacks. I insisted that enumerators carry extra nose masks and offer nose masks to household members who wanted them. To my surprise, many respondents took it well and requested even more nose masks to keep in their homes. In addition, measures were taken to observe all the covid-19 protocols. For example, all interviews were to be conducted outside under a tree or shed except when the weather did not allow it.

3.9 Study Limitations and Challenges

One limitation of this study is that it did not consider an intra-household analysis which explores the dynamics and power relations within a household. This type of analysis is particularly important in examining how resources, decision-making and responsibilities are distributed within a household. Focusing on the household head's gender may overlook some important nuances and complexities within male-headed and female-headed households. However, due to limited time and resources, I sought to examine the overall differences

between male-headed and female-headed households, which still provides valuable insights into the gendered nature of climate change adaptation practices and livelihood sustainability in smallholder farming households.

In terms of challenges, I was confronted with some difficulties related to accessing the study site for data collection. Around the time of my fieldwork, the government had issued a directive to disallow anyone from engaging in research work in the villages. Shortly after we began fieldwork, I was summoned to the police station, ordered to truncate data collection and to request clearance from the police headquarters. This process was going to take between 2 and 4 weeks, considering that I had limited time to collect data before the campaign for the parliamentary and local government by-elections. I was interrogated about my motivations and the purpose of the study. I gave assurance that I was a student at the University of Ghana and in Zimbabwe to collect data for the award of a degree. The police declined my offer to contact my institute for confirmation, stating they were uncertain whether the person on the other end of the line would be my director. Even worse, the police implied that my documents might be falsified. After the Ward Councillor intervened, and the police were sure of my parents' identity, I was permitted to continue gathering data.

For this reason, it took us four weeks of arduous work to gather all the necessary data. This challenge was strongly tied to the security threat, as there was a general concern of raising the villagers' suspicions about what we were doing. The issue was resolved by ensuring that all the enumerators, including myself, always carried national identity cards (chitupa). An identity card is so important in Zimbabwe that showing one to anybody will ensure they know where you are from because the names of the Chief and village headmen are imprinted. Our safety was also guaranteed by introducing ourselves to the village headmen in each sampled village. Village headmen were the first point of contact in each enumerated village.

Another challenge encountered was the request for gifts by the respondents. Even though the objectives and purpose of the study were clearly outlined and explained, respondents still expected some reward for their time. The issue of some villagers requesting to be interviewed even though their households had not been selected was related to this dilemma. Some villagers believed we represented an organisation that would show up later to provide food and other household items. One particular female household head lamented that households A, B, and C are consistently chosen each year for some programme, while her household has never been selected. This was coupled with the fact that there was an ongoing '*tsotso*' stove[3] project (fuel-efficient smokeless stoves) during the fieldwork period and people who had not benefited from that programme felt left out once more after not being selected to participate in my study. However, those agitating to participate and requesting gifts were reassured that the study was for academic purposes and benefits to the communities would come in the form of interventions and programmes by the required stakeholders after the dissemination of findings.

The final challenge represented translating and interpreting the research instruments into the local language. The agriculture Extension Officer assisted in this regard due to his vast knowledge of the jargons and terms used in the research instrument. Additionally, research assistants received proper training and participated in role-play to ensure their grasp of the questions in both Shona and English languages.

Even though these challenges interrupted the data collection and shortened the time spent on the fieldwork, it did not compromise the quality of the data collected. The adequate training of the enumerators ensured that survey data was complete, and all questionnaires were validated.

[3] *'Tsotso'* stove is an energy efficient stove introduced in the 1980s by David Hancock at the Development Technology Centre (University of Zimbabwe). '*Tsotso*' in Shona means 'small log or twigs', which is how the stove is powered. It requires just a few logs or twigs to cook an entire meal for the family. Over the years it has continued to improve, and various versions have emerged with the implementation carried out by both governmental and non-governmental organisations. In the study area the one that was being implemented during the data collection period was built with bricks and cement and implemented under a local NGO.

CHAPTER FOUR

PERCEPTIONS AND EXPERIENCES OF CLIMATE CHANGE AMONG SMALLHOLDER FARMERS IN WARD 11

4.1 Introduction

This chapter begins by describing the socio-demographic profiles of respondents to allow for a better appreciation of the composition and structure of farming households in Ward 11, Goromonzi district, Zimbabwe. Generally, farmers' perceptions on the changing climate are influenced by their experiences of the phenomenon (Yaro, 2013), which includes the signs they notice, the effects on livelihoods and their beliefs on what drives the climate to change. This chapter focuses on farmers' perceptions and experiences of climate change and whether they are aware that the climate is changing. This is particularly important since awareness of climate change prompts adaptation decisions and behaviours.

Additionally, the chapter provides evidence of climate change as witnessed by farmers through meteorological and ecological indicators over time. This is followed by a discussion on the perceived causal factors contributing to climate change along with the ways they interfere with farmers' livelihood portfolios in the study area. Findings are discussed in reference to important sociodemographic variables, including gender, age, and level of education of the household head in order to facilitate a better understanding of the differences among various social categories.

4.2 Socio-demographic Characteristics of Smallholder Farming Households in Ward 11

Ward 11's demographic characteristics reveal that male farmers[4] were the predominant group, comprising approximately 57 per cent (n=147) of the sampled population, while female farmers[5] constituted 43 per cent (n=109). This trend was similar with the qualitative sample, where the 13 household heads who participated comprised seven male and 6 female farmers (Appendix 3A). The age distribution of the farmers indicated that the majority were above 36 years, with a large proportion (52 %) falling within the 36-60 years (adults) age category. Among those in the 36-60 years age group, there was a higher percentage of male heads (53%), whereas female heads were more prevalent in the elderly (60+ years) category (48%) (Table 4.1).

The profiles further show that a higher proportion of smallholder farmers (43%) had attained their secondary education ("O" and "A" levels). In terms of educational differences based on gender, a higher percentage of female farmers (17%) had received no formal education compared male farmers (12%). Additionally, more female farmers (45%) had completed primary education compared to male farmers (34%). Conversely, a higher proportion of male farmers (54%) than female farmers (37%) had attained secondary education (Table 4.1). These findings suggest that the disparities in educational levels between male and female smallholder farmers increased as the level of education completed increased. In terms of marital status, male heads of households accounted for about 84 per cent of all married or cohabiting respondents, while female farmers constituted only 29 per cent of those married or cohabiting. Female heads of households constituted the majority (60%) of widowed respondents (Table 4.1).

[4] Male farmers in this study refers to men who were heads of farming households in the study villages.
[5] Female farmers refers to women who were heads of farming households in the study villages.

Table 4.1: Socio-Demographic Characteristics of Smallholder Farming Households

Variable	Full sample (n=256) Freq (%)	Male (n=147) Freq (%)	Female (n=109) Freq (%)
Age Category			
Youth (18-35yrs)	23 (8.98)	15(10.20)	8(7.34)
Adults (36-60yrs)	134 (52.34)	85(57.82)	49(44.95)
Elderly (60+yrs)	99 (38.67)	47(31.97)	52(47.71)
Education Status			
No formal education	37 (14.45)	18(12.24)	19(17.43)
Primary	99 (38.67)	50(34.01)	49(44.95)
Secondary and above	110 (42.97)	78(53.74)	40(36.70)
Marital Status			
Married/Cohabiting	137 (61.71)	111(84.09)	26(28.89)
Widowed (*Single, divorced, separated, widowed*)	60 (27.03)	6(4.55)	54(60)
Separated/divorced	17 (7.65)	8 (6.06)	9 (10)
Single	8 (3.6)	7 (7.78)	1 (1.11)
Household Type			
Nuclear	165 (64.45)	102(69.39)	63(57.80)
Extended	91 (35.55)	45(30.61)	46(42.20)

Source: Fieldwork, 2022

Nuclear family households were more dominant (64 %) in the Ward, with male-headed and female-headed nuclear households constituting about 69 per cent and 58 per cent respectively. This suggests that communal living is gradually getting eroded as households are becoming more and more nucleated. Female-headed households were slightly more extended (42.2 %) in nature, which is not surprising because women tend to be caregivers to family members and other relatives.

Table 4.2 presents summary statistics on household sizes within Ward 11. Notably, the average household size was higher at 4.7 persons, exceeding the district-wide average of 3.8 persons per household, as reported in the Zimstat (2022) census report. On a national scale, official statistics indicate an average household size of 4.0 persons, underscoring the unique demographics of Ward 11. Further analysis reveals a nuanced difference between female-headed and male-headed households. Female-headed households had an average household size of 4.5 persons while male-headed households had an average of 4.8 persons per household.

However, despite their smaller household sizes, female-headed households appeared to bear a greater burden of dependents, as evidenced by a higher dependency ratio (mean = 1.3) compared to male-headed households (mean = 0.89). The dependency ratio was measured by the number of dependents in the household divided by working household members multiplied by 100. This disparity could be attributed to the fact that more female heads of households are likely to care for elderly family members, the sick, or orphans, among others, thus raising questions about their capacity to effectively address the challenges posed by climate change. Additionally, it is worth noting that female-headed households generally have fewer income earners when compared to their male-headed counterparts, making them more burdened with providing household needs.

Table 4.2: Household Size and Type and Gender of Household Head

Variable	Male (n=147)			Female (n=109)		
	Mean	Min	Max	Mean	Min	Max
Household size	4.8	1	12	4.5	1	10
Dependency ratio	0.9	-1	6	1.3	0	5

Source: Fieldwork, 2022

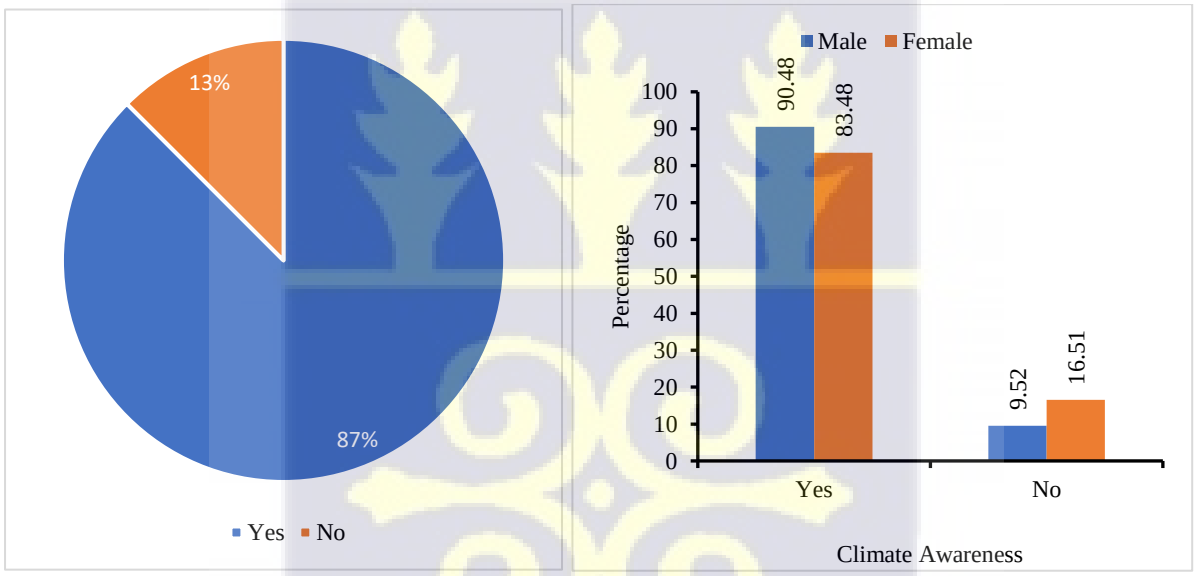
4.3 Socio-Demographic Characteristics and Climate Change Awareness

Adopting and implementing climate change adaptation practices is possible when farmers perceive climate change and identify it as a concern (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Asante et al., 2021; Hassan & Nhemachena, 2008; Maddison, 2007; Mutandwa et al., 2019). Climate change awareness is thus considered a key determinant of adaptation and mitigation practices (Hassan & Nhemachena, 2008). Climate change awareness views were solicited from smallholder farmers in Ward 11. The farmers were asked whether they were aware that the climate is changing? Figures show that a majority of the farmers (87%; n=224), acknowledged that the climate is changing (Fig. 4.1A). However, nearly four per cent of smallholder farmers were unaware of any climate change (Fig. 4.1A).

In terms of gender distribution, about 90 per cent of male heads were aware of changes in the climate compared to 83 per cent of female heads of farming households (Fig. 4.1B). Among the respondents who were not aware of climate change, majority were women, compared to men (Fig. 4.1B). The absence of a significant statistical association between gender and climate change awareness implies that gender does not matter in climate change awareness, which is consistent with findings from other studies in Ghana (Assan et al., 2020), Tanzania (Kaganzi et al., 2021) and Nepal (Pandey, 2020) where gender indifferences were observed in climate change awareness among smallholder farmers.

Figure 4.1

Farmers' climate change awareness



A: General population *B: By gender.*

Source: Fieldwork, 2022

Age and educational level may have an influence on climate change awareness (Asante et al., 2021; Assan et al., 2020; Dang et al., 2019; Kaganzi et al., 2021; Rishikesh Pandey, 2020; Teye et al., 2015). However, the relationship between these variables and climate change awareness is not universal (Teye et al., 2015). Higher education may improve one's understanding of climate change. Farmers who are older may have a greater understanding of changes in the

climate than younger generations due to accumulated experience. Conversely, younger individuals may be more conscious of the climate because of exposure to social media and other informational platforms that they typically use. Table 4.3 portrays the frequencies for education, age, and climate change awareness.

Table 4.3: Climate Change Awareness by Education and Age of the Household Head

HHH Characteristics	Awareness of climate change		
	Yes (n=224) Freq (%)	Otherwise (n=32) Freq (%)	Total (n=256) Freq (%)
Educational Level			
No formal education	35 (94.59)	2 (5.41)	37 (100)
Primary	87 (87.88)	12 (12.12)	99 (100)
Secondary and above	102 (85.00)	18 (15.0)	120 (100)
Chi2 (Pr)			**2.4014 (0.301)**
Age Category			
Youth (18-35yrs)	19 (82.61)	4 (17.39)	23 (100)
Adults (36-60yrs)	116 (86.57)	18 (13.43)	134 (100)
Elderly (60+yrs)	89 (89.90)	10 (10.10)	99 (100)
Chi2 (Pr)			**1.1306 (0.568)**
Total	224 (87.5)	32 (12.50)	256 (100)

Source: Fieldwork, 2022

While the associations between climate change awareness, education and age were not statistically significant, some differences were observed. A significant proportion of farmers (95%) who affirmed the climate is changing had a household head with no formal education (Table 4.3). This suggests that education has no correspondence with climate change awareness. The data showed that elderly farmers (60+ years) constituted a higher percentage of farmers with no formal education, which provides evidence that climate change awareness is linked to historical perspectives on weather patterns and climate trends and not necessarily educational level. This finding contradicts observations by other researchers showing that higher education levels correspond with higher climate change awareness (Ayal & Leal Filho, 2017; Habtemariam et al., 2016; Mutandwa et al., 2019; Teye et al., 2015) (Teye et al., 2015).

Even though all farmers of different age groups exhibited climate change knowledge, a higher proportion of the elderly (60+ years) farmers (90 %) showed greater awareness and knowledge

about climate change than the adults (36-60 years) (87 %) and the youth (18-35 years) (83 %). This suggests that older farmers or people, in general, are familiar with changing climate trends as a result of accumulated experiences over time. Maddison (2007) points out that older people are more likely to notice climate change than young people. Old age signifies a wealth of experience, thus enabling older farmers to sense and report changes in the climate with legitimacy (Ayal & Leal Filho, 2017; Habtemariam et al., 2016). This is despite the arguments that younger farmers are veritably more perceptive of climate change (Semenza et al., 2011) because they are more attuned to contemporary global issues such as climate change. Other researchers also argue that age has no bearing on how farmers perceive climate change, with both younger and older farmers having similar perceptions (Teye et al., 2015). The finding on age and climate change awareness compares favourably with observations by Asante et al. (2021) in Ghana, and Habtemariam et al. (2016) in Ethiopia on the association between age and climate change awareness.

4.4 Local Understanding of Climate Change

Knowledge and understanding of climate change locally help farmers and communities to appreciate the changes and respond appropriately by implementing adaptive measures to safeguard livelihoods. A phenomenology of climate change in the local context is essential as it gives meaning to those living and experiencing it. In ward 11, climate change is construed locally as '*kuchinja kwemaririro ekunze'* or '*kushanduka kwemwaka*', meaning 'changing of the seasons or changing of the weather' in the English language. The depiction and understanding of climate change in the local language suggest that farmers are aware of the phenomenon, validating findings in the Goromonzi district by Gutsa (2017), where participants interpreted climate change as '*kuchinja kwemwaka*'.

Interviews with smallholder households revealed that climate change or '*kuchinja kwemamiriro ekunze'* is often associated with the cropping season. Since farming is a significant livelihood activity in the area and relies on the climate, it is reasonable to relate climate change to the cropping season. An elderly male farmer from Mambera village stated that he noticed the changing climate when "the times we used to receive rain and plant our crops became unpredictable". He explained further that "In the past, we received the first rain after harvest, known as *'gukurahundi'* in August (the rain which is intended to clear and rid the fields of chaff or waste from the previous harvest) and the second rain, known as '*bumharutsva*' in October meant to cleanse the fields in preparation for planting rain. In between, we received another rain called *'mavhurachando'* in June, marking the beginning of winter. Then, we would receive the rains we needed for planting in November (effective rains), but now all the seasons are mixed up, we no longer have these rains. These days even when the rain comes, it is accompanied by cyclones locally known as *'dutu'*, which prevents us from planting. We also experience freezing weather in the cropping season, which destroys our crops". The naming of the different types of rains is no longer relevant for farmers since they no longer correspond with the known and widely accepted patterns, consistent with Gutsa's (2017) findings on the irrelevance of naming significant rains in the district.

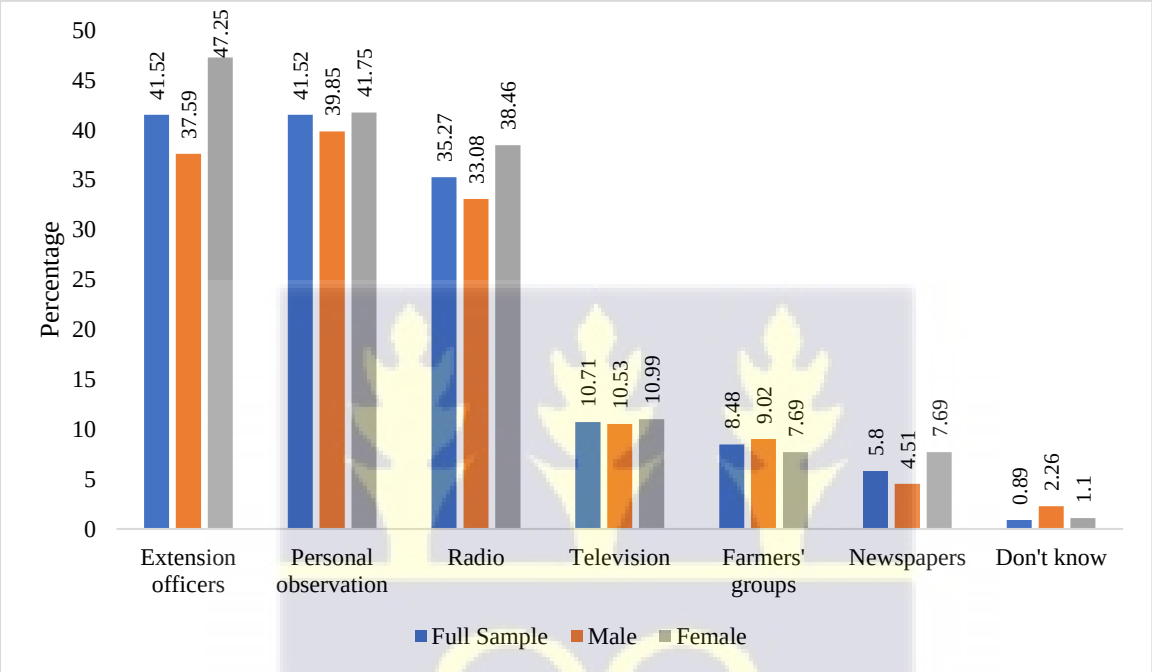
4.5 Sources of Climate Information to Smallholder Farmers

Generally, understanding the preconditions for smallholder farmers' uptake of climate change information facilitates the effective implementation of adaptation practices (Sanga & Elia, 2020). This is because such information helps farmers to plan farming activities, including land preparation, crop selection and soil enhancement (C Singh et al., 2016). The adoption of mitigation strategies by farmers and the resilience of farming systems against the consequences of climate change can both benefit from timely and relevant climate change information.

Climate change awareness among smallholder farmers in Ward 11 was transmitted through various sources, including radio, television, extension officers, farmers' groups, newspapers, other villagers, and personal observations, as shown in Figure 4.2.

Figure 4.2

Sources of climate change information by gender of the household head



Source: Fieldwork, 2022 (Respondents selected multiple responses)

A majority of farmers were found to have obtained climate change information from other villagers, extension officers, their own personal observations, and the radio (Fig. 4.2). 'Other villagers' as a significant source of climate change information suggests that close interactions in farming communities facilitates climate change awareness. Again, because of the nature and structure of African communities, where the value of information sharing by word of mouth is highly favoured, farmers frequently prefer and trust informal and interpersonal sources (C Singh et al., 2016). Informal sources of information offer very easy and cheap access without the need for gadgets or financial commitments. The findings on personal observation and the radio as a source of climate change information substantiate observations from Tanzania

(Kaganzi et al., 2021; Sanga & Elia, 2020) and Malawi (Henriksson et al., 2021) where smallholder farmers in the studied areas relied on the radio and observation to assess weather and rainfall patterns.

Newspapers and farmer's organisations were the least identified sources of climate change information in Ward 11 (Fig 4.2). Newspapers emerging lowest could be as a result of the cost involved in their purchase and again, the availability of technological devices like mobile phones, televisions, and radios which has rendered newspapers obsolete. The AGRITEX officers were ranked as the second-most key source of climate change information after "other villagers". Identification of extension officers as a critical source of information makes sense because they are trusted as distributors of reliable information (Sanga & Elia, 2020). This corresponds with one of the department's mandates to offer extension services to farmers, including research-based agriculture and climate change information.

The extension officer for Ward 11 said, “We function primarily to cascade information about new technologies and innovations from research institutions to farmers and teach farmers through farmer schools and demo plots. Most importantly, we offer details on climate change, its effects, and ways to mitigate it.” Extension officers are crucial in bringing climate change education and awareness to farming communities. Based on broader knowledge about climate change, they offer timely guidance on when farmers should engage in farming activities in order to enhance agricultural productivity.

The gender distribution shows that more female farmers in Ward 11 acquired climate change information from extension officers (47 %), personal observation (42%) and the radio (38%) compared to their male counterparts. More male farmers on the other hand, relied on other villagers (55 %) and farmers’ groups (9%) as their primary sources of information, however, these observed differences were not statistically significant (Figure 4.2). These sources of

climate information have been reported in other studies across Africa (Assan et al., 2020; Diouf et al., 2019; Ngigi et al., 2017; Witinok-Huber et al., 2021). The studies also identified male farmers as having more access to extension services than female farmers. On the contrary, the findings of this study seem to suggest that female farmers are becoming more integrated into extension services, which is encouraging. Extension agents are often perceived as willing to accommodate the informational needs of various farmer groups (Kakota et al., 2015), which could explain the observed preference by female farmers.

Researchers have argued that farmers of all categories with access to extension services tend to be more perceptive about climate change and are inclined to implement adaptation practices best suited to the changing climate and its impacts on their livelihoods (Atube et al., 2021; Mutandwa et al., 2019; Mwololo et al., 2019; Zamasiya et al., 2017). Likewise, age and education also determine who has access to and uses climate change information (Sanga & Elia, 2020). Depending on preferences and accessibility, different age groups and farmers of varying educational backgrounds may use different sources. Table 4.4 presents the results on the household heads' age categories and education in relation to climate information sources in Ward 11.

Even though there was no statistical association (p-value = 0.589) between age and information sources, some generational differences were observed between the age categories. More of the youths (18-35 years) reported other villagers (68 %), in contrast to the elderly (60+ years) who cited personal observation (47 %) and extension officers (43%) as primary sources of climate change information. Adult farmers (36-60 years) acquired climate change information more from the radio (39%) and farmers' groups (10%) (Table 4.4). When compared to adults and elderly farmers, the youth appeared to engage in more informal and interpersonal relationships within their communities, as evidenced by their reliance on other villagers for climate change

information. Older farmers, however, would naturally rely on their own observations because they have a wealth of life experience and institutional memory that could be used as a source of information. Extension officers were ranked as the second most favoured source of information by the elderly because they are considered reliable (Sanga & Elia, 2020). Naturally, information from a reliable source and word-of-mouth, two characteristics of extension services, would be welcomed by older farmers.

Table 4.4: Information Sources by Age and Education of Household Head

Source	(18-35yrs) Freq (%)	(36-60yrs) Freq (%)	(60+yrs) Freq (%)	No Edu Freq (%)	Primary Freq (%)	Sec + Freq (%)
Other Villagers	13 (68.42)	59 (50.86)	42 (47.19)	21 (60)	41 (47.13)	52 (50.98)
Extension Officers	7 (36.84)	48 (41.38)	38 (42.7)	14 (40)	36 (41.38)	43 (42.16)
Radio	7 (36.84)	45 (38.79)	27 (30.34)	6 (17.14)	31 (35.63)	42 (41.18)
Personal obs.	6 (31.58)	43 (37.07)	42 (47.19)	16 (45.71)	42 (48.28)	35 (34.31)
Television	2 (10.53)	12 (10.34)	10 (11.24)	2 (5.71)	10 (11.49)	12 (11.76)
Farmers' Groups	1 (5.26)	12 (10.34)	6 (6.74)	2 (5.71)	3 (3.45)	14 (13.73)
Newspapers	1 (5.26)	9 (7.76)	3 (3.37)	1 (2.86)	3 (3.45)	9 (8.82)
Don't Know	1 (5.26)	1 (0.86)	2 (2.25)	-	-	2 (1.96)
Total	38 (200)	229(197.4)	170 (191)	62 (177.1)	166(190.8)	209(204.9)
Chi2 (Pr)		**76.5434 (0.589)**			**67.8096 (0.833)**	

Source: Fieldwork, 2022 (Respondents selected multiple responses)

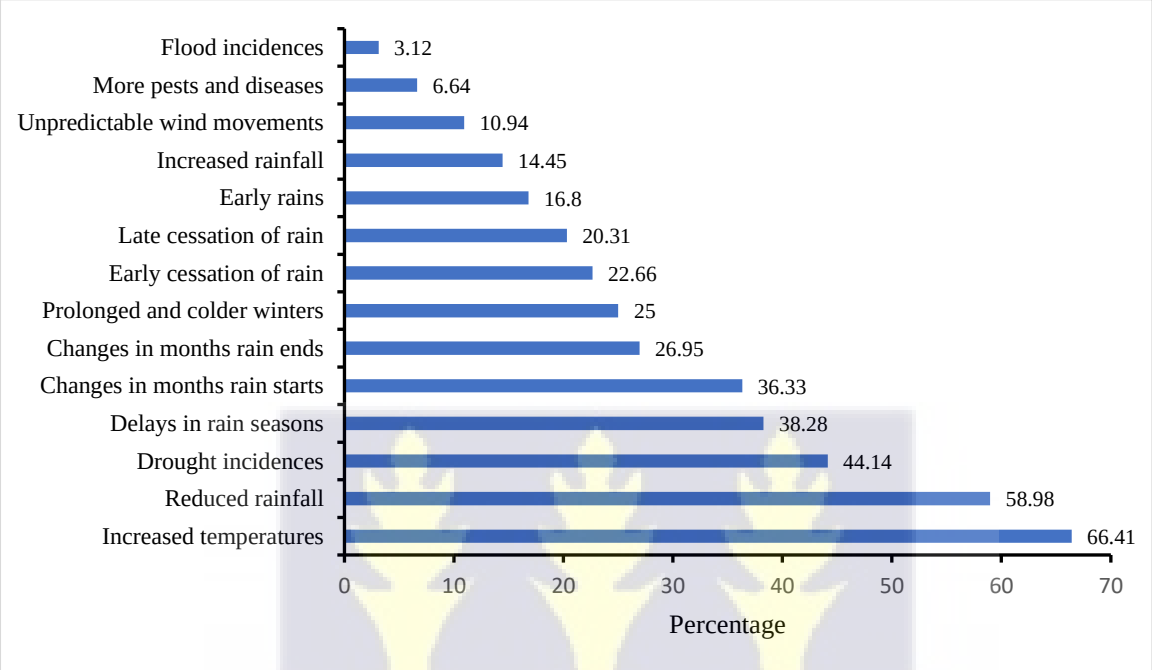
4.6 Evidence of the Changing Climate in the Past 5 to 10 Years: Farmers' Perspectives

Smallholder farming households experience climate change in various ways and to varying degrees. They monitor the environment and use changes observed to gauge climate variability and change. Generally, smallholder farmers have accurate observations of the trends in climate change, specifically those related to agricultural production, which is the primary source of livelihood. In Ward 11, smallholder farmers noticed changes associated with increased rainfall and temperature variability (Figure 4.3). Farmers reported increased temperatures, decreased rainfall, drought occurrences, delays in the start of rainy seasons, changes in the months in which seasonal rainfall begins, changes in the months in which seasonal rainfall ends, and early

cessation of rain as the most noticed and experienced manifestations of climate change over the previous 5 to 10 years.

Figure 4.3

Indicators of climate change observed by farmers in the past 5 to 10 years



Source: Fieldwork, 2022 (Respondents selected multiple responses)

The climate change indicators pinpointed by Ward 11 smallholder farmers are congruent with observations made in the smallholder sector across sub-Sahara Africa (Adzawla et al., 2019; Antwi-Agyei & Nyantakyi-Frimpong, 2021; Baffour-Ata et al., 2021; Dick-Sagoe et al., 2022; Makuvaro et al., 2018; Mutandwa et al., 2019). For example, several studies in smallholder communities in Northern Ghana reported several manifestations of climate change similar to those identified by Ward 11 farmers. Yaro (2013) identified rainfall variability, increased temperatures, and ferocious winds, Teye et al. (2015) observed increased temperatures and rainfall variability while Antwi-Agyei and Nyantakyi-Frimpong (2021) reported more frequent windstorms, floods, and unpredictable rainfall. In Zimbabwe, higher temperatures, seed loss and reduced crop yield were found to have negatively impacted farmers leading to increased poverty, hunger, and starvation (Makuvaro et al., 2018).

Household characteristics, including gender, age and education, may influence how farmers observe and make sense of climate change indicators (Assan et al., 2020; Kaganzi et al., 2021; Rishikesh Pandey, 2020). Though there was no statistical significance between gender and observed changes over time (p-value = 0.601), some variations were noticed (Table 4.5). The gender distribution shows that female farmers observed increased temperatures (67%), drought incidences (47%), and delays in the onset of rainy seasons (40%). In contrast, a significant majority of male farmers noticed reduced rainfall (63%), changes in months rain start (37%) and end (31%). The lack of statistical significance between farmers' observations of changes and their gender supports the observations by other researchers that gender is not the main determinant of climate change perceptions (Assan et al., 2020; Kaganzi et al., 2021; Rishikesh Pandey, 2020).

Table 4.5: Observed Changes by Gender and Age of the Household Head

Variable	Male Freq (%)	Female Freq (%)	Youth (18-35yrs) Freq (%)	Adults (36-60yrs) Freq (%)	Elderly (60+yrs) Freq (%)
Increased temperatures	97(65.99)	73 (66.97)	16 (69.57)	92 (68.66)	62 (62.63)
Reduced rainfall	93 (63.27)	58 (53.21)	11 (47.83)	75 (55.97)	65 (65.65)
Drought incidences	62 (42.18)	51 (46.79)	8 (34.78)	58 (43.28)	47 (47.47)
Delays in the onset of rain seasons	54 (36.73)	44 (40.37)	4 (17.39)	55 (41.04)	39 (39.39)
Changes in the months rains start	54 (36.73)	39 (35.78)	7 (30.43)	41 (30.6)	45 (45.45)
Changes in the months rains end	45 (30.61)	24 (22.02)	5 (21.74)	34 (25.37)	30 (30.3)
Prolonged/colder winters	39 (26.53)	25 (22.94)	10 (43.48)	35 (26.12)	19 (19.19)
Early cessation of rain	34 (23.13)	24 (22.02)	1 (4.35)	32 (23.88)	25 (25.25)
Late cessation of rain	28 (19.05)	24 (22.02)	2 (8.7)	22 (16.42)	28 (28.28)
Early arrival of rains	26 (17.69)	17 (15.6)	2 (8.7)	20 (14.93)	21 (21.21)
Increased rainfall	20 (13.61)	17 (15.6)	2 (8.7)	18 (13.43)	17 (17.17)
Unpredictable wind movements	14 (9.52)	14 (12.84)	5 (21.74)	13 (9.7)	10 (10.1)
More diseases and pests	11 (7.48)	6 (5.5)	4 (17.39)	7 (5.22)	6 (6.06)
Floods Incidences	6 (4.08)	2 (1.84)	-	6 (4.48)	1 (1.01)
Total	586 (391.0)	418 (383.4)	78 (339.1)	508(379.1)	415(419.2)
Chi2 (Pr)	**131.1883 (0.601)**			**300.6670 (0.112)**	

Source: Fieldwork, 2022 (Respondents selected multiple responses)

Apparent generational differences were also observed between the youths (18-35 years), adults (36-60 years) and the elderly (60+ years) in their observation of climate change indicators over time (Table 4.5). Elderly farmers, by far, noticed and reported more changes in the climate compared to the youth and the adults (Table 4.5). A higher percentage of the elderly (60+ years)

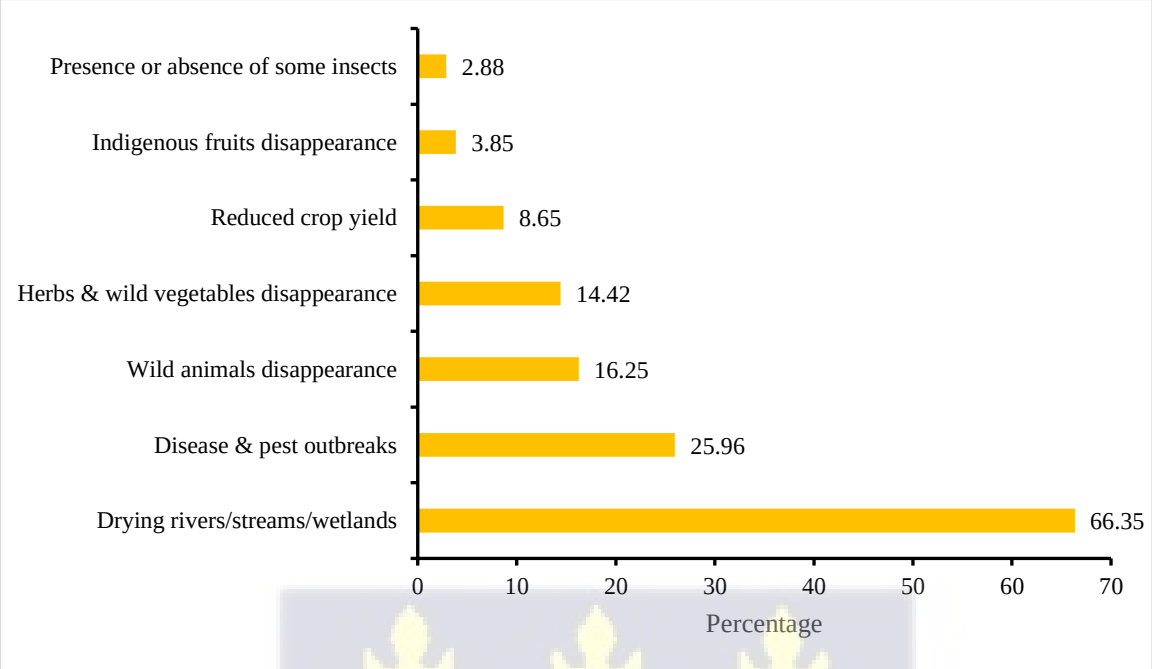
observed a considerable decrease in rainfall (65.65 %), changes in the months rainy seasons start (45.45 %) and end (30.3%), drought incidences (47.47%), delays in the onset of rain (41.04%), and early (25.25%) and late (28.28%) cessation of rain. Elderly farmers may have personally witnessed and experienced climatic shifts, which explains why they reported changes that have occurred in the climate with ease. While more youth (18-35 years) than adults (36-60 years) or the elderly (60+ years) reported longer and colder winters (43.48%) and erratic wind patterns (21.74%), adult farmers (41.04%) constituted the majority of those who reported delays in the onset of the rainy season (Table 4.5). This finding suggests that age increases climate change perceptions due to acquired experience over time.

4.6.1 Indigenous Knowledge and Climate Change

Farmers and other indigenous people frequently observe local indicators to determine how the climate has changed. Smallholder farmers in Ward 11 were asked if they had noticed local indicators of climate change (Appendix 3B). Approximately 59 per cent of the farmers responded in the affirmative, suggesting they were knowledgeable about indigenous knowledge. About 41 per cent did not notice or were unaware of local climate change indicators. Farmers who acknowledged local signs were asked for more information about the specific signs they noticed (Figure 4.4).

Figure 4.4

Observed key local signs of climate change



Source: Fieldwork, 2022 (Respondents selected multiple responses)

The noteworthy local signs observed were the drying up of rivers, streams and wetlands, disease and pest outbreaks and the disappearance of wild animals. The disappearance of several herb and vegetable species, wild animals and fruits, the presence or absence of certain insects, and decreased crop yields were mentioned by a few farmers (Fig 4.4). These findings resonate with observations from other studies in Ghana, Zimbabwe and Tanzania. Antwi-Agyei and Nyantakyi-Frimpong (2021) reported the drying of water bodies and wetlands in Northern Ghana, Dube and Phiri (2013) observed the disappearance of flora and fauna in South Western Zimbabwe, in particular the mopane worm, while Mbilinyi et al. (2013) reported the disappearance of wild grass, vegetation, small streams and rivers as indicators of climate change.

Gender distribution indicates that about 68 per cent of male farmers and 63 per cent of female farmers observed the drying of rivers, streams, and wetlands. Female farmers had the highest

proportions of those who reported the absence of wild animals (23.68%) and pest and disease outbreaks (28.95%) (Table 4.6). The observed differences were not statistically significant (p-value = 0.325) implying that both farmer categories are capable of employing their indigenous knowledge to predict changes in the climate.

Table 4.6: Observed Local Signs by Gender and Age Category of the Household Head

Key Local Sign	Male Freq (%)	Female Freq (%)	Youth (18-35yrs) Freq (%)	Adults (36-60yrs) Freq (%)	Elderly (60+yrs) Freq (%)
Drying of rivers, streams and wetlands	45 (68.18)	24 (63.16)	5 (55.56)	43 (72.88)	21 (58.33)
Disease and pest incidences/outbreaks	16 (24.24)	11 (28.95)	2 (22.22)	17 (28.81)	8 (22.22)
Herbs and wild vegetable disappearance	12 (18.18	3 (7.89)	1 (11.11)	5 (8.47)	9 (25)
Disappearance of wild animals	8 (12.12)	9 (23.68)	2 (22.22)	8 (13.56)	7 (19.44)
Disappearance of indigenous fruits	3(4.55)	1 (2.63)	-	2 (3.39)	2 (5.56)
Presence or absence of some insects	2 (3.03)	1 (2.63)	1 (11.11)	1 (1.69)	1 (2.78)
Other (reduced crop yield)	10 (10.61)	2 (5.26)	2 (22.22)	6 (10.17)	1 (2.78)
Total	93 (140.91)	51 (134.21)	13 (144.44)	82 (138.98)	49 (136.11)
Chi2 (Pr)	**21.2205 (0.325)**		**47.3158 (0.143)**		

Source: Fieldwork, 2022 (Respondents selected multiple responses)

The association between age and observed local indicators was statistically insignificant (p-value = 0.143). However, differences existed between the age categories. Compared to the other two age groups (youth and elderly), a higher proportion of adult farmers (72.88%) reported the drying of rivers, streams, and wetlands. The elderly (25%) were more aware of the disappearance of wild herbs and vegetables than the other age categories. This result suggests that older farmers are more knowleadgeable and better understand non-timber forest products, including vegetables, mushrooms, and herbs that serve as household dietary supplements. The finding is unsurprising because older people have always been perceived as having institutional memory as well as being the custodians of traditional knowledge (Jiri et al., 2015).

Interviews with farmers unearthed additional insights on plant phenology, animal behaviour and metereological signs. These signs were found to be helpful in the prediction of hunger and droughts in the study areas. In the Timuri village, a middle-aged female head of household explained that an abundance of the *'mazhanje'* fruit (wild loquat) indicates a successful rainy season and plenty of food. Another elderly female head used the appearance of birds as a sign

of a good rainy season. She recounted, “if you see these *‘mafudzamombe’* (cattle egret) today, the rain will come today or at the latest by tomorrow. But when there is a drought, *‘hazviite’* (emphasising that it is impossible), you will never see this type of bird”. Other strange occurences such as a lone baboon roaming in unusual places were identified as signfying the onset of rainfall. In addition to plant and animal indicators, rainfall forecasting in the area typically involved the evaluation of cloud appearance. Farmers used the colour of the clouds, either blue or red, to anticipate when it would rain. In probing further, a young male farmer from Ngoshi village explained that "a crimson cloud in the sky is an indication of low rainfall and drought or hunger.”

Clearly, from the discussion above, animal and insect behaviours, plant phenology and meteorological indicators serve as valuable tools in rainfall and other weather-related predictions. Results on bird, plant and meteorological observations reported in this study are consistent with findings from studies across sub-Sahara Africa where the behaviour of animals, birds and plants and meteorological patterns are used as local indicators for predicting weather and climate (Assan et al., 2020; Baffour-Ata et al., 2021; Jiri et al., 2015; Siambombe et al., 2018; Sibanda & Sibanda, 2021).

Even though indigenous knowledge is helpful in assisting farmers to cope with climate change, it presented some challenges to smallholder farmers. Farmers complained about the increasing unpredictability of indigenous knowledge systems. They associated the unreliability of indigenous knowledge to climate variability. For example, farmers claimed that the abundance of wild fruits in recent times did not always portend favourable rainfall. Sometimes there are abundant wild fruits, but no rains fall, and vice versa. This worry and concern about the ineffectiveness of indigenous knowledge systems is consistent with Nyahunda and Tirivangasi (2019) findings in Zimbabwe's Mazungunye communal lands, where farmers bemoaned the

unpredictable nature of indigenous knowledge due to climate change, making adaptation and mitigation difficult. The difficulty in forecasting weather directly increases the vulnerability of both male and female farmers and endangers farming activities leading to food scarcity (Assan et al., 2020).

4.7 Smallholder Farmers' Perceptions of the Causal Attribution of Climate Change

People's perceptions about climate change are accompanied by a desire to understand its causes, thus informing how they respond to it. Identifying and acknowledging the causes of climate change has enabled farmers in Ward 11 to implement adaptation practices to safeguard their livelihoods. Researchers have argued that farmers' awareness of the causal factors facilitates the prevention of harmful practices and the adoption of good practices that yield the best results (Yaro, 2013). Table 4.7 presents the attributed causes to the perceived climate change indicators in Ward 11.

Table 4.7: Perceptions of Climate Change Causes and Age Category of the Household Head

Cause	Full Sample Freq. (%)	Youth (18-35yrs) Freq (%)	Adults (36-60yrs) Freq (%)	Elderly (60+yrs) Freq (%)
Violation of traditional Norms	88 (39.29)	8 (42.11)	38 (32.76)	42 (47.19)
Fossil fuel burning, e.g. petrol, coal etc	78 (34.82)	9 (47.37)	37 (31.90)	32 (35.96)
God's will & sin	73 (32.59)	4 (21.05)	43 (37.07)	26 (29.21)
Deforestation	69(30.8)	8 (42.11)	39 (33.62)	22 (24.72)
Desecration of sacred trees, rivers, forests etc	43 (19.2)	5 (26.32)	22 (18.97)	16 (17.98)
Total	351 (156.7)	34 (178.95)	179 (154.31)	138 (155.06)
Chi2 (Pr)			**44.6831 (0.211)**	

Source: Fieldwork, 2022 (Respondents selected multiples responses)

The perceived climate change causes reported by smallholder farmers in this study were twofold: anthropogenic and divine attributes. Identified factors included deforestation, burning of fossil fuel, God's will and sin, the desecration, and violation of traditional norms such as working on holy rest days (*'chisi'*) and violation of sacred places and objects such as cutting down trees like *'muhacha'*, which is believed to be a dwelling for the ancestral spirits. *'Chisi'*,

also known as a holy day in the English language is a day of rest and to thank the ancestors for being guardians of the land. These causes are consistent with findings from studies in Ghana and Tanzania among smallholder farmers (Assan et al., 2020; Mnimbo et al., 2016). Smallholder farmers studied in Ghana identified God's will and deities as causes of climate change (Assan et al., 2020).

It is not unexpected that deforestation emerged as one of the primary causes of climate change. Deforestation was highlighted by the agriculture extension officer as a critical issue in Ward 11 and the district as a whole. The main reason given for cutting down trees was for household firewood fuel, the predominant source of cooking fuel (91.8%) and water heating (95.31%) in the winter months. This is accelerating the depletion of forests and many trees, including exotic and wild fruit trees like *'muhacha,'* (mobola plum/parinari curatellifolia) *'muzhanje,'* (wild loquat/kirkiana) *'mutohwe,'* (snot apple/garckeana) *'musasa,'* (zebrawood/brachystegia spiciformis) in the studied villages. Farmers were aware of the need to preserve trees but could not do without the firewood provisions from these trees. With the assistance of Extension and Environment Management Officers, farmers have been trying to curb deforestation by trimming the branches of any trees in their yards instead of felling the entire tree if they need firewood. This enables households to have a steady supply of firewood and, at the same time, save the environment.

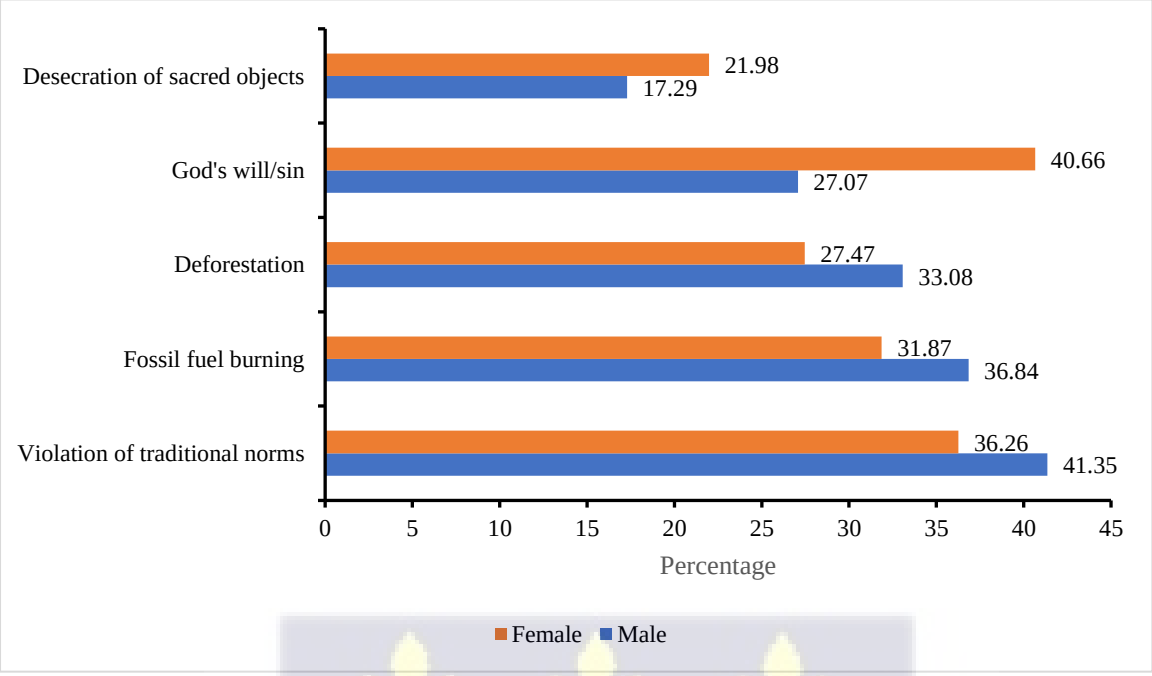
Since the majority of trees are cut down for firewood, finding alternate sources of cooking fuel could help solve the problem. In order to save trees, clean energy adoption could be very helpful. At the time of the data collection, the *'tsotso'* stove was being popularised in the Ward by a local NGO. The stove is fuel-efficient; it heats up quickly with only a few sprigs and can cook an entire meal without additional firewood. The *'tsotso'* stove was introduced in the country in the 1980s by David Hancock at the Development Technology Centre (University of

Zimbabwe). It is an energy efficient fast cooking stove which has continued to develop and evolve over time. '*Tsotso*' in Shona means 'small log or twigs', which is how the stove is powered. Over the years, the design of the stove has continued to improve, and various versions have emerged with the implementation carried out by both governmental and non-governmental organisations. The *'tsotso'* stove initiative was earmarked to reduce deforestation but was met with cost challenges. Households were required to provide materials like cement and bricks and pay technicians for the installation of the stove. For households who could afford the cost, the intervention was timely; however, other households could simply not afford the *'tsotso'* stove and were wary of how they were going to meet their cooking energy needs.

In terms of gender distribution, a majority of female farmers identified God's will and sin (40.66 %), while for male farmers, the violation of traditional norms (41 %) and deforestation (33.08 %) were prominent (Figure 4.5). Gender differences in the perceived causes of climate change in Ward 11 substantiate observations by Assan et al. (2020) who found differences in the perceived causal attributes of climate change between male and female smallholder farmers in Ghana. The divine attribution of climate change among female farmers in the current study is not surprising because Mnimbo et al. (2016) reported similar findings from their study in Tanzania in which women farmers attributed climate change to God's will.

Figure 4.5

Perceived Causes of Climate Change and Gender



Source: Fieldwork, 2022 (Respondents selected multiple responses)

The reason why many female farmers attributed climate change to God's will and sin could be expounded further by qualitative findings which unearthed great concern about recent kidnappings and murders of young children in Zimbabwe. At the time of the data collection, many mothers had organised themselves into groups and took turns escorting their children to and from school to protect them. A female farmer from Bungu village lamented that the apparent changes in climate and the subsequent impacts resulted from "too many sins in the country. Our children are being kidnapped and murdered here and there. The country is under a curse. Customarily we would say the blood of those innocent children is seeking revenge, which is why our rainfall patterns and temperatures have become erratic". Furthermore, farmers perceived the wickedness and selfishness prevailing in the community as a cause of climate change. Many female farmers, in particular, expressed that greed was widespread in the community, which had led to the rich taking advantage of the poor at any cost. These,

according to interviewed farmers, were some of the issues triggering drought spells and extreme heat that made farming difficult.

Even though there was no statistical significance (p-value = 0.211) between farmer's age and causal attribution, some generational differences were observed (Table 4.7). The youth (18-35 years) identified the burning of fossil fuel (47.37 %) and deforestation (42.11 %) as causes of climate change, while the elderly (60+ years) cited violation of traditional norms (47.19 %), and the adults (36-60 years) attributed climate change to God's will and sin (37.07 %). One explanation for this outcome could be that younger farmers are possibly more informed about science and technology and may be more concerned about the environment and contemporary global issues such as climate change, hence their identification of deforestation and the use of fossil fuels as factors contributing to climate change. The elderly, on the other hand, are more familiar with local customs and culture and are therefore more likely to associate climate change with ancestral desertion and desecration of traditional norms and values.

The in-depth interviews offered additional insights on the violation of traditional norms and the potential repercussions. An elderly male farmer from Mambera village stated, "we didn't follow tradition and taboos of the land and have committed traditional wrongs, and now we cry of the shortage of rain and hunger, forgetting that those things we were part and parcel of, have put us into this predicament. We have neglected the *'masvikiro'* (spirit mediums) who used to intercede for us to get good rains because of Christianity." It became clear that smallholder farmers felt they were being punished for not adhering to traditional customs and norms.

The question of spirit mediums and the role they play in facilitating and predicting weather is widely acknowledged in rural areas in Zimbabwe. Just like the elderly farmer from Mambera village, many smallholder farmers believed in the spiritual traditions and the consultations of *'masvikiro'* (spirit mediums). According to the farmers, pleased ancestors ensure that

community members have good health and abundant food. Displeased ancestors unleash their anger on the communities for disrespecting traditional norms, which manifests in bad weather conditions, droughts, and hunger. Assan et al. (2020) have argued that angry deities or ancestors are believed to evoke havoc in communities resulting in observed climate change impacting farmers' livelihoods.

4.8 Farmers' Perceived Climate Change Effects

Climate change reflects on human welfare through varied impacts on the different sectors of society. In the agriculture sector, both farm and non-farm activities are affected by climate change impacts. In Ward 11 of the Goromonzi district, farming portfolios in smallholder households encompass crop cultivation and animal-rearing (Zimstat, 2019). Additionally, other non-farm activities, including skilled and non-skilled work, are undertaken by smallholder farmers. The on-farm activities are climate dependent, implying that any change in the environment poses a risk to these livelihood activities and subsequently puts farmers at risk of food insecurity and poverty.

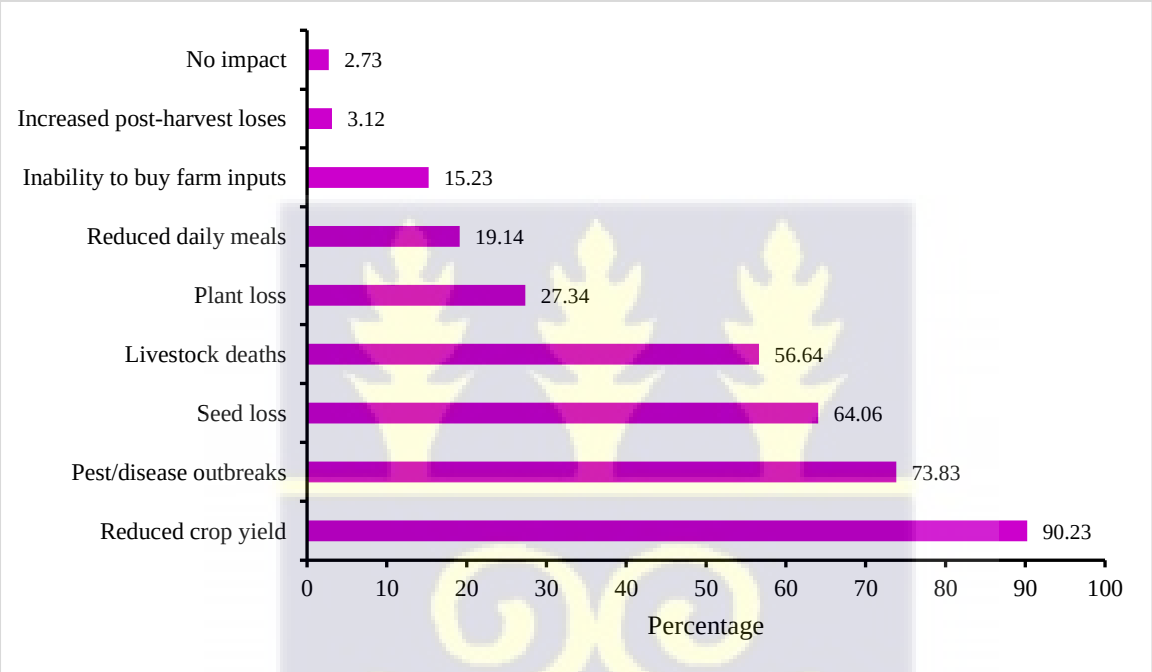
The main crops cultivated in the studied villages were maize (93%), groundnuts (*nzungu*) (51%), and Bambara beans (*nyimo*) (16%). Other crops, like sugar beans, cowpeas, or *'nyemba'* sunflowers, millet, and sweet potatoes, were often intercropped with these main crops. The three main livestock types reared were cattle (34%), goats (53%), and fowls (89%) (Appendix 3C). In addition, though in smaller numbers and in fewer homes, guinea fowls, or *'hanga,'* turkeys, pigs, and rabbits were raised. These crops and livestock are central to smallholder farmers' livelihoods in the area and are at risk of extreme climate change events. The results on climate change effects on crop and animal production and household welfare are presented in the following sections.

4.8.1 Farming Portfolios *(Crop and Animal Production)*

To ascertain the specific effects of climate change on crop and animal production, households were asked to report their perceptions of how climate change had affected these activities. Figure 4.6 depicts the reported effects on households' farming portfolios.

Figure 4.6

Climate change effects on crop and animal production



Source: Fieldwork, 2022 (Respondents selected multiple responses)

Reduced crop yield, outbreaks of pest and disease, livestock deaths, seed loss either due to delayed rains or poor germination ranked higher in terms of the perceived impacts on crop and animal production (Fig 4.6). Undependable rainfall meant farmers partially lost seeds that were either buried on the ground by heavy rains, scorched by excessive heat or washed away by too much rain. Figure 4.7 provides a better illustration of the effects of climate variability on maize crops in Ward 11 villages. Two scenarios are presented, crop A which suffered a mid-season dry spell that resulted in the loss of seeds and fertiliser and crop B, which was planted later to full maturity.

Figure 4.7

Two different fields showing climate change effects

***A**: Stunted & wilted crops due to mid-season dry spell* *B: Crops that benefitted from delayed planting*

Source: Fieldwork 2022

The major effects identified in the quantitative analysis, were confirmed by the qualitative data. It emerged from the interviews that low crop yield, livestock deaths, pest and disease outbreaks, and seed loss due to delayed rains were significant problems experienced by smallholder farmers due to climate shocks and stressors. The extension officer for Ward 11 echoed what the farmers had said, stating that a decreased crop yield is triggered by various conditions, such as seed loss from heavy or delayed rainfall, pest and disease infestations, and a lack of farm inputs. About seed loss, he added, "we notice a dry spell of around two to three weeks after the first 'effective rains', which could come anytime between October and December. Farmers would have sown the seed by that time, though. Farmers are left with nothing since the excessive heat destroys the seeds". These observed impacts, particularly reduced crop yield, increased pests and diseases and loss of plants and seeds could significantly compromise the area's food availability and security.

Pests and diseases can be detrimental to both animal and crop farming, leading to crop destruction and deaths of livestock. Livestock deaths can compromise a household's ability to engage in effective farming due to a loss of draught power and the income derived from the sale of animals as well as a loss of nutrient sources for the household. The climate change effects outlined by farmers in Ward 11 were among the top-most reported effects in the literature (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Assan et al., 2020; Dick-Sagoe et al., 2022; Dube et al., 2018; Makuvaro et al., 2018; Mnimbo et al., 2016; Musakwa et al., 2020). These researchers found that the decline in crop yield, increases in pests and diseases, and the destruction of crops were some of the effects of climate change on smallholder livelihoods across Africa.

In terms of gender, the results show that both male and female smallholder farmers in Ward 11 experienced climate change impacts. However, male farmers reported a higher percentage of reduced crop yield (91%) and livestock deaths (57%) than female farmers. On the other hand, female farmers were more afflicted by seed loss (72%), pest and disease outbreaks (78%) and plant loss (34%) than male farmers (Table 4.8). The experience of climate change shocks by both male and female farmers is consistent with findings by Antwi-Agyei & Nyantakyi-Frimpong (2021), Assan et al. (2020) in Ghana and Mnimbo et al. (2016) in Tanzania on how climate change effects including reduced crop yield, pest and disease outbreaks, plant and seeds losses among others adversely affected both male and female farmers' agricultural activities and household welfare.

Table 4.8: Perceived Effects on Crop and Animal Production by Gender and Age

Crop & Animal Effects	Male Freq (%)	Female Freq (%)	18-35yrs Freq (%)	36-60yrs Freq (%)	60yrs + Freq (%)
Reduced crop yield	134(91.16)	97 (88.99)	21 (91.3)	119 (88.81)	91 (91.92)
Pest/disease outbreaks	104(70.75)	85 (77.98)	17 (73.91)	93 (69.40)	79 (79.79)
Seed loss	85 (57.83)	79 (72.48)	11 (47.82)	85 (63.44)	68 (68.98)
Deaths of livestock	84 (57.14)	61 (55.96)	12 (52.17)	69 (51.49)	64 (64.65)
Plants loss	33 (22.45)	37 (33.94)	2 (8.7)	36 (26.87)	32 (32.32)
Reduced daily meals	28 (19.05)	21 (19.27)	3 (13.04)	24 (17.91)	22 (22.22)
Unable to buy farm input	18 (12.24)	21 (19.27)	1 (4.35)	16 (11.94)	22 (22.22)
No impact	4 (2.72)	3 (2.75)	-	6 (4.48)	1 (1.01)
More post-harvest loses	2 (1.36)	6 (5.5)	1 (4.35)	2 (1.49)	5 (5.05)
Total	492 (334.69)	410 (376.14)	68 (295.65)	450 (335.82)	384 (387.88)
Chi2	**110.4599 (0.105)**			**190.5708 (0.394)**	

Source: Fieldwork, 2022 (Respondents selected multiple responses)

Some generational differences in climate change effects on crops and livestock were detected, though no statistical significance was established by the chi-square test (p-value = 0.394). The data indicated that compared to the youth (18-35 years) and adult (36-60 years), a considerable proportion of the elderly (60+ years) experienced reduced crop yield (92%), pest and diseases attacks (80%), lost livestock due to deaths (65%), lost seeds (69%) and plants (32%) due to rainfall variability and were unable to buy farm inputs (22%) as a result of climate change effects (Table 4.8). The youth farmers (18-36 years) reported the least impact because they own less of these assets and may not be overly invested in farming. The findings suggest that older farmers are more exposed to climate change due to the nature of their activities and the type of assets possessed, which are easily affected by climate disturbances.

Interviews with smallholder farmers and key informants helped to shed more light on the climate change effects that had plagued the communities. Farmers talked mostly about decreased crop yield and deaths of livestock as the main issues encountered in Ward 11. The death of livestock was associated with several diseases such as bird flu for poultry and a tick-borne disease that killed cattle. Two names of diseases were mentioned: redwater and January diseases (both tick-borne diseases). Farmers emphasised and elaborated on how the cows were dying in their narratives. One adult male farmer from Chikodzonga village recalled, "it was frightening how these cows were dying. We were helpless. The cow is fine one moment, then

froth starts coming out of its mouth and nose, and finally it collapses and dies." Many farmers were concerned about the welfare of their cattle and the effects the fatalities would have on their income and well-being. Farmers even stopped eating beef as a source of protein because they were unclear about the quality of the meat being sold or shared in good faith by neighbours and other relatives. This adversely affected the quality of meals consumed by households.

Elderly (60+ years) farmers in particular were apprehensive as they watched their lifelong accumulations slip away through mysterious deaths. It is therefore not unexpected that the elderly smallholder farmers identified livestock loss as one of the main climate change effects. At that age, they would typically have received more animals as bride price for their daughters and through retirement or life-long purchases. Narratives by some of the interviewed household heads amply described the burden and anxiety suffered as a result of the loss of livestock to diseases. Two elderly household heads from Mambera village, a male and a female, bemoaned the disease-related demise of all their cattle and other livestock. The elderly female farmer recounted her losses with bitterness. "I had ten cows and 16 goats, and they all died. When my daughters got married, I got two *'mombe dzeumai'* mother's cows, (a cow given to the mother of the bride in honour and to thank her for giving birth to the bride) and they reproduced till I had 10. Never once did I have to ask for draught power. However, all left on me now is the empty kraal you see there. Even the chickens had eye problems and wounds, most of them perished".

The elderly male farmer found himself in a similar situation. "We had cows in this family, we were the envy of many in this village, he lamented. Today, we should be boasting about 12 cows, but several of them perished between 2019 and now (2022) because of the outbreak. I lost all but two". Farming households endured considerable distress due to livestock deaths, making it difficult to pursue large-scale production. Additionally, livestock has traditionally

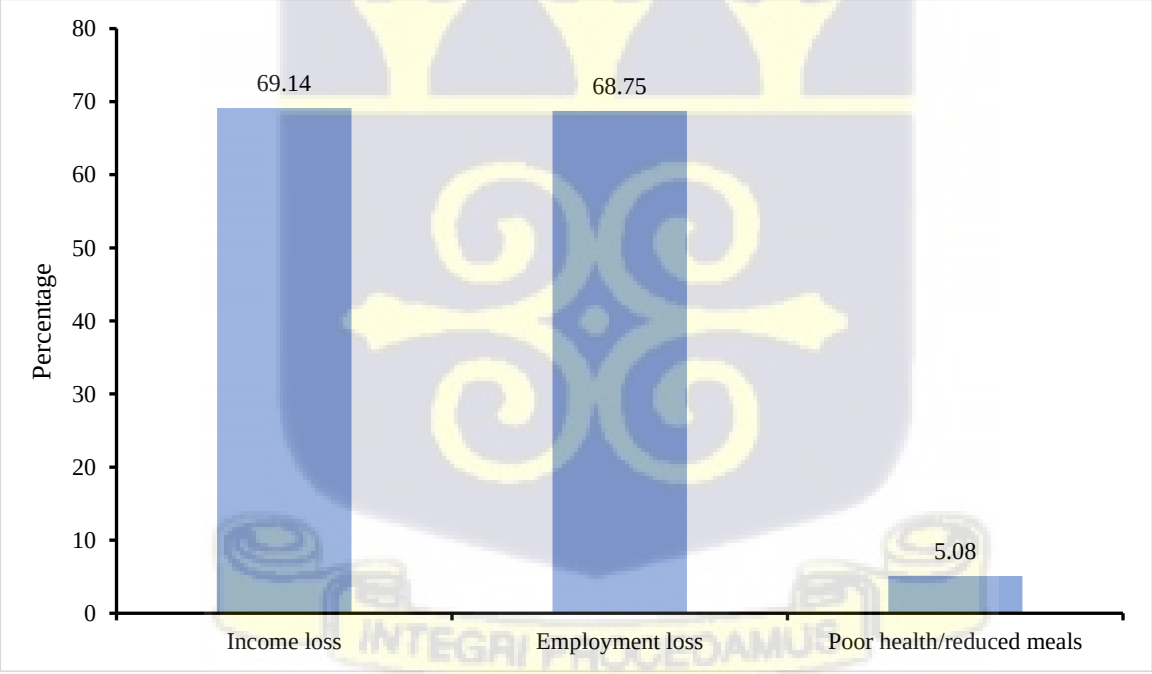
been sold to urban residents or visitors who travel to the countryside for special occasions to augment household income. The loss of livestock due to deaths, sale or theft has left many households vulnerable as they no longer have draught power for farming and a safety net in times of shock. Again, the loss of livestock implies that farmers' physical capital has been compromised, making the implementation of climate change adaptation activities challenging.

4.8.2 Household Welfare

Overall, nearly 94 per cent of all farming households perceived a high impact of climate change on household welfare. Income loss and employment loss were the topmost experienced indirect climate change effects on household welfare by all farmer categories (Figure 4.8).

Figure 4.8

Household Welfare Effects



Source: Fieldwork, 2022 (Respondents selected multiple responses)

The chi-square test did not establish a statistical association between age of the farmer and climate change's effects on household welfare (p-value = 0.207) (Table 4.9). However, the

results show that household heads of all age categories suffered loss of income, with households headed by adult farmers (36-60 years) reporting a slightly higher percentage (70.15%) of income loss compared to those headed by elderly farmers (69%) and youth farmers (65%), respectively. Additionally, employment loss was experienced by households headed by farmers of all age categories, with slightly higher proportions for adult farmers (70.14%) and youth farmers (69.57%) (Table 4.9). This seems to suggest that these farmer age groups are actively engaged in multiple income generating activities. The loss of income and employment observed among the youth-headed and adult-headed households in this study is not surprising because these age categories are more likely to engage in alternative employment to eke out a living compared to the elderly, who may have fewer opportunities to work outside farming. This implies that these age categories are more susceptible to loss of income and employment as a result of climate change effects or other challenges.

Table 4.9: Household Welfare Effects by Gender and Age Category of the Household Head

Effects	Male	Female	Youth (18-35yrs)	Adults (36-60yrs)	Elderly (60+yrs)
	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)
Income loss	94 (63.95)	83 (76.15)	15 (65.22)	94 (70.15)	68 (68.69)
Employment loss	115 (78.23)	61 (55.97)	16 (69.57)	94 (70.14)	66 (66.66)
Poor health/ food scarcity	7 (4.76)	6 (5.5)	2 (8.7)	5 (3.73)	6 (6.06)
Total	216 (146.94)	150 (137.62)	33 (143.47)	193 (143.7)	140 (141.42)
Chi2 (Pr)		**18.9217 (0.063)**			**27.1032 (0.207)**

Source: Fieldwork, 2022 (Respondents selected multiple responses)

In terms of the gender disaggregation, the chi-square analysis established an association between the gender of the household head and impacts on household wellbeing (p-value = 0.063), suggesting that gender influences how a household's welfare is impacted by climate change effects. The distribution by gender shows a higher percentage (76.15%) of female-headed households than male-headed farming households (63.95%) reporting income loss. On the other hand, more male-headed households reported employment loss (78.23%) than female-headed households (55.97%) (Table 4.10). It is not surprising that income and

employment loss were the most felt effects by households in the studied villages. This could be associated with the reduced job opportunities and loss of employment observed in the study. Farmers tend to engage in 'any kind of work', *'kungwavha-ngwavha'* or *'kukiya-kiya'* in Shona, which does not offer income and job security. Loss of income observed among female farmers is consistent with findings by Chidakwa et al. (2020), on loss of income affecting women's wellbeing in rural Zvishavane, Zimbabwe.

The qualitative data provided further insights into the differential livelihood effects between male and female farmers in Ward 11. Farmers highlighted the scaling down of farming activities in the Ward, the loss of farm labour *'maricho'* and the accelerated land reform programme that led to the take-over of LSCFs owned by white farmers. These conditions curtailed employment opportunities for many farmers in the area. Although some farming households continued to farm on a medium scale, the area's agricultural production has significantly decreased over time.

Regarding scaling down of farming activities, farmers found it difficult to intensify agricultural production because most often their input investment perished as result of climate change and rainfall variability. Farmers thus minimised their investments leading to low production. A lack of inputs and draught power, which significantly reduced the acreage of farmland under cultivation also contributed to the scaling down of farming activities. Draught power access for many households was truncated by the widespread death of cattle across the nation, which left many farming households without herds. As a result of these challenges, many farming households could only afford to farm for household consumption.

Farm work for pay, *'maricho'* provided an avenue for women, in particular, to earn income from working in farms belonging to medium-scale farmers. *'Maricho'* is a practice whereby sections of land are demarcated, and a price is agreed upon for weeding, harvesting, planting,

or other farming tasks that an individual or the entire family can undertake. Sadly, farm work for pay has become scarce due to declining farming activities. Another type of work that had declined is cattle herding *'kufudza mombe'*. This activity was a substantial income-generating activity for both male and female farmers, particularly young boys, and girls. Every village has a two-day tradition known as *'dzoro'* in which families with cattle alternate to herd and graze the herds. Farming households without labour for cattle herding pay other households to provide labour in exchange for wages. All these initiatives afforded households with alternative means to generate extra income. The loss of cattle and scaling down of farming activities have led to the loss of these employment opportunities.

The other dimension to consider is the departure of large-scale white farmers from adjacent areas due to the Fast-track land reform programme (FTLRP). Frascati, a popular white farmer, owned a large farm that primarily employed women from the communal areas. "Frascati provided us with employment opportunities and quick cash," a middle-aged female farmer from Timuri village stated. She explained further that women and men were left with few options for generating income after the white farmers left. "I worked there as a young woman, and the cash helped my family, but these days those opportunities are gone", she said. Loss or reduced income and limited work opportunities constitute indirect climate change effects that are experienced negatively by households. These effects impede adaptation decisions in many farming households. The highlighted findings have shown that the livelihoods of male and female farmers in Ward 11 have been impacted adversely by climate change which is consistent with findings by Assan et al. (2020) in Ghana, where smallholder farmers experienced a loss of income, poor health, and reduced ability to cater for daily meals, impacting their wellbeing.

4.9 Conclusion

This chapter has fully examined the gender dimensions of climate change perspectives, including its observed indicators, perceived causes, and how it has affected livelihood portfolios in Ward 11, Goromonzi district. Smallholder farmers were fully aware of the vulnerability context, understood climate change and experienced its impact on their agricultural and other livelihood activities. All studied farmers were aware that the climate has been changing regardless of their gender, age group and level of education. This understanding stemmed from various information sources, including extension officers, radio, television, other villagers, and personal experience available to the farmers in the area.

Farmers of all social categories had first-hand experience with the changing climate and pinpointed specific signs that confirmed their awareness that the climate was changing. These signs were primarily related to rainfall and temperature variation, including droughts. Indigenous knowledge played a key role in farmers' recognition of the changes occurring in the climate over time. Attributed causes of climate change by farmers were linked to the changes farmers had noticed. The direct impacts of the perceived changes in the climate on livelihood portfolios were noticeable across all the studied farming households. Other indirect effects on households included loss of money and employment or work, reduced daily meals, and ill health.

The chi-square test of association did not yield statistically significant results linking gender, age, and educational level of the farmers to climate change perceptions. However, the study did uncover notable variations in climate change experiences and perceptions based on these demographic characteristics among smallholder farmers in the studied villages. These differences provided valuable insights into how different farmer groups understood environmental change. For instance, the study showed that farmers with no formal education

had higher awareness of climate change compared to those with primary education and above. This category of farmers constituted a higher percentage of the elderly (60+ years), who also reported more changes in the climate than young farmers (18-36 years) and adult farmers (36-60 years). Their long historical perspective on weather patterns and climate trends influenced their recognition of the long-term changes.

Variations were also evident in the sources of climate information. Female farmers tended to rely more on extension officers and the radio while male farmers relied more on other villagers. Similarly, causal attribution of climate change showed gender differences, with female farmers attributing it mainly to religious factors (God's will and sin) and male farmers to cultural factors (violation of traditional norms).

The study highlighted that climate change effects had a universal impact on farmers' livelihoods affecting all age and gender groups. However, elderly household heads (60+ years) reported more significant impacts than young (18-35 years) and adult (36-60 years) household heads. Female-headed households experienced more income losses as a result of the indirect impacts of climate change,

While climate change perceptions were relatively consistent across all smallholder farmers in Ward 11, the study showed that the experiences of climate change differed based on household characteristics, including gender. The experiences of the vulnerability context were gendered, indicating that male heads and female heads of households were impacted differently. The discussion in this chapter has demonstrated that climate change perceptions in Ward 11 have no gender dimension, but the experiences of the vulnerability context are gendered and influenced by other household demographics such as age and education.

The next chapter profiles the household assets of smallholder farmers and attempts to categorise these households into distinct groups based on the assets they own. The objective is

to gain insights into the different levels of asset ownership and their potential implications for households' livelihood sustainability. The chapter also examines asset ownership patterns between male-headed and female-headed households.

CHAPTER FIVE

GENDER AND ASSET OWNERSHIP PATTERNS IN SMALLHOLDER FARMING HOUSEHOLDS

5.1 Introduction

The previous chapter examined climate change perceptions in smallholder households, which are essential in climate change management because they enable farmers to perceive the risks and potential impacts, motivating them to take adaptation actions. This chapter examines assets ownership, another critical component of climate change management. The focus of this chapter is to profile farming households' assets and outline the gender differentiation in asset ownership in the study area. Asset profiling is an essential component of ascertaining the adaptation capabilities of farmers because assets can be deployed by farmers to pursue adaptation. The discussion on household asset holdings is structured around the sustainable livelihood framework's five capitals: human, natural, physical, financial, and social. Farming households are then characterised into distinct groups based on asset endowment.

5.2 Description of Assets Ownership in Smallholder Farming Households

Describing the livelihood assets holdings in different smallholder households is critical and helps in detailing how households could deploy these assets in pursuance of adaptation activities. Assets description would also highlight the ownership patterns in farming households based on household characteristics such as gender, age, and education status.

5.2.1 Human Capital

Human capital is central to farmers' livelihoods and an essential component of climate change adaptation (Kuang et al., 2019; Li et al., 2020). Human capital in this study was measured by the education level of the household head, household size and type and labour engagement. A detailed description of these human capital variables was provided in chapter four under the socio-demographic and background characteristics of respondents. Based on these variables, human capital was found to be low among female-headed households because of low levels of education, higher dependency ratio and a large proportion of the elderly (60+ years). Conversely, male household heads were observed to have higher education levels, lower dependency ratio and larger household sizes. This section will concentrate on hired labour in farming households, which was not discussed in the previous chapter.

5.2.1.1 Hired Labour

The use of hired labour was uncommon in Ward 11. A majority of households relied on family labour, which was typically unpaid. Because of this, many households (79%) did not engage hired labour. However, a greater proportion (25%) of male-headed than female-headed households (15%) engaged hired labour (Table 5.1). It is possible that male-headed farming households cultivate more crops than female-headed households, resulting in their higher engagement of hired labour. This finding is consistent with Chipenda's (2018) observations in resettlement farming communities in the Goromonzi district of Zimbabwe, where more male farmers than females dominated the use of hired labour because of their large farm investments.

Table 5.1: Use of Hired Labour by Farming Household

Do you use hired labour?	Full Sample	Gender	
		Male	Female
	Freq (%)	Freq (%)	Freq (%)
Yes	53(20.7)	36 (24.49)	17 (15.60)
No	203(79.3)	111 (75.51)	92 (84.40)
Total	256 (100)	147 (100)	109 (100)
Chi (Pr)			3.0155 (0.082)
How often do you use hired labour?			
Permanent	8 (15.09)	6 (16.67)	2 (11.76)
Occasionally	41 (77.36)	28 (77.78)	13 (76.47)
Both	4 (7.55)	2 (5.56)	2 (11.76)
Total	53(100)	36(100)	17(100)

Source: Fieldwork, 2022

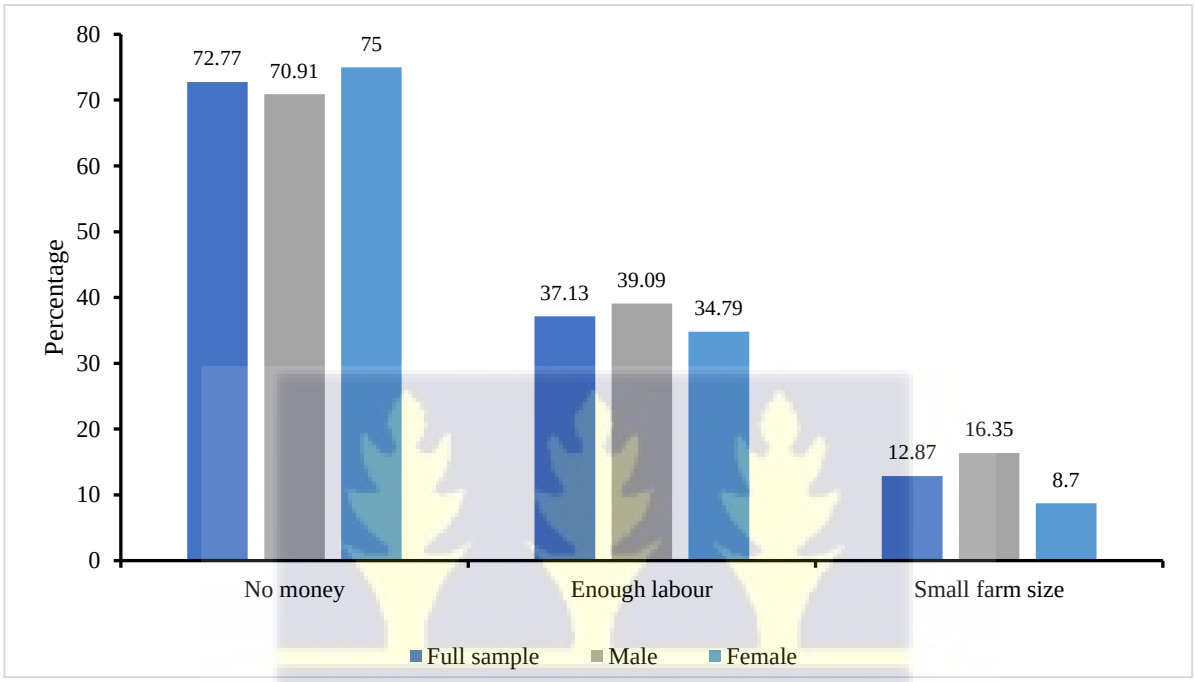
The results further indicate that occasional use of hired labour was most favoured over permanent labour, with both male-headed and female-headed households engaging in occasional use of hired labour (Table 5.1). The occasional use of hired labour is deemed advantageous and cost-effective because workers are recruited and paid as needed, such as when it's time for ploughing, planting, weeding, harvesting, de-husking, or shelling. Permanent labour, on the other hand, necessitates financial commitments because workers must be paid each month or at a mutually agreed-upon period, which burdens household budgets (Addison, 2019).The main highlight of the findings on the use of hired labour is that smallholder farming households minimally engage hired labour.

Several reasons account for this, including lack of funds (73%), adequate family labour (16%), small farm size (13%), and labour not needed (21%) (Fig. 5.1). Both male and female-headed households faced financial limitations in hiring labour Figure 5.1. The fact that lack of money topped the reasons for not engaging hired labour in both male-headed and female-headed households gives an indication that households could benefit from hired labour but have do manage without it due to financial constraints. This is concerning as it can hamper farming operations, especially if mammoth agricultural tasks must be executed within a specified time. For example, ploughing and planting before the mid-season dry spell or early cessation of rain.

This finding converges with evidence from Zimbabwe and Ghana, where the lack of finances, mainly cash, impeded the use of hired labour by farmers (Addison, 2019; Garcia et al., 2020).

Figure 5.1

Reasons for not using hired labour



Source: Fieldwork, 2022 (Respondents selected multiple responses)

Even though financial limitations impeded households' ability to engage hired labour for farming and other domestic tasks, additional provisions to guarantee communal access to labour were in place. For example, some of the studied villages utilised a form of collective labour support locally known as '*nhimbe*/*humwe*'. The '*nhimbe'* or '*humwe'* concept calls for individual members of farming households to get together in groups and labour on each other's farms in turns, undertaking tasks such as ploughing, planting, weeding, harvesting, construction or shelling (Addison, 2019; Nyahunda & Tirivangasi, 2021). Tavuyanago et al. (2010) describe *'nhimbe'* as a traditional cooperative system for carrying out household tasks, including farming and construction work. This offsets labour demands (Addison, 2019),

guarantees farming households' timely completion of tasks and reduces labour burden, especially for the aged, disabled or child-headed households.

The Mambera village headman explained how collective labour is practised in his village. "Usually, we don't work individually; villagers work on each other's farms according to a set schedule in groups of three or more. The host provides food and drinks to the labourers who execute the set tasks. This has lessened the labour pressure on many villagers, particularly the elderly, who would otherwise be unable to work in their capacity. A good example is Mai Tsuro (pseudonym), an elderly widow from our village who received assistance from some of the villagers". This explains how the community labour system functions to help households that require labour due to old age, disabilities, illnesses, or any other circumstances that may reduce agricultural productivity. Similar reciprocal community labour systems were found to be practised in Ethiopia under the names '*ofera*' or '*jigie*' and largely benefitted women and the aged who had no draught power (Mersha & Van Laerhoven, 2016).

5.2.1.2 Human Capital Index

In order to further elucidate the human assets in smallholder farming households in the study area, a human capital index was constructed using education, household size and households' use of hired labour. These indicators are among the essential characteristics of human capital and are associated with climate change adaptation and household resilience because they relate to the acquisition and deployment of production and living resources (Li et al., 2020). This index helps to explain how households are faring in some critical human capital indicators and has a scale ranging between 0 (low human capital) and 1(high human capital). The data shows that the average index score for farming households was 0.5, with a standard deviation of 0.2. Likewise, both male-headed and female-headed households had an average human capital score of 0.5 (Table 5.2). This performance can be described as moderate based on the equal

interval classification adopted in this study (Basaraner & Cetinkaya, 2017). This is an important finding because human capital is presumed to significantly influence smallholder households' economic recovery (Shi et al., 2011). Smallholder households in Ward 11 can rely on this asset to pursue adaptation and secure livelihood sustainability (Li et al., 2020).

Table 5.2: Means and Standard Deviations for Human Capital

Variable	Mean	Standard Deviation
Human Capital	0.5	0.2
Gender		
Male	0.51	0.21
Female	0.5	0.19

Source: Fieldwork, 2022

5.2.2 Natural Capital

Natural capital is an essential asset for farmers (Kuang et al., 2019; Shinbrot et al., 2019). Natural capital includes land, water, air, and environmental services (hydrological cycle, sinking pollutants) derived from nature (Scoones, 1998). Livelihoods, especially farming are derived from these natural resources. The measurement for natural capital was the total land possessed by farming households in acres. Table 5.3 presents the average scores for total lands possessed by smallholder farming households in Ward 11. The data show that farming households possessed an average of 3.04 acres of land. The gender disaggregation shows that female heads of households possessed an average land size of 3.09 acres while male heads of households possessed an average land size of 3.00 acres (Table 5.3).

Table 5.3: Average Total Land Possessed in Acres

Variable	Obs	Mean Total land	SD	Min	Max
Full Sample	256	3.04	1.96	1	12
Gender					
Male	147	3.00	1. 89	1	9.9
Female	109	3.09	2.05	1	12

Source: Fieldwork, 2022

Land is so central to livelihoods that its possession by farmers ensures better livelihood outcomes (Kaganzi et al., 2021; Mensah et al., 2022; Murken & Gornott, 2022). The type of land tenureship practised in any given area could enable or disable land access by farmers (Shumba, 2011). This is because different tenure systems have prescriptions for access and ownership among individuals. The prevailing land tenure system in Ward 11 is communal ownership (99.61%) (Table 5.4). These communal areas consist of reserved lands known as *maruzeva* in Shona that are governed by chiefs through village headmen on behalf of the government. Under this system, village headmen administer communal lands based on membership in a clan or family.

Various land acquisition modes under this system were found in Ward 11. Many of the farmers had acquired their lands through inheritance and customary allocation based on indigeneity. A few of the households had permission to use land from the owners, while rented, and some had purchased the lands (Table 5.4). Being an indigene in Zimbabwe, particularly in the villages, is an important identity that guarantees an individual many privileges. Seen as "a daughter or son of the soil" or *'mwana wevhu',* this identity means that as an indigene, access to land becomes easier than those considered strangers.

Table 5.4: Land Tenure Type and Modes of Access

Household land variables	Male Freq (%)	Female Freq (%)	Full sample Freq (%)
What is the land tenure system in your community?			
Communal	146 (99.32)	109 (100)	255 (99.61)
Other	1 (0.68)	-	1 (0.39)
Total	147 (100)	109 (100)	256 (100)
How did you acquire all your lands? (Mode of access)			
Customary allocation	75 (52.82)	43 (40.92)	118 (47.39)
Inherited	78 (54.93)	78 (72.90)	156 (62.65)
Permission to use	4 (2.82)	5 (4.67)	9 (3.61)
Rented	2 (1.41)	-	2 (0.8)
Purchased	6 (4.23)	5 (4.67)	11 (4.42)

Source: Fieldwork, 2022 (Respondents selected multiple responses for mode of access)

5.2.2.1 Gender, Land Access, and Acquisition

Improving access to and ownership of land enables smallholder farmers, particularly those headed by females, to secure and maintain their livelihoods (Jost et al., 2016; Toro, 2016). Land access by all the smallholder farmers in Ward 11 was possible, regardless of their gender. Respondents were asked whether women had equal access to land as men in the community. Table 5.5 shows that about 70 per cent of farmers agreed that women had equal access to land in the studied villages. A higher proportion of women (74%) perceived themselves as having equal access to land, and almost 66 per cent of men believed this to be the case. This finding could help explain why women possessed more land (mean=3.09) than men (mean=3.00), as presented in Table 5.3 under total land possessed by farming households. The primary condition that would guarantee women's access to land access is membership into a family from the village through marriage or kinship ties. From the data, farmers identified marriage (76%), inheritance (59%), and male kin (19%) as the primary avenues through which women could access land for farming (Table 5.5).

Table 5.5: Land Access and Modes of Land Access by Smallholder Farmers

Land variables	Male (n=147) Freq (%)	Female (n=109) Freq (%)	Full sample (n=256) Freq (%)
Do women have equal access to land?			
Yes	97 (66.99)	81 (74.31)	178 (69.53)
No	43 (29.25)	24 (22.02)	67 (26.17)
Don't know	7 (4.76)	4 (3.67)	11 (4.3)
Total	147 (100)	109 (100)	256 (100)
How do women access land? (Access modes)			
Marriage	115 (78.23)	79 (72.48)	194 (75.78)
Inheritance	73 (49.66)	79 (72.48)	152 (59.38)
Male kin	33 (22.45)	15 (13.76)	48 (18.75)
Buying/Hiring	22 (14.97)	13 (11.93)	35 (13.67)
Don't know	4 (2.72)	1 (0.92)	5 (1.95)
Other	2 (1.36_	4 (3.67)	6 (2.34)

Source: Fieldwork, 2022 (Respondents selected multiple responses for access modes)

The interviews with farmers and key informants provided additional insights into how land access is differentiated by gender. The respondents expressed that male farmers can access land through lineage, either as inheritance or parental allotment. Women too can inherit or be

allotted portions of land as spouses or daughters, though this is not guaranteed. As a spouse, a woman can inherit land after the passing of a husband. This kind of inheritance is governed by customs that may require the woman to be married into the family. Culturally in Zimbabwe, a married woman is one whose bride price has been fully paid and whose husband has fulfilled all the customary requirements necessary in marriage. For single women who cohabit without performing the traditional marriage rights, the risk of losing land and other benefits afforded a married woman at the death of a spouse is high. These findings suggest that marriage and male kin remain significant avenues through which women can access land in Ward 11, which is in line with other studies that reported similar modes of land access and acquisition in farming communities (Azong et al., 2018; Ingwani, 2021; Tsikata & Yaro, 2014).

Other perspectives expressed by female and male farmers suggested that access to communal lands is possible if the woman is a native and known to the village headman, who is the custodian of communal lands. Walker (2003) argues that locally managed systems of customary rights govern land distribution and access in much of Sub-Sahara Africa. Therefore, village headmen play an important role in land governance and women's access to land. Typically, village headmen facilitate and approve land allocations to women and other indigenes. Families allocated lands from the communal areas, overseen by the village headmen, can transfer their lands to unmarried female children, with authorisation from the village headman. Married daughters can be allocated too from the family lot, if the land is available and the family agrees with the allocation. On his own accord, the village headman can also allocate available and uncultivated lands to women from the village. Farmers again indicated that female farmers could borrow portions of uncultivated land from other villages. These avenues for land access only guarantee user rights but not ownership.

Generally, findings on gender-based land access indicated that female farmers in Ward 11 villages had land-user rights though they lacked ownership. Female farmers were also not necessarily restricted from accessing land for farming activities. This finding compares favourably with observations by Azong et al. (2018) in Cameroon, where studied female farmers lacked land ownership rights but enjoyed user rights to land. Access to land is critical as it allows farmers to intensify and diversify production, lowering the risk of losses (Adzawla et al., 2019). However, unequal access to this critical resource between male and female farmers can worsen gender inequalities and lead to the ineffective implementation of adaptation (Prügl et al., 2021; C Singh et al., 2016). As established by this study, female farmers' access to land reflects well on their ability to make adaptive decisions and maintain livelihood resilience. This finding contradicts observations from other studies (Garcia et al., 2020; Shrestha et al., 2019; Wrigley-Asante et al., 2019) that documented women farmers as lacking access to and ownership of land.

Overall, farming households fared moderately in natural capital making possible for them to rely on this resource to pursue adaptation and enhance sustainability. Scholars have argued that natural capital has the potential to enhance other livelihood capital (physical, social, human, and financial), and access to it is considered a central livelihood strategy (Carney et al., 1999; Nawrotzki et al., 2012). Making the best of natural capital can improve rural livelihoods (Sati, 2022) and aid smallholder farmers in combating the adverse effects of climate change.

5.2.3 Physical Capital

At the household level, physical capital comprises livestock, personal household, and economic items that farmers can convert into cash. These physical capital indicators are important because they reflect the endowment of smallholder households (Kuang et al., 2019).

Researchers have pointed out that physical capital is crucial in this regard as it is positively associated with household income and plays a critical role in enhancing other assets (Sun & Yu, 2014). The household survey solicited details about households' physical capital endowment. Physical capital was computed using total livestock, household items and economic assets values. These variables were valued in US dollars and presented as a raw value of all the physical assets holdings of the households (Table 5.7). The analysis first discusses the values for livestock, household items and economic assets and how they vary by gender. The final section then presents the overall physical capital values for all farmer categories.

5.2.3.1 Livestock

Livestock is essential in improving the livelihoods of smallholder farming households (Chipunza et al., 2013; Mkuhlani et al., 2020). It is also a key determinant of climate change adaptation (Obert Jiri et al., 2017). Livestock ownership serves as a source of protein and manure, as well as a safety net for households in times of hardship. Livestock is also seen as a symbol of household wealth and status (Chipunza et al., 2013; Obert Jiri et al., 2017). Table 5.6 presents livestock frequencies for Ward 11, Goromonzi district.

Table 5.6: Livestock Ownership in Farming Households

Variable	Full Sample Freq (%)	Gender of Household head	
		Male Freq (%)	Female Freq (%)
Own Livestock			
Yes	207 (80.86)	122 (82.99)	85 (77.98)
No	49 (19.14)	25 (17.01)	24 (22.03)
Total	266 (100)	147 (100)	109 (100)
Type of Livestock Owned			
Chickens	184 (88.89)	109 (89.34)	75 (88.24)
Goat	109 (52.66)	69 (56.56)	40 (47.06)
Cow	70 (33.83)	49 (40.16)	21 (24.71)
Turkeys	15 (7.25)	8 (6.56)	7 (8.24)
Guinea Fowls	10 (4.83)	7 (5.74)	3 (3.53)
Rabbits	9 (4.35)	5 (4.10)	4 (4.71)
Pigs	5 (2.42)	4 (3.28)	1 (1.18)
Donkeys	3 (1.45)	3 (2.46)	0 (0.00)
Sheep	1 (0.48)	1 (0.82)	0 (0.00)
Total	406 (196.14	255 (209.02)	151 (177.65)

Source: Fieldwork, 2022 (Respondents selected multiple responses for type of livestock owned)

Livestock ownership patterns show that nearly 81 per cent of all farming households owned livestock. A higher proportion of male-headed households (83%) owned livestock than female-headed households (78%). The main livestock owned by farming households were chickens, goats and cattle. The others were guinea fowls, turkeys, rabbits, and pigs (Table 5.6). The type of livestock owned by smallholder households in Ward 11 conforms to findings from other studies carried out in Zimbabwe that identified cattle, goats, and chickens as the main animals in farming communities (Chipunza et al., 2013; Mkuhlani et al., 2020). The total livestock value for each household was calculated by multiplying the number of animals (cattle, goats, birds) owned, by the current value in US dollars. The results indicated that the mean livestock value in Ward 11 villages was US$1,079.

Overall, female-headed households had lower mean livestock value (US$643) compared to male-headed households (US$1,379) (Table 5.7). Suggesting that male farmers owned more livestock, especially those with value like cows, than female farmers. Cattle ownership was predominant in the area before an outbreak almost wiped away entire herds across the country. This situation left many households with no draught power and reduced income, adversely affecting farming activities in the area. In-depth interviews with household heads revealed the depth of impact caused by the death of cattle in the district. Many farming households had to resort to *'pfumvudza'* (zero tillage) to cultivate crops. A female head commented, "The Redwater disease killed our cattle. All our cattle gone; wealth gone".

5.2.3.2 Household assets

Household items are essential in assisting our daily activities by making us comfortable and can be disposed of in times of need to generate income (Chingombe & Musarandega, 2021; Mavhura et al., 2017). Household assets included personal household items such as electronic gadgets (television, radio, mobile phones, solar panels), furniture (beds, sofas, wardrobes,

dining chairs, jewellery, etc.), bicycles, and cars. The total household asset value was computed by calculating the current market value of each item in its current condition. The data show that the mean household asset value for all farmer categories was 548.5 US$. Female-headed households had a lower mean household asset value (US$516) than male-headed households (US$572) (Table 5.7).

5.2.3.3 Economic assets

Economic assets form a critical component of capital necessary for livelihood enhancement. This is because such assets can be used to generate cash to cushion the household against financial shocks (Chingombe & Musarandega, 2021). The economic assets computed in this study included farm equipment (ploughs, scotch carts, irrigation equipment, cultivators, planters) and commercial businesses, among others. The total household economic asset value was computed by calculating the current market value of each item in its current condition. The results indicate an average economic asset value of US$997.6 for female-headed households, while male-headed households had an average value of US$770 (Table 5.7). Economic assets such as ploughs, scotch carts, tractors, and other farm implements increase productivity and make farming more accessible and efficient.

Table 5.7: Farming Household's Means for Physical Capital Variables in US Dollars

Variable	Livestock value	HH assets value	Econ. assets value	Physical Cap (p-value = 0.533)
Male (N=147)				
Mean	1,379	572.4	770,4	2,472.9
Min	5	10	6	10
Max	48,190.0	11,200	17,037	68,320
Female(N=109)				
Mean	643.3	516.4	997,6	2,000.6
Min	5	10	5	18
Max	7,140	3,750	36,490	46,240
Full Sample(N=256)				
Mean	1,079.0	548.5	867,3	2,271.8
Min	5	10	5	10
Max	48,190.0	11,200	36,490	68,320

Source: Fieldwork, 2022

5.2.3.4 Physical Capital Value

The overall mean value of physical capital in smallholder households was US$2,272, as shown in Table 5.7. The average physical capital value for male-headed smallholder farming households was US$2,473. On the other hand, the average physical capital value for female households was US$2,001, indicating that female-headed households had a lower physical capital value than male-headed households (Table 5.7). These observed differences were not statistically significant (p-value = 0.533) suggesting that gender has no influence in farming households' physical endowment. (Appendix 3D) The lower values for livestock and household items owned by female-headed households may explain this difference (Table 5.7).

5.2.4 Financial Capital

The financial capital of farming households was determined by the ability to save and access credit. Based on the findings, the financial capital in Ward 11 was minimal. At the time of data collection, physical cash circulation was limited. Most households had limited cash and preferred to transact business using Ecocash. This may be partially a result of the nation's current economic difficulties. Currently, Zimbabwe trades in multiple currencies, mainly the Zimbabwean Dollar (ZWL), observed as Real Time Gross Settlement dollar, commonly known as the RTGS$ and United States dollar (US$). Between 2019 and 2020, the RTGS$ was adopted as the official currency, but despite this move, the US dollar (US$) remained the dominant currency used in trading and business transactions. Due to the scarcity of US dollars, smallholder households' ability to obtain physical cash was diminished.

Table 5.8: Farming Households Income Savings Variables

Financial Capital	Male Freq (%)	Female Freq (%)	Full Sample Freq (%)
Savings			
No	113 (76.87)	92 (84.40)	205 (80.08)
Yes	34 (23.13)	17 (15.60)	51 (19.92)
Total	147(100)	109(100)	256 (100)
Chi2 (Pr)			2.2263(0.139)
Where did you save the money?			
At home	30 (88.24)	12 (70.595)	42 (82.35)
With a cooperative	6 (17.65)	4 (23.53)	10 (19.61)
With a bank	6 (17.65)	3 (17.65)	9 (17.65)
On Ecocash	7 (20.59)	2 (11.76)	9 (17.65)
Informally (relative /trader)	4 (11.76)	3 (17.65)	7 (13.37)
Total	53 (141.18)	24 (141.14)	77 (150.98)

Source: Fieldwork, 2022 (Respondents selected multiple responses for where they saved money)

The financial savings variables of smallholder farming households are shown in Table 5.8. The data analysis showed that the study area had poor saving culture, with the majority of households (80%) not having any savings. The gender disaggregation showed that more female-headed households (84%) had no savings compared to their male counterparts (77%) (Table 5.8). This could be an indication that female-headed households are not earning enough from their livelihood activities to save some for a rainy day or are spending most of their income and other resources on family upkeep. Balikoowa et al. (2019) found that female-headed households' livelihoods in Uganda were weak, which had implications for their financial capabilities. Additionally, female farmers may be unable to save because they have limited opportunities to work away from the farm, leading to poor savings and agricultural investments.

Among the few who had saved money in the past year prior to data collection (20%), the savings were mostly kept at home (82%), suggesting that informal methods of saving money were favoured (Table 5.8). One of the reasons for this could be the absence of banks and formal financial institutions in the area. The closest banks were in Harare or other growth points, some kilometres from the villages. Despite the unavailability of formal financial institutions, small informal cash cooperatives, or *'mukando'* in Shona, exist in the area and provide financial aid

to farmers. These groups allow members to contribute the same amount of money daily, weekly, or monthly, and the same members can borrow money from the group with interest. Money contributed is shared equally at a specified time and can be used to launch a project or business. Though some farmers indicated that they belonged to such groups, others were financially constrained and could not keep up with the subscriptions necessary for membership. Nevertheless, farmers emphasised the benefits of *mukando* and acknowledged their important role in providing financial aid to them.

5.2.4.1 Access to Credit

Access to credit minimises farmers' liquidity constraints and promotes productivity and commercialisation (Sekyi et al., 2020) through the purchase of farm implements and labour required to enhance outputs. Sadly, as with savings, access to credit or borrowing opportunities were limited for smallholder households in Ward 11, with only 16 per cent of the studied households having had access to credit. Nearly 84 per cent of households lacked access to credit facilities (Table 5.9). The data showed that both male-headed (84%) and female-headed (84%) households lacked access to credit facilities in the year prior to data collection. Several reasons may account for farmers' inability to access credit. In the studied villages, farmers' main reasons for not accessing credit were the 'unwillingness to go into debt' and 'no need for credit' (Table 5.9). This may be related to the worry that one won't be able to repay the loan, particularly if crops fail or livestock perish.

Relatives and friends were the primary credit providers for smallholder households. Relatives were the main source of credit for both male and female farmers with corresponding percentages of 70 and 60, respectively. Female heads of households, to a greater extent, relied on friends (65%) as a source of borrowing credit compared to their male counterparts (39%). Extended families and social networks constitute essential support systems for farmers as they

are readily available and do not require stringent rules to assist in times of financial need. Overall, the majority of borrowed credit went into purchasing food and other household supplies (65%). However, female farmers spent most of their borrowed credit on food and other household items (71%) and the purchase of farming implements (47%) compared to male farmers (61% and 13%, respectively) (Table 5.9). The observed expenditure differences could indicate the different responsibilities shouldered by male and female farmers as well as the differences in their needs.

Overall, the smallholder farming households in Ward 11 performed poorly in the measured financial capital variables. This can be attributed to the lack of savings and access to credit in the area precipitated by few opportunities for off-farm income and low income from agriculture due to increased climate variability, droughts, extreme heat and pest and diseases. Zhang and Fang (2020) observed that households that depend primarily on agriculture as a major source of income tend to suffer losses due to the vulnerability of agriculture to climate change. The poor performance of farming households in financial capital is concerning because financial capital directly determines the quality of life and the capacity to deal with risks (C. Zhang & Fang, 2020). Also, financial capital is considered a lubricant in accessing all other forms of assets (Mishi, 2014), therefore, its poor performance in Ward 11 poses a potential challenge in climate change management and livelihood sustainability.

Table 5.9: Financial Capital Variables in Smallholder Farming Households

Household financial capital variables	Male Freq (%)	Female Freq (%)	Full Sample Freq %)
Access to credit/Borrowed credit			
Yes	23 (15.65)	17 (15.60)	40 (15.62)
No	124 (84.35)	92 (84.40)	216 (84.38)
Total	147 (100)	109 (100)	256 (100)
Chi2			0.0001(0.991)
Reasons for not accessing credit			
Didn't want debt	74 (59.68)	50 (54.35)	124 (57.41)
Didn't need credit	52 (41.94)	43 (46.74)	94 (43.98)
Lack of collateral	27 (21.77)	11 (11.96)	38 (17.59)
High repayment interest	26 (20.97)	12 (13.04)	38 (17.59)
Other (No credit source/fear)	2 (1.61)	5 (5.43)	7 (3.24)
Total	147 (57.42)	109 (42.58)	256 (100)
Where did you borrow the money from?			
Relative/kin	16 (69.57)	10 (58.82)	26 (65)
Friends	9 (39.13)	11 (64.71)	20 (50)
Informal lending group	3 (13.04)	2 (11.76)	5 (12.5)
Trader/shopkeeper	1 (4.35)	1 (5.88)	2 (5.0)
Credit group	2 (8.7)	-	2 (5.0)
Bank	-	1 (5.88)	1 (2.5)
Other (employer/school)	1 (4.35)	1 (5.88)	2 (5.0)
Total	32 (139.13)	26 (152.94)	58 (145.0)
What did you use the credit for?			
Food & supplies	14 (60.87)	12 (70.59)	26 (65)
Education (fees)	8 (34.78)	5 (29.41)	13 (32.5)
Buy farm implements	3 (13.04)	8 (47.06)	11 (27.5)
Medical expenses	4 (17.39)	1 (5.88)	5 (12.5)
Capital for business	2 (8.70)	2 (11.76)	4 (10)
Social obligations	4 (17.39)	-	4 (10)
Pay debt	2 (8.7)	1 (5.88)	3 (7.5)
Buy livestock	-	1 (5.88)	1 (2.5)
Total	37 (160.87)	30 (176.47)	67 (167.5)

Source: Fieldwork, 2022. (Frequencies for reasons for not accessing credit, source of credit and use of credit were multiple responses)

5.2.5 Social Capital

Social capital is another key variable considered in adaptation and livelihood sustainability research. In the context of this study, social capital was measured by membership into a group and community participation and engagement by any household member, and from which some benefits were derived. In Ward 11, group membership was observed to be minimal. Based on the results presented in Table 5.10, only about 34 per cent of the farming households belonged to a group, while approximately 66 per cent did not.

Table 5.10: Do you belong to any social group?

Group membership	Male (n=147)	Female (n=109)	Total (n=256)
Yes	57 (38.78)	29 (26.61)	86 (33.59)
No	90 (61.22)	80 (73.39)	170 (66.41)
Chi (Pr)		4.1554 **(0.042)**	

Source: Fieldwork, 2022

A majority (66.41%) of both male and female farmers did not belong to a social group, but among those who belonged to a group, a majority were male farmer (39 %) compared to female farmers (27 %). The chi-square test was significant (p-value=0.042), suggesting that gender influences membership into social groups (Table 5.10). The types of groups in the area varied in scope, size, and purpose. Faith-based groups dominated, followed by self-help cooperatives or associations and women's groups (Table 5.11). While more female households belonged to faith-based and women's groups, male heads of households were more involved in self-help cooperatives and credit groups. Groups and other organisations often stepped in to help struggling households in the absence of government assistance. Male and female heads of households both benefited significantly from group membership in terms of funeral and illness assistance (60%), education and training (49%), and credit and savings (33%) (Table, 5.11).

Faith-based groups stood out in terms of supporting community members. They bridged the social service gap in the study villages by offering psycho-social support and financial support. The services provided by faith-based organisations proved essential to church members and other vulnerable community members, including the elderly, the sick, the disabled, and the bereaved. Given that the majority were widowed and cared for more dependents, this may help to explain why so many female households belonged to such groups.

Table 5.11: Social Capital Variables in Smallholder Households

Group membership	Male Freq (%)	Female Freq (%)	Full Sample Freq (%)
Which type of group do you belong to?			
Faith-based	22 (36.6)	14 (48.28)	36 (41.86)
Self-help cooperative/association	21 (36.84)	6(20.69)	27 (31.39)
Women's group	14 (24.56)	8 (27.59)	22 (25.58)
Credit group	8 (14.04)	3 (10.34)	11 (12.79)
Credit group	8 (14.04)	3 (10.34)	11 (12.79)
Men's group	3 (5.26)	2 (6.9)	5 (5.81)
NGO-based	1 (1.75)	-	1 (1.16)
Family-based	1 (1.75)	-	1 (1.16)
Other	3 (5.26)	3 (10.34)	6 (6.98)
Why do you not belong to a group?			
Busy schedule/no invitation/no money	14 (50)	7 (38.89)	21 (45.65)
Age	3 (10.71)	7 (38.89)	10 (21.74)
Religion	5 (17.86)	3 (16.67)	8 (17.39)
I am not a native	6 (21.43)	1 (5.56)	7 (15.22)
Illness disability	1 (3.57)	5 (27.78)	6 (13.04)
Political affiliation	4 (14.29)	-	4 (8.7)
Marital status	2 (7.14)	1 (5.56)	3 (6.52)
Because of my gender	2 (7.14)	-	2 (4.35)

Source: Fieldwork, 2022. (Respondents selected multiple responses)

The findings on group membership as an indicator of social capital show that it was very limited in the study villages. Similar observations were made by Zamasiya et al. (2017) and Omolo & Mafongoya (2019) in Zimbabwe and Kenya, where group membership was limited among smallholder farmers and pastoralists. Group involvement is critical for social identity, emotional support, networking, material assistance and services (He & Ahmed, 2022). Nevertheless, households relied on other forms of social capital, such as extended family and friends. Through the use of social capital, farmers can effectively combat the negative impacts of climate change while harnessing social cohesion and unity, which are also essential for fostering resilience (Saptutyningsih et al., 2020).

5.2.5.1 Community Participation and Engagement

The main community activities in Ward 11 were village meetings, agricultural fairs, communal labour (*nhimbe/humwe*), village courts, and programmes by extension officers, NGOs, and other institutions. To better understand farmers' involvement in these community activities,

respondents were asked if they were unable to participate in any community events and to provide the reasons why. Responses from farmers are presented in Table 5.12.

Table 5.12: Variables for Community Engagement and Participation

Community engagement	Male Freq (%)	Female Freq (%)	Full Sample Freq (%)
Are there any community activities you are unable to participate?			
Yes	28 (19.05)	18 (16.61)	46 (17.97)
No	119 (80.95)	91 (83.49)	210 (82.03)
Total	147(100)	109(100)	256(100)
Chi2 (Pr)			0.2726(0.602)
Which activities are you unable to participate in?			
Village courts	13 (46.43)	11 (61.11)	24 (52.17)
Village meetings	9 (32.14)	8 (44.44)	17 (36.96)
Programmes by NGOs and institutions	11 (39.39)	4 (22.22)	15 (32.61)
Agriculture fairs	9 (32.14)	3 (16.67)	12 (26.09)
Programmes by extension officers	8 (28.57)	4 (22.22)	12 (26.09)
Communal labour	10 (35.71)	2 (11.11)	12 (26.09)
Other	4 (14.29)	4 (22.22)	8 (17.39)

Source: Fieldwork, 2022. (Respondents selected multiple responses)

Smallholder households participated in community activities to a significant extent (82%). Group participation in male-headed households was almost 81%, and nearly 83% in female-headed households. Only about 18 per cent of the households could not participate in community activities for several reasons. The main activities, which the farmers were unable to participate in were village courts, village meetings, programmes by NGOs and other institutions, communal labour, programmes by extension officers and agriculture fairs (Table 5.12). Overall, the findings indicate that community involvement and engagement in Ward 11 were inclusive, which may help foster the adaptation and resilience of farming households.

The qualitative results unearthed that the reasons why many of the household heads did not belong to groups or participate in community activities were unequal treatment, perceived as discrimination and favouritism in group participation, limitations associated with aging and frailty and caring responsibilities for elderly and young family members. Female participants especially cited discrimination and favouritism as challenges to their group participation and engagement. They felt left out, with one elderly female farmer from Timuri village narrating

how she has always been excluded in NGO-based groups. When asked whether she belonged to a group she retorted that "which groups, they only ask their favourites to join so that they can share the money and items among themselves". She continued that "households A, B, C are always chosen, but for me, who do I know to be invited to join". These perceptions also led to some level of suspicion among villagers and can in the long term threaten social cohesion.

On the whole, the smallholder farming households fared poorly in some of the measured social capital variables, such as group membership and participation, but performed well in others, such as community involvement and engagement. Understanding what aspects of social capital are lacking in the studied villages is important because, in addition to other capitals, social capital is another important resource people take advantage of to pursue their livelihood goals in the context of a SLF. All forms of social capital ranging from group membership, networking, establishing communication channels and developing relationships of trust, are very important in climate change adaptation and enhancing livelihood sustainability. Several researchers have supported this claim and argue that the basic characteristics of social capital, including shared knowledge, skills and support are essential in climate change management and livelihood enhancement (Belay & Fekadu, 2021; Kuang et al., 2019; Nyahunda & Tirivangasi, 2021, Saptutningsih et al., 2020).

5.3 Characterisation of Smallholder Farming Households

Due to the smallholder households' variability in asset holdings, their livelihood portfolios and adaptation practices differ (Nguthi, 2007). These differences, to a greater extent, influence households' decisions and adaptation behaviours. In this vein, it was useful to classify the smallholder farming households in the study village into homogenous groups based on asset profiles. Three distinctive groups emerged from the categorisation: low-asset, medium-asset, and high-asset households (Table 5.13). Farming households differed in their asset endowment,

with a majority (83%, n=207) of the households falling within the low-asset category. The proportion of medium-asset households was about 14 per cent (n=34), while a few were in the high-asset category (3%, n=8).

A gender analysis from the data indicated that a majority of both female-headed (83 %) and male-headed (83 %) households were predominant in the low-asset household category (Table 5.13). This suggests that both farmers categories were asset constrained. This finding deviates from common research trends e.g. (Balikoowa et al., 2019; Kakota et al., 2011; Nabikolo & Bashaasha, 2012) that identify mostly female-headed households to be resource-constrained thereby lacking adequate investments in agriculture and other livelihood ventures.

In terms of education, farmers with no formal education were more prevalent in the low-asset household category (92 %), followed by those with primary education (83%) and secondary and above (79%). The chi-square test established a statistical association (p-value = 0.038) between asset category and education level of the household head (Table 5.13), suggesting that asset endowment increases with educational level. Educated farmers are likely to access better income, enabling them to acquire more assets for the household.

Regarding age and asset endowment, the chi-square results showed a significant association (p-value = 0.000) between the age of the household head and asset holdings, suggesting that age influences farming household's asset endowment. Elderly farmers (60+ years) (88%) dominated the low-asset household category, followed by the adults (36-60 years) (84%) and the youths (18-35 years) (57%) (Table 5.13). This finding implies that old age comes with a more significant loss of income and assets due to, for example, retirement, lack of energy to expend in income-generating activities and fewer opportunities to participate in the labour force. Elderly farmers have also been identified as being weak and more dependent on family, who may only offer minimal assistance (Omolo & Mafongoya, 2019). This may present

challenges to such households making it difficult to engage in livelihood portfolios that have diversified income (Zhang, Mishra & Zhu, 2019). The finding on older farmers falling within the low-asset category is consistent with findings in Kenya, where Omolo and P. Mofongoya (2019) observed that elderly farmers were the poorest in the studied communities.

Table 5.13: Household Asset Category by Household Type, Gender, Education and Age of Household Head

Variable	Low-Asset (n=208) Freq (%)	Medium-Asset (n=34) Freq (%)	High-Asset (n=8) Freq (%)
Gender			
Male	118 (83.10)	20 (14.1)	4 (2.8)
Female	89 (83.1)	14 (13.08)	4 (3.74)
Chi2 (Pr)			0.2060(0.902)
Education level			
No formal education	35 (92.22)	1(2.78)	0 (0.00)
Primary	80(83.3)	15 (15.63)	1 (1.04)
Secondary & above	92 (78.63)	18 (15.38)	7 (5.98)
Chi2 (Pr)			**10.15(0.038)**
Age category			
Youth (18-35yrs)	12(57.14)	5(23.81)	4 (19.05)
Adults (36-60yrs)	110 (83.97)	18 (13.74)	3 (2.29)
Elderly (60+yrs)	85 (87.63)	11 (11.34)	1(1.03)
Chi2 (Pr)			**22.09(0.000)**
Household type			
Nuclear	124 (78.48)	28 (17.72)	6(3.8)
Extended	83 (91.21)	6 (6.59)	2 (2.2)
Chi2 (Pr)			**6.82/0.033**

Source: Fieldwork, 2022

Most extended family households (91%) were dominant in the low-asset household category, compared to nuclear family households (78%) (Table 5.12). Conversely, nuclear family households (18%) were more prevalent in the medium-asset and high-asset (3.8%) household categories. This difference was statistically significant (p-value = 0.033) suggesting an association between the type of households and asset ownership. Nuclear families are better able to accumulate and retain their assets since they may not need to spend as much money on providing for extended family members. On the other hand, extended family households spend more on household needs and welfare, potentially depleting available resources. This is particularly more pronounced in situations where fewer family members are economically productive and have to shoulder the burden of providing the needs of the larger family, leaving

fewer resources to be invested in livelihood activities that could build household assets. This notwithstanding, the communal way of life, where the extended family lives together and shares resources, has some benefits, in terms of providing psychosocial, emotional, labour and economic support to each other, which can enhance climate change adaptation (Eyasmin et al., 2021).

The depicted figures on smallholder farming households' assets holding indicate that education, age and the type of household (nuclear or extended) influence the asset profiles of farmers. The chi-square test results have provided evidence to conclude that households' asset holdings are influenced by the age and education level of the household head and household type, while gender has no influence on households' asset endowment. Assets are critical in pursuing livelihood and adaptation activities (Funk et al., 2020; Hassan & Nhemachena, 2008; Obert Jiri et al., 2017) and influence outcomes in terms of food security and general household well-being. Whether men and women can pursue any farming activity depends on the availability of assets.

5.4 Conclusions

Even though, the SLF portrays the household as a unitary whole, it overlooks other important intra-household dynamics that influence livelihood outcomes. This study still considered it as a valuable framework for analysing households' decision-making processes to pursue livelihood goals. Thus, a household's livelihood depends on human, natural, physical, financial, and social capital. This chapter profiled farming households' assets and examined how farming households in the studied villages fared in terms of asset endowment.

The households were found to have human, natural, physical, financial, and social capital at their disposal. However, apart from human capital, farming households underperformed across

the natural, physical and financial based on the measured variables. Social capital which was measured by group membership and community participation showed that while group membership was limited, community engagement was very inclusive in the study area. This explains why a majority of both male-headed and female-headed households were prevalent in the low-asset household category. The poor performance of farming households in the other key assets (social, physical financial and physical) has implications for climate change management capacities, livelihood diversification and sustainability.

Three types of households emerged based on the asset profiling namely, low-asset, medium-asset and high-asset households. Overall asset ownership patterns in farming households were not necessarily differentiated by the gender of the household head. Both household categories were asset constrained. A key highlight from this chapter is that women had access to land just as their male counterparts, which is encouraging and can potentially enhance their adaptive capacities. There was a notable differentiation in asset ownership by age and education level of the household head and type of household, whether nuclear or extended. Households with a head without formal education, elderly and extended families were observed to be in the low-asset categories. Asset profiling proved critical in this chapter because assets are key in livelihood pursuits, including adaptation decisions and behaviours of farmers. However, climate change impacts on livelihoods might affect the asset holdings of the various farming households. The consequences could be favourable or unfavourable as households may pursue and implement strategies that could increase or deplete their asset endowments.

The next chapter explores the position that households are rational entities that make decisions based on their livelihood asset endowment to pursue adaptation and livelihood goals. The chapter examines adaptation practices implemented by smallholder households in the studied villages in Ward 11 and the livelihood sustainability prospects of these households.

CHAPTER SIX

GENDER, ADAPTATION AND SUSTAINABLE LIVELIHOODS PATHWAYS IN SMALLHOLDER FARMING HOUSEHOLDS

6.1 Introduction

The linkages between climate change adaptation and livelihood sustainability provide the key to understanding how households can effectively counteract challenges posed by climate change while maintaining their ability to secure livelihood sustainability. This chapter looks at adaptation behaviours in smallholder households and livelihood outcomes and sustainability. The first section of this chapter discusses climate change adaptation practices in Ward 11 within the context of gender and other key variables. Specifically, the section highlights the implemented strategies, barriers to climate change adaptation and the determinants of adaptation in the households. The second section examines the households' livelihood prospects. It describes household income and food security as important livelihood outcomes, which contribute to sustainability. Enhancing agricultural production and safeguarding household income and food security allows farming households to maintain sustainability and build resilience in times of crisis. The section also determines the relationship between implemented adaptation strategies, food security, household income and other variables and livelihood sustainability. The final section provides a synthesis of the chapter and conclusion.

6.2 Gender and Climate Change Adaptation Practices in Ward 11 Smallholder Farming Households

Adaptation strategies are implemented to manage climatic shocks and other non-ecological stressors and varies from activities that are undertaken on the farm and off-farm (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Hassan & Nhemachena, 2008; Obert Jiri & Mafongoya, 2020;

Ylipaa et al., 2019). To address the effects of climate change and build resilience, smallholder farmers must adjust farming activities and other livelihood activities. This section discusses the factors farmers consider in selecting and implementing adaptation measures. Additionally, it describes the adaptation practices employed by farming households in Ward 11 with reference to the household head's gender, age, education, and asset endowment.

6.2.1 Factors Influencing Smallholder Farmers' Selection of Adaptation Strategies

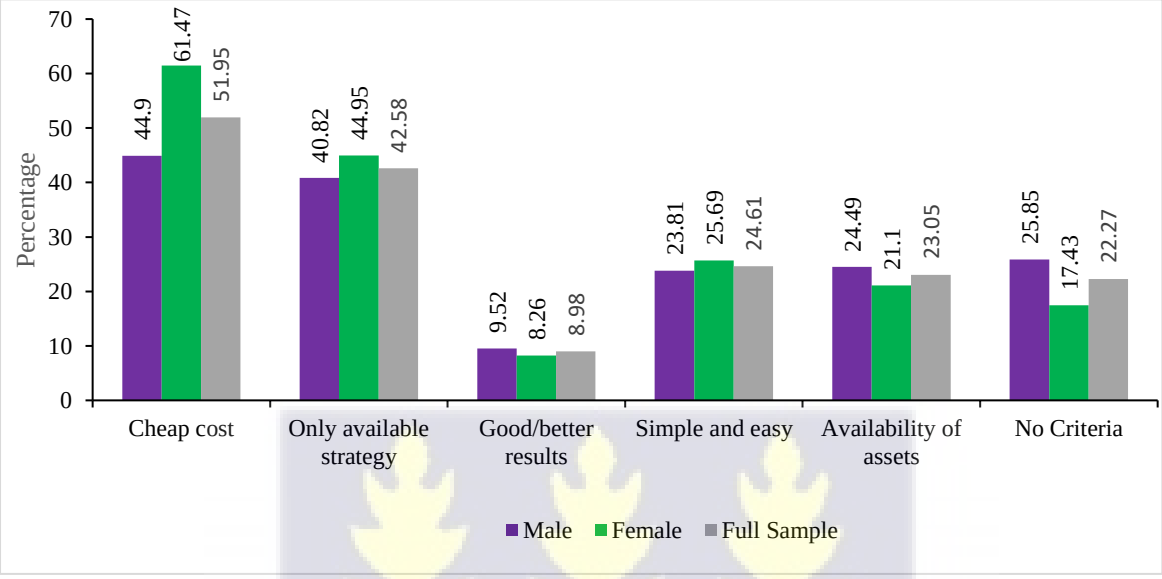
Before examining the adaptation strategies implemented by farming households in Ward 11, it is important to understand how farmers make decisions on which strategies to implement. This sub-section is dedicated to highlighting the selection criteria of adaptation strategies. Farmers will consider the cost and benefits before adopting an adaptation strategy over the other. Farmers were asked why they choose particular adaptation strategies for implementation. The results indicated that the cheaper the cost of adopting a strategy, the more likely it was for a household to implement it. Again, if a household was given just one option for an adaptation method, the likelihood of adopting that strategy was very high. The same applies to the likely acceptance of simple techniques that do not require specialised knowledge or skills in implementation. Priority for adopting and implementing a strategy was also based on the availability of assets (Figure 6.1).

A gender analysis showed that with the exception of asset availability (24%) and good results (10%), which were the main considerations for male farmers, female farmers considered cost (61%), only available strategy (45%) and easy implementation (26%) as main factors influencing their adaptation decisions (Figure 6.1). These results imply that a female-headed household's choice of adaption method is significantly influenced by cost. Thus, costly adaptation initiatives are more likely to be abandoned or disregarded by female farmers as they may be considered unnecessary. The finding on cost as a determining factor in selecting a

strategy is consistent with other studies in smallholder communities (Dube et al., 2018; Mushore et al., 2021).

Figure 6.1

Selection Criteria and Gender of the Household Head



Source: Fieldwork, 2022. (Respondents selected multiple responses)

6.2.2 Adaptation Practices Prevailing in the Farming Households

Generally, the results indicate that zero tillage, mixed farming, shifting of planting dates, off-farm activities, crop staggering, crop rotation, planting trees, mulching, stopping growing crops and planting hybrid varieties were the most widely implemented adaptation strategies by smallholder farming households in Ward 11 villages (Table 6.1). Although mentioned by a few farmers, intercropping, irrigation and water harvesting were additional household adaptation strategies. Furthermore, the qualitative interviews revealed fertiliser and manure application and spraying of insecticides and weedicides as other strategies practised in the area.

Table 6.1: Adaptation Practices in Ward 11 Villages by the Gender of Household Head

Adaptation Strategy	Full sample (n=256) Freq (%)	Male (n=147) Freq (%)	Female (n=109) Freq (%)	Pearson Chi2
Zero-tillage	212 (82.81)	120 (81.63)	92 (84.40)	0.561
Mixed farming	207 (80.86)	122 (82.99)	85 (77.98)	0.341
Shift planting dates	194 (75.78)	113 (76.87)	81 (74.31)	0.637
Off-farm activities	164 (64.06)	98 (66.67)	66 (60.55)	0.313
Crop rotation	162 (63.28)	96 (65.31)	66 (60.55)	0.435
Crop staggering	162 (63.29)	96 (65.31)	66 (60.55)	0.435
Tree planting	162 (63.28)	99 (67.35)	63 (57.80)	0.117
Mulching	156 (60.94)	97 (65.99)	59 (54.13)	**0.055**
Stopped growing crops	128 (50.0)	71 (48.30)	57 (52.29)	0.527
Hybrid varieties	116 (45.31)	71 (48.30)	45 (41.28)	0.265
Intercropping	86 (33.59)	45 (30.61)	41 (37.61)	0.241
Crop irrigation	81 (31.64)	48 (32.65)	33 (30.28)	0.686
Water harvesting	7 (2.73)	5 (3.40)	2 (1.83)	0.447

Source: Fieldwork, 2022

6.2.3 Climate Change Adaptation and Farmer's Demographic Characteristics *(Gender, Age and Household Assets)*

Adaptation strategies by the gender of the household head showed some variations. Male-headed households had higher proportions for implemented adaptation strategies than female-headed households. For example, male-headed households dominated in the application of shifting planting dates (76.9%), crop rotation (65.3%), crop staggering (65.3%), use of hybrid seed varieties (48.3%), mulching (66.1%), tree planting (67.4%), mixed farming (83.1%) and off-farm income generating activities (66.7%). Female-headed households, on the other hand, prevailed in implementing zero tillage (84.4%), intercropping (37.6%), and stopped growing crops (52.29%) (Table 6.1). The only adaptation method that indicated statistical significance according to the chi-square test was mulching (p-value = 0.055).

Gender differences in climate change adaptation are complex and multidimensional and may be attributed to several reasons, including differential access to resources (S. Ahmed & Kiester, 2021) and cultural, social, financial and institutional barriers (Mersha & Van Laerhoven, 2016; Wrigley-Asante et al., 2019). Differences in adaptation between male and female smallholder

farmers have been reported in other studies in developing countries (Adzawla et al., 2019; S. Ahmed & Kiester, 2021; Antwi-Agyei & Nyantakyi-Frimpong, 2021; Assan et al., 2018, 2020; Balikoowa et al., 2019; Dah-gbeto & Villamor, 2016; Garcia et al., 2020; Mersha & Van Laerhoven, 2016; Wrigley-Asante et al., 2019).

Table 6.2 presents the disaggregation of adaptation strategies by household asset category. The results show that all household categories implemented adaptation strategies but to varying degrees. Apart from the implementation of zero-tillage (85%) and crop staggering (66%) which were higher for low-asset households, the implementation of the other strategies was higher for medium and high-asset households, suggesting that assets are critical in farmers' adaptation to climate change impacts. The low-asset farming households largely practised zero tillage, probably because of the government's incentives (fertilisers and seeds) to those willing to adopt it. The results indicate that households with more assets have a higher adaptive capacity thus are better adopters than resource-constrained households.

The chi-square test established statistical significance between household asset category and water harvesting (p-value = 0.001) and crop irrigation (p-value = 0.008), suggesting that the implementation of these strategies to mitigate climate change effects depends on asset holdings. This result supports the assumption of the sustainable livelihood approach that human, physical, financial, social and natural assets are deployed by households in pursuit of livelihood activities in order to enhance livelihood outcomes (DFID, 2000). Therefore, farmers with better asset endowments have more options for coping with climate change risks (Paul et al. 2016).

Table 6.2: Adaptation Strategies by Household Asset Category

Adaptation Strategy	Low-asset (n=207) Freq (%)	Medium-asset (n=34) Freq (%)	High-asset (n=8) Freq (%)	Pearson Chi
Zero-tillage	175 (84.54)	27 (79.41)	6 (75)	0.608
Mixed farming	170 (82.13)	26 (76.47)	8 (100)	0.293
Shift planting dates	155 (74.88)	30 (88.24)	7 (87.5)	0.178
Crop staggering	137 (66.18)	16 (47.06)	5 (62.5)	0.100
Off-farm activities	134 (64.73)	21 (61.75)	6 (75)	0.779
Crop rotation	128 (61.84)	23 (67.65)	5 (62.5)	0.810
Tree planting	128 (61.84)	23 (67.65)	7 (87.5)	0.288
Mulching	124 (59.9)	21 (61.76)	6 (75)	0.685
Stopped growing crops	106 (51.21)	14(41.18)	6 (75)	0.208
Hybrid varieties	92 (44.44)	17 (50)	6 (75)	0.210
Intercropping	65 (31.4)	14 (44.12)	2(25)	0.305
Crop irrigation	55 (26.57)	18 (52.94)	3 (37.5)	**0.008**
Water harvesting	4 (1.93)	1 (2.94)	2 (25)	**0.001**

Source: Fieldwork, 2022

Households headed by elderly (60+ years) farmers by far had the highest proportions of farmers who employed intercropping, crop rotation, crop staggering, hybrid crop varieties, mulching, zero tillage, tree planting, mixed farming and stopped growing crops (Table. 6.3). Despite the fact that this age group was more prevalent in the low asset category (Table 5.12), they represented the largest proportions of farmers, who adopted these strategies. This may be explained by a number of reasons. Older farmers are thought to have vast knowledge accumulated from years spent working on the farm. Their perceptions and experiences of climate change over time may give them the skills they need to better adapt. Farmers that are older may have indigenous knowledge that could help them manage climate change (Nhemachena & Hassan, 2007). For example, adaptation strategies like crop staggering, mulching and zero tillage favoured by this age group are considered indigenous. Farmers have traditionally used these methods, which call for and utilise the resources at their disposal. This result corroborates findings by Diarra et al. (2021) in Mali, where aged farmers in their study sample adopted more strategies than younger ones.

It also unsurprising that the findings show a higher proportion of the youth heads of households (18-35 years) participating in off-farm income-generating activities. This is because the youth

are motivated to engage in various income-generating activities because they are regarded as being more aspirational, energetic and on a quest to build their future. The chi-square tests showed that the implementation of crop rotation, mulching and participation in off-farm activities showed statistically significant association with age with p-values of 0.057, 0.08 and 0.007, respectively. This demonstrates that implementing these adaptation strategies is influenced by the age of the farmer.

Table 6.3: Adaptation Strategies by Age Category of Household Head

Adaptation Strategy	Youth (18-35yrs) Freq (%)	Adults (36-60yrs) Freq (%)	Elderly (60+yrs) Freq (%)	Pearson Chi
Zero-tillage	17 (73.91)	108 (80.60)	87 (87.88)	0.171
Mixed farming	15 (65.22)	107 (79.85)	85 (85.86)	0.070
Shift planting dates	20 (86.96)	105 (78.36)	69 (69.70)	0.132
Off-farm activities	18 (78.26)	94 (70.15)	52 (52.53)	**0.007**
Crop rotation	10 (43.48)	83 (61.94)	69 (69.70)	**0.057**
Crop staggering	11 (47.83)	83 (61.94)	68 (68.69)	0.156
Tree planting	11 (47.83)	82 (61.19)	69 (69.70)	0.113
Mulching	10 (43.48)	79 (58.96)	67 (67.68)	**0.080**
Stopped growing crops	10 (43.48)	65 (48.51)	53 (53.54)	0.605
Hybrid varieties	8 (34.78)	59 (44.03)	49 (49.49)	0.403
Intercropping	6 (26.09)	45 (33.58)	35 (35.38)	0.698
Crop irrigation	6 (26.09)	44 (32.84)	31 (31.31)	0.810
Water harvesting	1 (4.35)	3 (2.24)	3 (3.03)	0.826

Source: Fieldwork, 2022

6.2.4 Description of the Main Adaptation Practices in Ward 11

This section briefly describes the main adaptation strategies employed by smallholder farmers in Ward 11.

Zero-Tillage (Pfumvudza)

Overall, in Gutu Ward 11, the soil conservation technique most prevalent in the area is zero tillage *'pfumvudza'*. It is a conservation agriculture technique that sustainably maximises the use of resources and ensures households have enough food to eat and sell for income. The programme is instituted under the ministry of agriculture through the AGRITEX department. Many households in the district widely practised *'Pfumvudza'*, possibly because of the

incentives of seeds and fertiliser to adopters. The technique involves pot-holing the farm before the rain and enhancing the fertility and moisture of the soil using manure, fertiliser, and mulching. The agriculture Extension officer for Ward 11 stated that "farmers are encouraged to do potholing of three plots for maize and one for a legume around September -October". The officer explained further that of the three plots of maize, one is consumed when fresh, the second is harvested for household consumption and the third is sold to generate income. This strategy harnesses food security and improves household nutrition and income.

While conservation farming has been proven effective in boosting crop yield, its sustainability was questioned by some of the adopters in Ward 11 villages. Farmers were concerned about the labour demands and late distribution of farm inputs, which made the implementation of zero-tillage difficult. Similarly, Dube et.al. (2018) also questioned the sustainability of conservation farming in the Gwanda district based on labour needs. In the study area, many farmers raised concerns about potholing and weeding, which they considered laborious. Farming households, especially those with elderly heads or less labour, for example, found it challenging to implement zero-tillage effectively because of the labour dynamics. An elderly male farmer from Bungu village affirmed, "because of my age, I cannot dig the holes. We are asked to dig the holes in the dry season, and it is extremely hard".

Additionally, the late supply of inputs also hampered the successful implementation of zero-tillage. According to the farmers, the distribution of inputs that should occur before planting starts frequently delayed, forcing them to look elsewhere for seeds and fertiliser. A female farmer from Gore village bemoaned the late delivery of inputs, "*Mudhumeni* (Extension officer) and his people did not give us the seeds and fertiliser on time. They called us to come for the *'pfumvudza'* inputs after we had already planted our own seeds. Unfortunately, it was

too late, the rains had ceased. I then decided to forego zero-tillage; besides, I cannot manage the labour," she said.

On the whole, the application of zero-tillage though widespread in the area, is marred by myriad challenges. Zero-tillage is widespread in Zimbabwe, and several studies have documented its application in smallholder farming communities (Dube et al., 2018; Gutsa, 2017; Makuvaro et al., 2018; Mutandwa et al., 2019). Across Africa, in farming communities, zero-tillage is also commonly practised (Adzawla et al., 2019; Antwi-Agyei & Nyantakyi-Frimpong, 2021; Autio et al., 2021). However, evidence also indicates that farmers are abandoning the application of conservation agriculture due to labour demands and the late distribution of inputs. For example, in the Chimanimani district of Zimbabwe, farmers studied by Chingombe and Musarandega (2021) indicated that they had stopped conservation farming due to labour demands and the late distribution of seeds.

Mixed Farming

Mixed farming is widely practised in the area, with both male and female farmers adopting the technique. Smallholder farmers engaged in crop cultivation and livestock rearing at the same time and place. The main crops grown were maize, groundnuts (*nzungu*) and *bambara* nuts (*nyimo*), while livestock constituted mainly fowls, goats and cattle. Although both male and female farmers practised mixed farming, a greater percentage of adopters were male farmers. This strategy was considered important by farming households because climate change effects had resulted in low crop yield, making livestock incorporation a valuable strategy in order to spread the risks of diminished productivity. Mixed farming as an adaptation strategy to climate change effects was reported in previous studies in farming communities in Ghana (Adzawla et al., 2019; Antwi-Agyei & Nyantakyi-Frimpong, 2021) and Zimbabwe (Asare-Nuamah et al., 2022).

Shifting Planting Dates

Adjusting planting dates (75.78%) is also common in farming households, with both male and female-headed households being adopters. Changing planting dates based on the rainfall trends in the cropping season is often implemented with crop staggering to safeguard against total crop loss from either mid-season dry spells or excessive rainfall. According to farmers, the main justification for implementing these strategies was the unpredictability of rainfall in intensity, duration, and timing. Given the climate variability, it is prudent for farmers to adjust planting dates to align with the rainfall trends. Over time, smallholder farmers have acquired local knowledge about the distinctive characteristics of each cropping season. They have accordingly prepared themselves to adjust to meet everchanging climatic trends. For example, farmers revealed that the time they planted in the 2020 cropping season differed from the 2021 planting dates. Findings on shifting planting dates substantiate those by other researchers in Ghana (Adzawla et al., 2019; Antwi-Agyei & Nyantakyi-Frimpong, 2021), Bangladesh (S. Ahmed & Kiester, 2021), Mali (Diarra et al., 2021), Lesotho (Dick-Sagoe et al., 2022), Zimbabwe (Mutandwa et al., 2019) and Kenya (Kalele et al., 2021), where smallholder farmers adjusted planting dates based on the rainfall patterns in the previous year.

Crop Staggering

Both male and female farmers expressed frustration with erratic rainfall patterns, which led to the loss of seeds that were either buried underground by heavy rain or scorched by excessive heat. In this regard, extension officers encouraged farmers to stagger their crops to reduce the risk of total crop loss. Insights from the interviews revealed that staggering involved planting maize or any other crop in two or three stages. First, at the onset of the effective rains sometime in November, then in the first and third or fourth week of December. Planting seeds at various stages in the cropping season is an important strategy that contributes to food security. However, it requires the availability of farm inputs such as seeds and fertilisers. During the

fieldwork, it was observed that households that planted additional crops a few weeks following the initial planting benefited from staggering. These households were the envy of many as other villagers frequently remarked, *'gore rino munacho chibage',* meaning this year you have a good yield. This finding on the implementation of crop staggering corresponds with Asare-Nuamah et al. (2022) and Jiri et al. (2015), who observed crop staggering as an important adaptation technique adopted by smallholder farmers.

Hybrid Varieties

Smallholder farmers (both male and female) largely adopted the cultivation of hybrid crop varieties. This was highly practical given the rising unpredictability and frequent mid-season dry spells. The most favoured hybrid seeds were maize and groundnuts. The fact that these were the two most widely staggered crops in the area may have contributed to the preference for short-seasoned hybrid varieties, especially maize. The maize crop varieties adopted by Ward 11 farmers included high-yielding, quick-to-mature, weed-resistant, and disease-and-pest-tolerant. These varieties help farmers to secure some yield, especially when rainy seasons are brief and erratic. As mentioned by farmers, the most favoured hybrid maize varieties were Seedco's '*tsoko'* (SC403) and *'shumba'* (SC649) and Pannar's Pan513, which are early to medium-maturing varieties. Previous studies in developing countries have reported the use of hybrid seeds that are drought and pest-tolerant and early maturing as an adaptation strategy to erratic rainfall patterns (Adzawla et al., 2019; Antwi-Agyei & Nyantakyi-Frimpong, 2021; Asare-Nuamah et al., 2022; Atube et al., 2021; Diarra et al., 2021; Dube et al., 2018; Kalele et al., 2021; Mushore et al., 2021).

Tree Planting

Different types of trees were grown by farmers, including fruit trees such as orange, mango, guava and peach and other exotic trees such as gum trees (eucalyptus) and Jatropha (*Jatropha*

curcas). All these trees were noticed in many households, but Jatropha trees were more prevalent. Farmers explained that they were encouraged by the government to plant jatropha trees due to their potential as an oil crop for biodiesel. This was seen as an opportunity for household income generation, even though, according to them, no one came to purchase the fruit or the plant. Aside from the motivation farmers provided for planting jatropha, other additional reasons for tree planting were the prevention of strong winds from destroying crops, evapotranspiration, and tackling soil erosion. Fruit trees were also planted for income generation and to supplement the household diet. Excess fruits such as mangoes and guavas were sold to buyers from the city, providing income for the household. Tree planting has also been reported in other studies among smallholder farmers in Uganda (Atube et al., 2021) and Lesotho (Dick-Sagoe et al., 2022).

Discontinuation of Crops

Some smallholder farmers also stopped growing crops to manage the effects of climate change. Typically, farmers may be unwilling to invest time, labour and other resources into cultivating crops that will not produce a good yield. This could explain why almost half of all the studied farming households stopped growing some crops such as rice, finger millet *(zviyo)* and bambara nuts *(nyimo)*. Farmers cited the non-viability of the crop, inadequate rain and the crops requiring intricate care and being labour-intensive as the main reasons for discontinuing the crops. Gutsa (2015) made similar observations that farmers stopped growing poor-yielding and labour-intensive crops as an adaptation mechanism in the Goromonzi district.

Manure Application

Manure application, either from composting or animal residue, is considered an efficient way of enhancing crop productivity and reducing farmers' production costs (FAO, 2015). Both male-headed and female-headed households in Ward 11 applied manure in their farms to

enhance soil fertility and improve crop yields. This strategy was favoured because it was readily available and depended on farmers' own raw materials, which was in tandem with the Extension Officer's remarks that the department encourages farmers to implement strategies that utilise their existing resources. Composting and livestock residue were the main sources of organic manure for farmers in the area.

Many farmers exhibited vast knowledge of manure application and were aware of its benefits on productivity. A male farmer from Bungu village stated that he had four composts "made of grass and remains from the previous harvest. Towards the rainy season, we cover the composts with soil to trap heat and aid decomposition. When it's ready, I apply it in the fields and ridge during the planting season. I also use cow and goat residues to boost soil fertility". Almost every interviewed farmer narrated such statements. This suggests that farmers are likely to adopt less expensive and easy-to-implement strategies since they do not have to invest many resources in applying them. Manure application can help boost farm productivity and enhance food security (Eyasmin et al., 2021). The finding on manure application by farmers compares favourably with observations from other studies among smallholder farmers where manure was adopted to enhance soil fertility, improve crop growth and reduce the cost of production (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Autio et al., 2021; Cholo et al., 2019; Eyasmin et al., 2021; Nyantakyi-Frimpong, 2017; Tahiru et al., 2019; Van Aelst & Holvoet, 2016).

Off-farm Activities

Farmers often seek alternative means of livelihood, such as off-farm activities, which enable them to supplement income and safeguard against unexpected climate shocks (Ume et al., 2021; Wrigley-Asante et al., 2019). In Ward 11, the main non-farm diversification activities were casual labour (18.8%), trading in food, clothing, and other household consumables (15.23%), masonry work including building, thatching, and landscaping (9.38%), migration

(6.64%) and foraging for non-timber forest products such as vegetables, mushrooms, and herbs (5.86%). Some households though few, engaged in prophetic and traditional consultations and healing, pit latrine and well digging, commercial transport provision, hairdressing and sewing and beer brewing (Appendix 3E). Complimenting agriculture by diversifying into a range of off-farm income-generating activities is essential to managing climate change risks. The finding on off-farm activities as an adaptation strategy employed by farming households is consistent with earlier related studies conducted in Ghana (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Assan et al., 2020; Wrigley-Asante et al., 2019; Yiridomoh et al., 2020), Zimbabwe (Mushore et al., 2021; Mutandwa et al., 2019) and Nigeria (Ume et al., 2021), where off-farm activities were adopted.

Participation in non-farm activities was gendered, with findings showing that a higher proportion of female farmers (22%) than male farmers (18%) participated in informal labour markets as domestic and casual labourers. On the other hand, more male farmers (16%) than female counterparts engaged in skilled occupations like masonry or construction. Trading in foodstuffs, clothing and other household consumables was equally undertaken by both male (18%) and female (18%) farmers). In the case of Ward 11, more female farmers (10%) than male farmers (4%) (Appendix 3E) were involved in migration, mainly to larger cities such as Harare and to neighbouring South Africa and Botswana in search of work. This finding deviates from observations by Wrigley-Asante et al. (2019) in Ghana, where male farmers dominated migration.

6.2.5 Adaptation Strategies and Crop Yield

Smallholder farmers were asked to indicate whether the implemented strategies had improved their crop yield. A majority (51%) of smallholder farmers indicated that the adopted strategies against the effects of climate change did not improve their crop yield, while about 49 per cent

responded in the affirmative. Among farmers who perceived enhanced crop yield, female heads of households constituted the majority (51%), while a significant proportion (53%) of male farmers reported that the yield had not improved (Table 6.4). Crop yield has been shown to have a bi-directional relationship with adaptation. For example, Diallo et al. (2020) observed that adaptation, particularly fertiliser application and cultivation of short-duration maize varieties, improved yield and food security in Mali.

Researchers have argued that improved crop yields positively influenced climate change adaptation behaviours and practices (Diallo et al., 2020; Mafongoya P, 2015). This implies that when farmers perceive improved crop yield, they are more likely to intensify adaptation. In Ward 11, however, most smallholder farmers did not perceive an improved crop yield after implementing adaptation. In addition to unpredictable weather patterns, poor soil fertility, pests and diseases, and a lack of implements impeded farmers' adaptation efforts leading to poor farm productivity (Asare-Nuamah et al., 2022; Autio et al., 2021; Chingombe & Musarandega, 2021; Dick-Sagoe et al., 2022). These conditions were also experienced by smallholder farmers in Ward 11, which could explain why their adaptation did not improve their crop yield.

Table 6.4: Crop Yield and Adaptation Strategies

Improved crop yield	Full Sample Freq (%)	Male Freq (%)	Female Freq (%)
Yes	125 (48.83)	69 (46.94)	56 (51.38)
No	131 (51.17)	78 (53.06)	53 (46.82)
Total	256(100)	147 (100)	109 (100)

Source: Fieldwork, 2022

6.2.6 Gender and the Barriers to Climate Change Adaptation

The ability of farming households to adapt to climate change is compromised as a result of constraints faced in farming activities. Several barriers have been documented in the literature, and they include physical, financial, sociocultural, informational, and climatic or ecological (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Asare-Nuamah et al., 2022; Chingombe &

Musarandega, 2021; Dube et al., 2018; Mushore et al., 2021; Nyahunda & Tirivangasi, 2019; Ume et al., 2021). Smallholder farmers in Ward 11 acknowledged the challenges faced in implementing adaptation to mitigate the adverse effects of climate change (Table 6.5).

Table 6.5: Barriers to Adaptation by Gender of Household Head

Barrier	Full Sample Freq (%)	Male Freq (%)	Female Freq (%)
Lack of production implements	228 (88.82)	133 (90.48)	95 (87.15)
Frequent droughts	236 (93.2)	127 (86.39)	109 (100)
Crop failure	202 (78.91)	113 (76.87)	89 (81.65)
Poor soil fertility	79 (30.86)	48 (32.65)	31 (28.44)
Pests and diseases	81 (31.64)	40 (27.21)	41 (37.61)
Lack of information &extension services	32 (12.31)	20 (13.6)	12 (11.01)
Increased rainfall variability	31 (12.11)	15 (10.20)	16 (14.68)
Lack of credit	9 (3.52)	3 (2.04)	6 (5.50)
Low prices for output	7 (2.73)	3 (2.04)	4 (3.67)
Lack of markets	5 (1.95)	4 (2.72)	1 (0.92)
Taboos	1 (0.39)	1 (0.68)	0 (0.00)
Tenure insecurity	1 (0.3)	0 (0.00)	1 (0.92)
Other	8 (3.12)	4 (2.72)	4 (3.67)
Total	920 (359.38)	511 (347.62)	409 (375.23)

Source: Fieldwork, 2022. (Respondents selected multiple responses)

The findings clearly show that the climate change impacts which farmers adapted to also doubled as impediments to their adaptation efforts. These factors collectively identified as climatic or ecological barriers constituted the majority of constraints to adaptation pinpointed by smallholder farmers in Ward 11. Specifically, farmers cited frequent droughts, pests and diseases, poor soil fertility and increased variability, which led to crop failure (Table 6.5). These scenarios can make adaptation efforts challenging since it is difficult to control the effects. For instance, if a farmer chooses to grow hybrid seeds as a strategy but then loses the seeds to excessive heat or disease infestation, the strategy would be deemed useless. For this reason, some scholars have pointed out that unreliable climate scenarios can pose greater adaptation challenges for smallholder farmers (Chingombe & Musarandega, 2021), particularly the shortage of rainfall in the past decades, which has constrained climate change adaptation (Dube et al., 2018).

A gender analysis showed that female farmers experienced these climatic barriers more than male farmers, possibly due to limited adaptive capacities in terms of livelihood assets necessary for adaptation presented in Chapter Five. In the asset mapping, female farmers had more dependents, owned less livestock, and were less educated than male farmers in the study area. This could have contributed to why they experienced more climatic barriers than male farmers.

Ecological barriers are worrying because regardless of how a strategy is well planned and executed, it will be unsuccessful if the environmental circumstances do not permit it (Dube et al., 2018). From the qualitative interviews, farmers voiced their frustrations on how ecological barriers rendered their adaptive efforts ineffective. For example, a female farmer from Chikodzonga lamented that she dug holes on a large scale for the zero tillage to plant more seeds and produce a bumper harvest. Yet, "when I planted, the rains stopped for about two weeks resulting in very poor germination. As a result, I lost a bag of fertiliser on that first attempt. I planted again for the second time, my crops grew, I applied fertilizer, hoping it would rain that day since the skies had dark clouds, but it did not rain. I lost my seed and a second bag of fertilizer. I then decided to plant on a different farming land, I applied fertiliser for the third time, and nothing grew. I felt hopeless, the rain failed me," she said.

A male farmer who invested in and implemented zero tillage, mulching, shift planting and fertiliser and manure application in his farm and garden lamented that these strategies failed to yield anything as a result of the changing weather patterns. He resigned to his fate and said, "the skies did not do us good as compared to the past cropping seasons". Farmers may deploy their resources, including improved seeds, fertilisers, labour, and other inputs in the implementation of adaptation strategies, but these investments become impractical if the climate continues to change. The combination of the cited climatic constraints could explain

why many of the farmers indicated that their implemented adaptation strategies did not yield favourable outcomes in terms of improved crop yield.

The findings on climatic barriers and the associated challenges to adaptation compare favourably with results from other studies across Zimbabwe. Asare-Nuamah et al. (2022), reported climate variability as a major ecological barrier to adaptation in the Mbire district, Zimbabwe. Also, in the Chimanimani and Nyanga districts of Zimbabwe, Chingombe and Musarandega (2021) and Mushore et al. (2021) reported climate stress and variability as key barriers to adaptation and in Kenya, crop failure and pest and disease infestations were observed as constraining factors confronting smallholder farmers (Autio et al., 2021). These drawbacks tend to contribute to the ineffectiveness of implemented adaptation strategies (Mushore et al., 2021). Climatic barriers should therefore be accounted for when implementing adaptation measures to circumvent the risk of farmers losing their investments and falling into poverty. These results demonstrate how vulnerable agriculture is to climate change because productivity remains compromised despite investments in adaptation.

The other major barrier observed in Ward 11 was a lack of production implements in terms of limited draught power, fertilisers, seeds, and equipment (Table 6.5). More male-headed households lacked farm implements (90%) than female-headed households (87%) (Table 6.5). It emerged strongly from the qualitative interviews that a lack of farm implements, particularly draught power was a major impediment to climate change adaptation in the study area in both male and female-headed farming households. Given that many smallholder households in the studied villages lacked adequate finances to invest in farm inputs, they expressed concern about the potential for food insecurity and poverty. Research carried out in smallholder communities throughout Africa, made comparable observations about how the inability to purchase farm inputs or the delayed deployment of inputs by governmental institutions hampered adaptation

Antwi-Agyei and Nyantakyi-Frimpong (2021), Chingombe and Musarandega (2021) and Nyahunda and Tirivangasi (2019). The lack of farm implements is worrying because these are necessities for households whose primary livelihood is farming.

Though mentioned by a small proportion of the sampled male and female farmers, the lack of extension services and information on agriculture and climate change, unavailability of credit, a lack of markets, and low prices for outputs were additional barriers reported (Table 6.5). These barriers to climate change adaptation, were also identified in other studies of smallholder communities in Ghana (Antwi-Agyei & Nyantakyi-Frimpong, 2021), Zimbabwe (Asare-Nuamah et al., 2022; Chingombe & Musarandega, 2021; Dube et al., 2018; Mushore et al., 2021; Nyahunda & Tirivangasi, 2019), and Nigeria (Ume et al., 2021) as barriers to climate change adaptation.

Overall, the results on constraints to adaptation have shown that female farmers experienced most of the identified barriers compared to male farmers. The highlighted challenges to the effective application of climate change adaptation limit farming households' ability to adapt and endanger livelihoods and household well-being. All barriers to adaptation influence the adaptation process of households in a differentiated manner and have implications for outcomes, including food security. Male and female farmers experience these barriers differently and ultimately have differentiated outcomes in managing them.

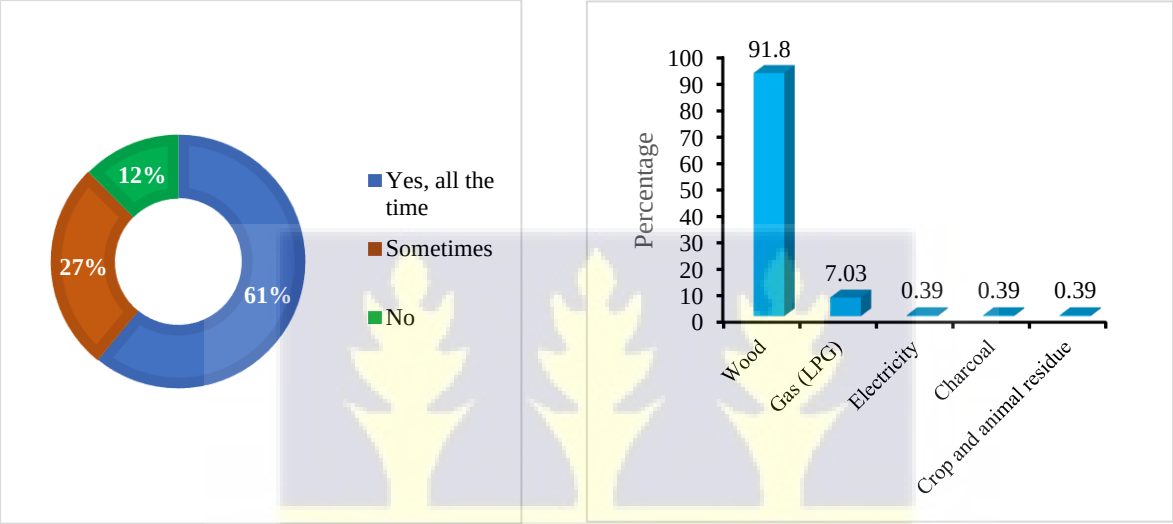
6.2.7 Gender Roles

Gender roles refer to the sexual division of labour or activities generally categorised into productive, reproductive and community work. Gender roles and obligations may hamper smallholder households' opportunities to engage in on-farm and off-farm adaptation activities (Marimo et al., 2021). Reproductive tasks like firewood collection and water fetching burden

households, leaving little time for farming activities (Emirie & Teferi, 2013). In Ward 11, approximately 92 per cent of smallholder households relied on firewood as their primary source of cooking fuel, and most often (61%) and occasionally (27%), transported water for household use, which required time investment (Figure 6.2).

Figure 6.2

Water and firewood fetching roles



A: Does the household fetch and carry water to the household each day? *B: Primary source of cooking fuel*

Source: Fieldwork, 2022 (Respondents selected multiple responses for B)

Given that many farming households fetched firewood and water for household use, the gender with the primary responsibility for performing these chores had to devote more time to executing these tasks. The results on the sexual division of labour show that women performed the majority of firewood gathering and water fetching roles with corresponding percentages of 87 and 74, respectively (Table 6.6). Water transportation was typically by the head from a well on or away from the property. Firewood was collected from surrounding areas in the commons, which expended a lot of time and energy. In male-headed households, which were observed to be predominantly married, male household members participated in adaptation activities both

on and off-farm, while wives performed reproductive tasks. On the other hand, female households were burdened with both productive and reproductive work. Many female-headed households lacked a male adult to assist with farming tasks and other off-farm activities because the heads of these households were mostly divorced, separated, or widowed. This meant that household duties, including firewood collection and water fetching, consumed much time.

Thompson-Hall et al. (2016) argue that the principal problem for adaptation is the disregard for the roles and responsibilities that produce patterns of vulnerability to climate change. This implies that adaptation needs are likely to differ for males and females and other social groups depending on how they sustain their lives and the respective roles each performs in their households and communities (Marimo et al., 2021). For these reasons, it is plausible that the observed patterns of adaptation in which male-headed households implemented more adaptation strategies than female households in the study area resulted from the burden of reproductive responsibilities on female-headed households.

Table 6.6: Firewood and Water Fetching Roles in Farming Households

Who usually fetches water for household use?	**Freq (%)**
Males	29 (12.95)
Females	195 (87.05)
Total	224 (100)
Who usually fetches firewood for household use?	
Males	61 (25.95)
Females	174 (74.04)
Total	235 (100)

Source: Fieldwork, 2022

Even though firewood collection and water fetching duties exerted a lot of pressure on female farmers in particular, the introduction of the *'tsotso'* stove (energy-efficient cookstove) proved to be a step in the right direction. This initiative was rolled out by the government and other stakeholders and has to some extent, liberated many women who, as a result, will not have to spend valuable time gathering firewood for cooking. The energy-efficient cooking stove, which

only requires a few twigs to cook an entire family meal, garnered excitement among female and male farmers. The fact that the *'tsotso'* stove would reduce the time commitment and cost of collecting firewood was emphasised by a female head of household from Ngoshi village. "I don't have to worry about firewood anymore. With just a little firewood, this stove can prepare all the meals for my family. This stove has saved me money and time". Male household heads expressed similar relief since they believed their wives would no longer need to spend as much time gathering the fast-dwindling firewood. "My wife doesn't have to spend all of her time in search of firewood that isn't even available. She can now spend more time helping with farm work", a male head of household from Bungu village remarked.

These sentiments confirm that fetching firewood has been a considerable burden for female farmers and other female household members. With the energy-efficient stove, time spent on firewood collection could now be spent on farming and other income-generating activities for the family. Notwithstanding the benefits of the stove, some concerns emerged from the recipients of the *'tsotso'* stove that could derail its sustainability. Users complained about the ashes that are blown throughout the house as a result of using the stove, which according to them, resulted in extra cleaning responsibilities. Enhancing households' adaptive capabilities would therefore require considerations for initiatives and how they aid or exacerbate vulnerabilities to climate change. Failure to take cognisance of the unintended outcomes of initiatives may constrain adaptation and disadvantage female-headed households.

6.3 Determinants of Smallholder Farming Households' Adaptation Choices

The ability to adapt to climate change is predicated on various household demographic characteristics, assets, and other independent factors. The Poisson regression model, as shown below, was used to analyse the determinants of households' adaptation intensity.

$$INCLAD_i = \beta_0 + \beta_1 HHSIZE_i + \beta_2 PHYCAP_i + \beta_3 FINCAP_i + \beta_4 NATCAP_i + \beta_5 GENACC_i + \beta_6 HHSEX_i + \beta_7 HHAGE_i + \beta_8 HHEDU_i + \beta_9 COMENG_i + \beta_{10} INDKNOW_i + \beta_{11} ACCEXT_i + \mu_i \quad Eqn(5)$$

Table 6.7 shows the predictions of the Poisson regression. A total of 249 observations were used in the Poisson regression estimation. The Pearson Chi-square statistics of 116.819 and the corresponding probability value of 0.00 show that the determining factors jointly and significantly cause variation in the dependent variable (the intensity of adoption). This shows the model best fits the dependent variable regressed on the various predictor variables. Additionally, to obtain the relationship between adaptation strategies and a variable, all other variables were held constant. Overall, the results revealed that household size, physical capital, age, extension services, gendered access to community lands, community engagement and participation and indigenous knowledge were significant determinants of intensity of adaptation (Table 6.7).

The regression results show that an increase in the household size, increases the odds of having a higher count of adaptation strategies. This result suggests that farming households with more members were better off in intensifying adaptation than those with fewer household members, possibly because they tend to have more labour reserves enabling them to pursue labour-intensive and multiple adaptations. Such households may have enhanced adaptive capability for both on and off-farm activities (Obert Jiri et al., 2017). Other studies have also established a relationship between larger household sizes and the adoption of more adaptation strategies in smallholder systems in sub-Saharan Africa (Atube et al., 2021; Belay & Fekadu, 2021; Faisal et al., 2021; Ume et al., 2021).

Table 6.7: Poisson Regression Results for the Determinants of Intensity of Adaptation

Dependent Variable: Intensity of Climate Change Adaptation	IRR	Rob Std Err	Z	p-value
Household size	1.02***	0.008	2.81	0.005
Physical capital	1.06***	0.015	4.00	0.000
Financial Capital	1.1075	0.064	1.22	0.224
Natural Capital	1.023	0.108	0.55	0.581
Access to community land (Men)				
Women	0.874***	0.032	-3.74	0.000
Sex of Household head (Male)				
Female	1	0.036	-0.01	0.993
Age Group of Household head (Youth) (18-35 yrs)				
Adults (36-60 yrs)	1.155**	0.076	2.20	0.028
Elderly (60 + years)	1.194**	0.083	2.55	0.011
Education level of household head (No formal edu.)				
Primary	1.033	0.062	1.53	0.594
Secondary and above	1.011	0.063	0.17	0.866
Community involvement (Yes)				
No	0.894***	0.038	-2.66	0.008
Indigenous knowledge (Yes)				
Otherwise	0.88***	0.032	-3.47	0.001
Access to extension services (No)				
Yes	1.099**	0.047	2.19	0.029
Constant	4.09***	0.544	10.59	0.000
No. of observations:				249
Pseudo r-squared				0.048
Chi-square				116.819
Prob>chi2				0.000
Akaike crit. (AIC)				1107.179
Bayesian crit. (BIC)				1156.422

*** *p<0.01*, ** *p<0.05*, * *p<0.10* Source: Fieldwork, 2022

Physical capital is considered a key factor influencing climate change adaptation (Shinbrot et al., 2019). In this study, physical capital showed a positive and significant relationship with the intensity of adoption. The results show that as physical capital increases, the odds of intensifying adaptation also increase (Table 6.7). This implies that the availability of physical assets such as farm equipment, household assets, and livestock has a positive influence on the ability of farming households to pursue on-farm adaptation and other livelihood diversification activities. Farmers can therefore deploy these assets directly or indirectly to pursue adaptation. For instance, ox-drawn ploughs and cattle can be used to till the land in preparation for planting. At the same time, household assets (e.g. sewing machines, jewellery etc.) and livestock can be sold to generate income which can be invested in implementing adaptation. Kuang et al. (2019) argued that physical capital reflects the endowment of farming households. Therefore, these

assets can be transformed to generate income that can stimulate agricultural productivity, livelihood diversification and adaptation practices (Faisal et al., 2021; Knowler & Bradshaw, 2007; C. Moser & Felton, 2007).

Further analysis of the results shows that the odds of implementing more adaptation strategies reduces when women have access to community lands compared to when men have access to such lands (Table 6.7) This finding suggests that access to land alone cannot be a sufficient condition for women's ability to adapt to climate change. Other supporting resources such as labour, availability of agricultural equipment, financial and physical assets are equally crucial to effective adaptation (Autio et al., 2021). In the case of Ward 11, land access by female farmers is not an issue of concern. However, it seems that female heads of households face other challenges related to the availability of productive resources and ecological barriers that hamper their adaptation efforts. Again, current findings revealed that female farmers have fewer assets, which would explain why they might not be able to utilise the land for climate change management fully. This underscores the value of scaling up initiatives to provide access to other crucial resources required for effective adaptation (Autio et al., 2021).

The age of the household head serves as a proxy for experience and thus positively influences the intensity of adoption. In this study, the Poisson regression results show that the odds of increasing adaptation strategies increase for households headed by adult farmers compared to youth-headed households. Similarly, adaptation intensification increases for households headed by the aged relative to youth-headed households (Table 6.7). This suggests that the implementation of adaptation strategies increases with the farmer's age. Diarra et al. (2021) point that aged farmers are more likely to be high adapters than young farmers. This is because, as farmers get older, they are perceived to have more experience in farming and climate awareness, which aids in their ability to recognise the threats posed by climate change and to

react appropriately (Atube et al., 2021; Muriithi et al., 2018; Ume et al., 2021). Age as a driver of climate change adaptation was reported among smallholder farmers in Ethiopia (Belay & Fekadu, 2021) and Mali (Diarra et al., 2021).

The results also show a negative but significant relationship between community involvement and adoption intensity. A household's lack of community involvement reduces the odds of having a higher count of adaptation strategies, than when the household engages in community activities (Table 6.7). This suggests that households derive some benefits from community participation which likely increases farmers urgency to respond to climate change. Community involvement provides shared experiences and awareness of how other farmers or villagers deal with similar challenges. This finding is consistent with observations from other studies among smallholder farmers in Africa (Belay & Fekadu, 2021; Diarra et al., 2021; Nyahunda & Tirivangasi, 2021; Omolo & Mafongoya, 2019) on the influence of social capital on climate change adaptation. In addition, adaptation behaviours are enhanced by the coordination of resources (sharing of seeds and fertilisers, labour), information sharing and knowledge mobilisation (new technologies etc.) (Nyahunda & Tirivangasi, 2021). Actions such as these foster collective and individual climate change action, build farmers' capacities and provide valuable opportunities for farmers to develop their skills and learn and apply evidence-based climate solutions.

Another critical element of adaptation is the application of indigenous knowledge (O. Jiri et al., 2015; Nyahunda & Tirivangasi, 2019). The regression results indicate a negative but significant relationship between a lack of indigenous knowledge and adaptation intensity. Thus, the odds of having a higher count of adaptation reduce for farming household heads with no indigenous knowledge compared to households headed by farmers with indigenous knowledge (Table 6.7). This suggests that farmers in Ward 11 with indigenous knowledge are

more likely to intensify climate change adaptation than their counterparts. Researchers have argued that indigenous knowledge presents both potential and challenges to adaptation. Challenges are largely associated with its unpredictable nature (Balasha et al., 2023; Nyahunda & Tirivangasi, 2019), and benefits in that it increase farmers' understanding of weather patterns and climate change, thus facilitating and promoting adaptation behaviours (O. Jiri et al., 2015; Nyadzi et al., 2021; Siambombe et al., 2018). The application of indigenous knowledge in climate change adaptation has been widely reported, and researchers have argued for its inclusion into meteorological forecasting and broader climate change policies (Antwi-Agyei & Nyantakyi-Frimpong, 2021; O. Jiri et al., 2015; Nkuba et al., 2020; Nyadzi et al., 2021).

Access to extension services showed a positive and significant relationship with the intensity of adaptation (Table 6.7). The results indicate that access to extension services by farming households increases the odds of farming households implementing more adaptation strategies relative to households with no access to extension services (Table 6.7). Extension officers provide necessary information on crop production and livestock management, new technologies and trends in weather patterns, which strengthen farmers' adaptability (Makate et al., 2016; Zamasiya et al., 2017). This is consistent with research conducted with smallholder farmers in Uganda (Atube et al., 2021), Ethiopia (Belachew & Ababu, 2021), and Zimbabwe (Mutandwa et al., 2019; Zamasiya et al., 2017), where extension agents and services played a critical role in farmers' increased adaptive capacity.

Overall, the Poisson regression model demonstrated that household size, physical capital, financial capital, age of the household head, access to extension services, access to community lands, community engagement and participation and indigenous knowledge are the major drivers of intensified climate change adaptation in Ward 11.

6.4 Livelihood Outcomes in Smallholder Households

Livelihood outcomes are the accomplishments and benefits households seek to derive from implementing specified activities and strategies. Conventional markers like income, food security, and the sustainable use of natural resources are examples of potential livelihood outcomes. Livelihood gains may also include decreased vulnerability, a stronger asset base, and improved well-being, including health (D. Carney et al., 1999; Scoones, 2015). Farmers increase food productivity, security, and income through climate change adaptation (Diallo et al., 2020; Etale & Simatele, 2021; Ndiritu & Muricho, 2021). Adaptation, therefore, can be implemented to build farmers' resilience and sustainability (Dick-Sagoe et al., 2022). Ward 11 smallholder farmers implemented adaptation strategies to counteract the adverse effects of climate change on their livelihoods and build resilience. In this study, food security and household income were considered as the livelihood outcomes that could support farmers' livelihood sustainability. This is important because they are the key variables in ensuring household well-being and reducing vulnerability (D. Carney et al., 1999; Kamaruddin & Samsudin, 2014; Mutea et al., 2019; Scoones, 1998).

6.4.1 Food Security

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (Food and Agriculture Organisation (FAO), 1996). In this definition of food security, four dimensions are emphasised; food availability, accessibility, utilisation, and stability. In this study, the analysis of food security focused on two measures, namely, the months of adequate household food provisioning (MAHFP) (Swindale & Bilinsky, 2010) and the household food insecurity access score (HFIAS) (Coates et al., 2007). These measurements capture three out the four dimensions of food security namely, accessibility, availability, and

stability. The HFIAS has been widely adopted in food security research across Africa. For example, Ayerakwa et al. (2020) used it in their study on the geography of agriculture participation and food security in Ghana, Mutea et al. (2019) adopted it in Kenya to research livelihoods and food security, Cholo et al. (2019) used the scale to study land fragmentation, climate change adaptation and food security in Ethiopia while Tadesse et al. (2017) used it in a study on household food insecurity and associated factors in Ethiopia.

6.4.1.1 Months of Adequate Household Food Provisioning (MAHFP) in Ward 11

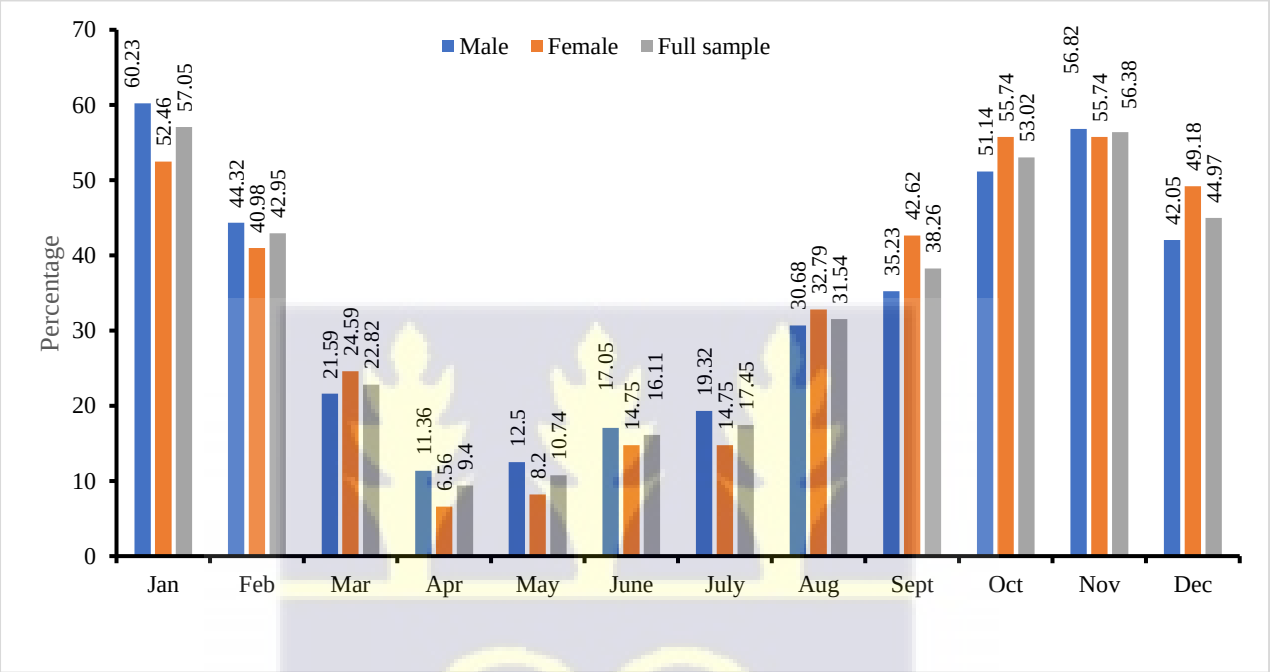
Zimbabwe has one rain and cropping season, with planting taking place between October and December. The mid-season spans from January to March and harvesting takes place between April and July. It is not uncommon for households to run out of food before the next harvest. Post-harvest losses and inadequate food storage, among other challenges, also mean that harvests may not be sufficient for households throughout the year. Makate et al. (2016) argued that improving food and income security is threatened by declining crop yields, poor soil fertility and other climatic and environmental risks. For a nuanced understanding of food security, farming households were asked to indicate the months in the past twelve months when they did not have enough food to eat.

As shown in Figure 6.3 the peak hunger period was experienced from October to January. The proportion of households who were food insecure in October was 53 per cent, this figure increased in November and January to 56 per cent and 57 per cent, respectively. The reason that could account for this could be that these months coincide with the planting season, and during this time most stored food from the previous harvest would have been depleted, leading to food scarcity in many households. Food insecurity began to decline from February to August (Figure 6.3). This is not surprising because these months align with the mid-cropping season when there is abundance of fresh corn, peanuts, bambara nuts and other crops which can simply

be boiled, salted and consumed. Food (in)security levels did not vary significantly by gender of the household head, demonstrating that all farming households were susceptible to food scarcity as well as availability.

Figure 6.3

Percentages for months of adequate household food provisioning



Source: Fieldwork, 2022; (Respondents selected multiple responses)

Insights from the qualitative interviews revealed that indeed the months between March and August are months of plenty food or *'maguta'*. Farmers agreed that abundant fresh farm produce and fruits has been essential to food availability in these months. According to them, certain crops, such as beans from the farm can be consumed even before maturity. Leafy greens from pumpkins, black-eyed beans, sweet potatoes, and spider wisp *'munyevhe'* that are planted alongside grains can all be consumed as soon as they grow, allowing households food access after the dry summer periods.

A female farmer from Ngoshi village explained that "as soon as the crops begin to fruit, we breathe a sigh of relief because we know that we'll have enough to eat". She further narrated

how her household relies on leafy greens from pumpkins, beans, sweet potato and '*munyevhe*' (spider wisp) during the cropping season saying, "we pluck the leaves from the crops (pumpkins, sweet potato etc.), harvest green beans and cook. By the time the corn is mature, we'll also be eating fresh maize ('*chibage chinyoro'*), fresh peanuts and an abundance of guava's, oranges, and mangoes. We don't worry about food at all during that period". These sentiments imply that households' food availability vary during the year. Farmers experience times of food availability and food scarcity within the year.

6.4.1.2 Household Food Insecurity Access Score

To further understand the food security status of farming households in Ward 11, another food security measure as proposed by Coates et al. (2007). was used. Households were categorised into four levels of food insecurity (access): food secure, mildly food insecure, moderately food insecure and severely food insecure. The classification of the households was based on the responses to the nine severity questions in the Household Food Insecurity Access Score (HFIAS) and coded "0" for "No" and "1" for "Yes". The procedure for scoring was used as follows; "0" was attributed if the event described by the question never occurred, and "1" if it occurred during the previous 30 days. With regard to the occurrence, "1" was attributed if the events rarely occur, "2" sometimes, and "3" often.

The responses to the nine occurrence questions were then summed using STATA to create a household food insecurity access score. The score ranged between "0" =minimum and "27" =maximum. The interpretation of the values is that the higher the score, the more the household is vulnerable to food insecurity. The lower the score, the less vulnerable the household is to food insecurity. The HFIAS of 0-1 is categorised as food secure, and all households above two were categorised as food insecure. Specifically, households that scored 2-7, 8-14 and 15-27

were classified as mildly, moderately, and severely food insecure, respectively. These categories show the household food insecurity access prevalence.

A "food-secure" household does not run out of food, go to bed hungry or go all day and night without food. A "mildly food insecure" household worries about not having enough food sometimes or often and cannot eat preferred foods, but it does not cut back on quantity. A "moderately food insecure" household sacrifices quality more frequently by eating a monotonous diet or undesirable foods sometimes or often, but does not run out of food, go to bed hungry or go the whole day and night without food. On the other hand, a "severely food insecure" household cuts back on meal size or the number of meals often and could either run out of food, go to bed hungry or go the whole day and night without food (Coates et al., 2007). Table 6.8 shows the general classification of households based on their food security status.

Table 6.8: Household Food Security Status

Food Security Status	Male	Female	Full Sample
	Freq (%)	Freq (%)	Freq (%)
Food secure	32 (21.77)	25 (22.94)	57 (22.27)
Mildly food insecure	32 (21.77)	18 (16.51)	50 (19.53)
Moderately food insecure	44 (29.93)	30 (27.52)	74 (28.91)
Severely food insecure	39 (26.53)	36 (33.03)	75 (29.3)
Total	147 (100)	109 (100)	256 (100)

Source: Fieldwork, 2022

Overall, only about 22 per cent of all farming households could be classified as food secure. Of these, about 22 per cent were male-headed and 23 per cent female-headed households. The rest of the households experienced mild to severe food insecurity (Table 6.8). The figures also show that severe food insecurity was more prevalent in female-headed (33%) than in male-headed households (27%). These figures indicate that food insecurity in the area is a serious problem that should not be ignored. Other studies have also identified food insecurity among farmers as concerning and compromising livelihood sustainability (Dzanku, 2019; Mutea et al., 2019).

Based on the two measurements of food security adopted in this study, the months of adequate household food provisioning and the household food insecurity access score, it is evident that food security is an issue of concern among farming households in the study area. These findings are not surprising considering that Zimbabwe is identified as having some of the highest levels of food insecurity in Sub-Saharan Africa, irrespective of the outcome of the cropping season (Government of Zimbabwe (GoZ), 2018). Furthermore, the state of food security in the study areas compares favourably with reports by the ZimStat (2016) which reported significant (22.6%) food poverty in Ward 11. The sustainable livelihood approach recognises food security as a significant livelihood outcome necessary for sustainable development (Ellis, 2000; Scoones, 1998). It is a key driver in achieving SDG 1 (No poverty), 2 (Zero hunger), 3 (Good health) and 12 (Responsible consumption and production) in order to advance individual and community well-being.

The qualitative interviews provided insights into the causes of food insecurity in farming households in the study area. According to farmers, the major causes of food scarcity were low crop yields, notably in the case of grains, and a lack of money to purchase dietary supplements. In many households, farmers reported that they did not have to worry about food throughout the year when the crop yield was good. Yet, when the harvests are poor, their food supplies run out long before the next cropping season, forcing them to rely on begging or food loans from relatives and neighbours.

A female household head from Mambera village remarked that when she has grains, she has no problems because she can prepare '*sadza'* (a Zimbabwean staple dish made with milled maize meal) in the morning and evening for her family. She believed that a lack of grains was worrisome since it signalled hunger for the family "*chibage igoridhe mwanangu*, (grain is gold, my daughter)", she said. The extension officer added his voice and expounded that "food

security in this district is concerning. Many households run out of food before the next cropping season. We have linked food scarcity to poor crop output brought on by climate variability. Unlike the years before, when households harvested enough for consumption and sale, these days, farmers are even lucky to harvest enough to eat. This is worrying". Farmers felt that if they could be supported with grain and other food items during the peak hunger period of the year, their concerns about food insufficiency would be addressed.

6.4.2 Household Income

Income is a key indicator of livelihood sustainability (Rajiv Pandey et al., 2017; Scoones, 2015; C. Zhang & Fang, 2020). Its availability enables successful adaptation and livelihood sustainability and vice versa (Adeagbo et al., 2021; S. Ahmed & Kiester, 2021; Rajiv Pandey et al., 2017). The SLF provides scope for assessing changes in socioeconomic conditions, including household income due to farming households' livelihood strategies. This study computed income using the total income generated in the past year from crop and livestock sales, non-farm self-employment, non-farm wage employment, remittances, and other transfers in US$. The per capita income was then computed from the total household income to get a sense of what each household member is worth. This was done by dividing the household income by the household size.

6.4.2.1 Sources of Income During the 2020/2021 Cropping Season

Given that poor crop yield, soil fertility and environmental degradation, among other factors, can compromise household income and security (S. Ahmed & Kiester, 2021; Makate et al., 2016), other sources of income are necessary to augment income and improve household well-being. Income is critical in reducing household poverty and food insecurity, which are key components of livelihood sustainability (S. Ahmed & Kiester, 2021; Kamaruddin & Samsudin,

2014; Mutea et al., 2019). Smallholder households in Ward 11 had various sources of income, with the primary ones being crop sales, non-farm wage employment, remittances and livestock sales (Table 6.9). It is not surprising that crop sales topped as a source of income in the farming households under study because smallholder farmers produce for household consumption and sale when there is a surplus. Similar observations were made by S. Ahmed and Kiester (2021) in Bangladesh, where more than half of the studied smallholder farmers derived much of their income directly from farming. In terms of shares, remittances contributed about 73 percent of income shares, followed by livestock (39%) and non-farm wage employment (34%).

Table 6.9: Sources and Shares of Household Income

Variable	Sources			Shares		
	Full Sample Freq (%)	Male Freq (%)	Female Freq (%)	Full Sample (%)	Male (%)	Female (%)
Crop Sales	120 (46.88)	64 (43.54)	56 (51.38)	21.17	19.65	23.38
Non-farm wage employment	104 (40.62)	65 (44.22)	39 (35.78)	34.12	36.14	31.17
Remittances	67 (26.17)	36 (24.49)	31 (28.44)	72.80	67.93	78.46
Livestock	59 (23.05)	36 (24.49)	23 (21.10)	38.55	37.64	39.85
Non-farm self-employed	44 (17.19)	30 (20.41)	14 (12.84)	12.13	15.40	7.39
Other transfers	33 (12.89)	17 (11.56)	16 (14.68)	-	-	-
Total	427(166.80)	248(188.71)	179(164.22)	-	-	-
Chi2 (Pr)			42.7124 **(0.037)**			

Source: Fieldwork, 2022: (Respondents selected multiple responses)

The top sources of income in female-headed households were crop sales (51%), non-farm wage employment (36%), remittances (28%) and livestock sales (21%). Conversely, male-headed households derived most of their income from non-farm wage employment (44%), crop (44%) and livestock (24%) sales and remittances (24%) (Table 6.9). The top income shares in female-headed households were remittances, livestock sales and non-farm wage employment. A similar trend was observed in male-headed farming households (Table 6.9). The observed differences were statistically significant (p-value = 0.037) suggesting that gender influences how farming households source their income.

The variation in sources of income between male and female farmers in this study compare favourably with other studies, for example, Musiyiwa (2014) and S. Ahmed and Kiester (2021), which reported gender differences in income sources between male and female-headed households in rural Zimbabwe. In these studies, male-headed households derived most of their income from casual and regular employment, while female farmers sourced most of their income from crop production, remittances, and trading. The different opportunities for earning income for male and female farmers could be due to disparities in income sources and their intersection with gender. The finding on remittances contributing the highest share to household income compares favourably with observations by M Ahmed et al., 2018 from a study in Bangladesh where remittances contributed the highest to farmers' income.

Additional perspectives on the importance of remittances in improving household income and welfare emerged from the qualitative interviews. Many rural farming households benefitted from remittances from relatives working in urban areas or abroad. Farmers mentioned that their ability to support themselves would have been compromised without remittances from family members, especially children living in the city and abroad (South Africa, Botswana, the United Kingdom, United States of America). Households were remitted both in cash and kind with items such as foodstuff, fertilisers, seeds, clothing, and livestock. According to the farmers, this allowed them to cater for household needs such as food, healthcare expenses and school fees. Even though not all farming households had a remitter, those fortunate enough to have that support felt their burdens eased whenever they received money or goods. "We feel lucky to have our children send us money and household items. This has made our lives comfortable", a male farmer from Mambera village said. Overall, it appears that households that received remittances were better off in terms of meeting their needs. This is because remittances are critical in income and livelihood security (Muzari et al., 2014). Other studies among

smallholder communities also reported remittances as a crucial aspect of household welfare and livelihood sustainability (Muzari et al., 2014).

The disparities in income-generating sources between male-headed and female-headed farming households as shown in Table 6.9 could suggest that average per capita income in these households also differ. Table 6.10 shows that the average income per capita for each farming households was US$ 262.08. The results also show significant (p-value = 0.056) differences in mean household income per capita across gender. Male-headed households had a higher annual income per capita average (US$354.52) than female-headed households (US$137.40). The fact that male-headed households' participation in non-farm wage employment was higher could help explain why their average per capita income was higher. Kakota et al. (2011) note that disparities in opportunities for off-farm work between men and women imply that men can potentially earn more income than their female counterparts. This has implications for livelihood profiles in these households and may limit adaptation options for female households.

Table 6.10: Household Per Capita Income in US$

	Observations	Mean	Std. Dev.	Min	Max
Full sample	256	262.08	883.49	0	11,906.67
Male	147	354.52	1138.14	0	11,906.67
Female	109	137.40	254.0	0	1.800
T-Test	Ho: diff = 0	Ha: diff ! = 0		p-value **(0.056)**	

Source: Fieldwork, 2022

6.4.3 Farming Households Livelihood Sustainability

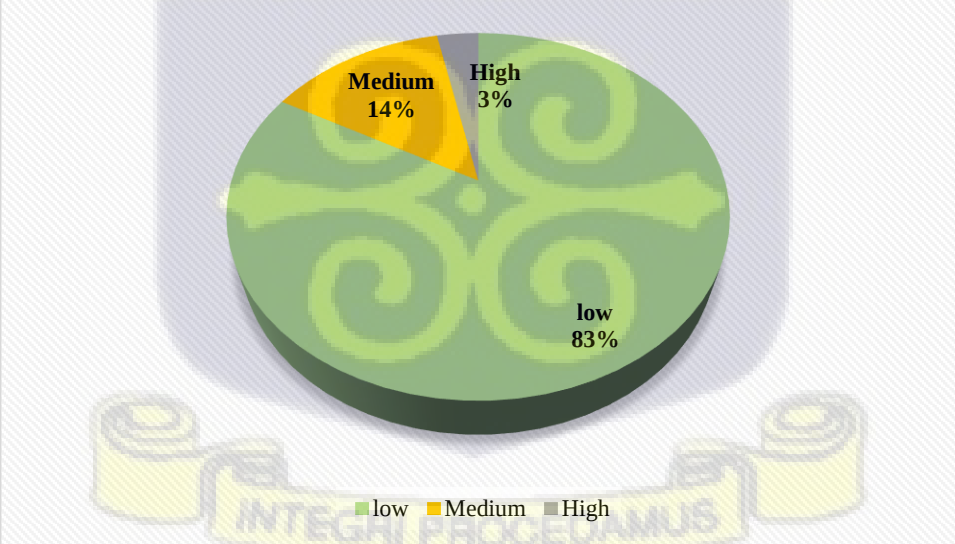
Assessing livelihood sustainability of farming households is important in climate change management and sustainable development. This study measured livelihood sustainability using the five livelihood capitals human, natural, physical, financial, and social at the disposal of farming households based on the SLF. Several studies measured livelihood sustainability using the five capitals against the notion that prosperous livelihood capitals enhance individual, household and community sustainability even in the face of extreme shocks (e.g. De & Das,

2021; Kamaruddin & Samsudin, 2014; Li et al., 2020; Pandey et al., 2017; Shinbrot et al., 2019; C. Zhang & Fang, 2020). Using the livelihood assets profiled in Chapter Five, I selected several indicators under the human, physical, natural, financial, and social capital and used them to construct a composite livelihood sustainability index (CLSI). I employed the PCA method to construct the index, with values between 0 and 1. One, indicates maximum sustainability and 0 no sustainability.

Figure 6.11 presents the composite livelihood index categories for farming households. The households were categorised as low, medium and high sustainable households based on equal intervals classification, where low = 0.00-0.25; moderate/medium = 0.26-0.75; and high = 0.76-1.00. Overall, about 83 per cent of smallholder households were in the low sustainability category suggesting that farming households in Ward 11 have inadequate livelihood assets (human, financial, physical, natural, and social), which makes them more vulnerable to shocks.

Figure 6.4

Household Livelihood Sustainability Performance



The composite livelihood index scores in Table 6.11 further show that the mean sustainability score for all households was 0.2 with a standard deviation of 0.12. There was no statistical difference (p-value = 0.257) between the sustainability score for male-headed (mean = 0.211)

and female-headed (mean = 0.19) households suggesting that both household categories had low sustainability viability (Table 6.11). The poor performance of the farming households in the livelihood sustainability indicators, specifically the financial, physical, and natural indices (Appendix 3F) reflected negatively in the composite livelihood sustainability index. This raises questions about farming households' ability to overcome climate change vulnerability and build resilience.

In recent years, Zimbabwe has suffered major economic setbacks coupled with climate change; these events have compromised the sustainability of farmers' livelihoods because of the effects on livelihood assets. The current observed low livelihood sustainability is not favourable to the stability and prosperity of smallholder farming households. Whether the sustainable livelihood capacity of farmers can be improved depends to a point on the implementation of effective adaptation in order to boost and build asset resilience (Eyasmin et al., 2021; Nkumulwa & Pauline, 2021).

Table 6.11: Composite Livelihood Sustainability Index

Variable	Male-Headed Households (n=147)	Female-Headed Households (n=109)	Full Sample (n=256)
Mean	0.211	0.19	0.2
Median	0.2	0.17	0.18
SD	0.01	0.12	0.12
T-test	Ho: diff = 0	Ha: diff ! = 0	p-value (0.257)

Source: Fieldwork, 2022

6.5 Gender Adaptation and Livelihood Sustainability Linkages in Smallholder Farming Households

Farming households' livelihood sustainability is predicated on various factors. To analyse households' livelihood sustainability, an OLS regression was used. Three more models, one for female-headed households and the other for male-headed households, and a model with both male-headed and female-headed were estimated. The dependent variable livelihood

sustainability is continuous and measured as a composite index. The empirical model is shown below.

$$SUSTLIVE_i = \beta_0 + \beta_1 INCLAD_i + \beta_2 INCOME\_PC_i + \beta_3 CHILD\_5_i + \beta_4 CHILD\_6-17_i + \beta_5 FS_i + \beta_6 HHSEX_i + \beta_7 ACCEXT_i + \beta_8 MIGRATE_i + \beta_9 HHTYPE_i + \varepsilon_i \qquad Eqn(7)$$

The relationships among continuous variables used in the model were assessed using pairwise correlation, with the results presented in Table 6.12. The correlation results established a relationship between each variable and sustainable livelihood. There is a positive correlation between household income per capita and sustainable livelihood, whereas the correlation between food insecurity and the presence of dependent children aged 0-5 years and 6-17 years is negative. The positive correlation between sustainable livelihood and per capita income is weak, as is the negative correlation between sustainable livelihood and both food insecurity and dependent children aged 0-5 years and 6-17 years.

Table 6.12: Pairwise Correlation Results for Sustainable Livelihoods and Continuous Variables in the OLS Regression Model

	Sustainable livelihood	**Income per capita**	**Food insecurity**	**Children dependents (0-5yrs)**	**Children Dependents (6-17 yrs)**
Sustainable livelihood	1.0000				
Income per capita	0.4899** *(0.0000)*	1.0000			
Food insecurity	-0.1485** *(0.0191)*	-0.01963 *(0.0016)*	1.0000		
Children dependents (0-5)	-0.1453 *(0.0219)*	-0.1383 *(0.0269)*	0.0614 *(0.3277)*	1.0000	
Children dependents 0-16	-0.1413** *(0.0257)*	-0.1010** *(0.1071)*	0.0142** *(0.8208)*	0.0824 *(0.1886)*	1.0000

*** p<0.01, ** p<0.05, * p<0.1

A number of diagnostic tests were performed on the OLS model to assess its correctness, appropriateness, and robustness. The heteroscedasticity test, which shows the behaviour of the variance of the residuals, reveals the presence of heteroscedasticity in the model (Prob>chi2=0.0113). This was corrected by using the robust standard error option (Appendix

2D). The test for model specification shows that the model is correctly specified (p-value<0.05) (Appendix 2A). The variance inflation factor (VIF), which measures the presence of multicollinearity in the model was estimated at 1.09, indicating the absence of multicollinearity (Appendix 2C). The F-statistics with the associated probability values reveal that the models are fit, and the explanatory variables jointly explain variations in the dependent variable (Table 6.13).

The OLS results in Table 6.13 indicate that adaptation strategies and livelihood sustainability are positively and significantly related. Adopting more strategies increases the livelihood sustainability of the household at a significance level of 0.01 in the Model 1 (Full Model). Thus, amplifying adaptation increases household livelihood sustainability. Research has established a link between adaptation and livelihood sustainability (Eyasmin et al., 2021; Nkumulwa & Pauline, 2021). For example, Eyasmin et al. (2021) demonstrated a positive correlation between sustainability and some adaptation practices, such as using hybrid seeds, crop diversification and off-farm employment. Nkumulwa & Pauline (2021) also found that climate-smart agriculture (CSA) promoted the resilience and adaptive capacities of households in Tanzania. Therefore, all thirteen adaptation practices implemented by smallholder households in Ward 11 can potentially enhance the livelihood prospects of farmers in the area.

Table 6.13: Ordinary Least Square Regression Results for the Determinants of Smallholder Households' Livelihood Sustainability

Variables[1]	(1) Full sample	(2) Male & Female	(3) Male Model	(4) Female Model
Adaptation strategies implemented	0.008***	____	____	____
	(0.003)			
Dominant male adaptation strategies	____	0.007*	0.008**	____
		(0.004)	(0.003)	
Dominant female adaptation strategies	____	0.008	____	0.016*
		(0.009)		(0.009)
Sex of household head ***(Male)***				
Female	-0.001	____	____	____
	(0.013)			
Household income per capita	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Infant dependents (0-5yrs)	-0.005	-0.005	-0.005	-0.006
	(0.006)	(0.006)	(0.006)	(0.006)
Children dependents (between 6-17 years)	-0.009**	-0.009**	-0.009**	-0.008**
	(0.004)	(0.004)	(0.004)	(0.004)
Food insecurity (HFIAS)	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Extension service access ***(No)***				
Yes	-0.007	0.008	-0.007	0.014
	(0.014)	(0.015)		
			(0.014)	(0.014)
Migration ***(No)***				
Yes	0.032**	0.033**	0.032**	0.037***
	(0.014)	(0.014)	(0.014)	(0.014)
Household type ***(Nuclear)***				
Extended	-0.043***	-0.043***	-0.043***	-0.042***
	(0.014)	(0.014)	(0.014)	(0.014)
Constant	0.159***	0.162***	0.167***	0.181***
	(0.025)	(0.026)	(0.024)	(0.023)
Observations	249	249	249	249
R-squared	0.320	0.318	0.316	0.310
F-Test	11.333	9.931	11.079	10.447
Prob>F	0.000	0.000	0.000	0.000

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: Fieldwork, 2022

[1] Category of variables in parenthesis are referenced categories

To analyse the gender dimension of livelihood sustainability in smallholder households in Ward 11, male-dominated strategies (adaptation practices mainly employed by male-headed households) and female-dominated strategies (adaptation practices mainly employed by female-headed households) were used in models 2, 3 and 4 as independent variables. The male-dominated adaptation strategies included crop staggering, mulching, tree planting, mixed farming, and off-farm activities, while female-dominated strategies were zero-tillage, intercropping and discontinuation of low-yielding and poor-performing crops.

The results show that adaptation strategies implemented are strong positive predictors of livelihood sustainability. In Model 2, the female-dominated strategies variable was not significant when controlling for male-dominated strategies but when controlling for female-dominated strategies, the male-dominated strategies variable was significant at 0.1 (Model 2). When further disaggregated into male dominant and female dominant strategies, they were also significant at 0.05 in Model 3 and 0.1 in Model 4 (Table 6.13). This suggests that the implemented adaptation strategies by farming households increased the livelihood sustainability of these households.

An effort was made to control for the model by including other variables that could explain the model better. These variables are income per capita, food insecurity, number of dependents in the household (infants-0-5 years and children between 6 and 17 years), access to extension services, migration and household type. A significant relationship between livelihood sustainability and income per capita, children dependents (6-17 years), migration and household type was established. The OLS results indicated that household income per capita had a positive and significant effect that stimulated the livelihood sustainability of the farming household. Thus, an extra increase in the household's income per capita by one dollar also increases the livelihood sustainability of the household at a significance level of 0.01 (Models 1, 2, 3 & 4) (Table 6.13). This shows that as income increases, it tends to positively impact the household's livelihood sustainability through asset acquisition and investments in the welfare of household members in terms of health and education, among other needs. On the other hand, this also implies that lower-income households are more likely to be constrained in their farming productivity, which depletes household assets and results in low livelihood sustainability. Kamarrudin et al. (2019) observed a similar trend in Malaysia, where low income corresponded with low sustainability in rural households.

The relationship between the number of dependent children and household livelihood sustainability was significant but negative. The results show that an additional increase in the number of dependent children in a household (6-17 years) reduces the livelihood sustainability of the household at a significance level of 0.05 in all models (Models 1,2, 3 & 4) (Table 6.13). This suggests that more dependent children exert pressure on household resources, as a larger portion of the resources is spent on food, education, healthcare, and other necessities that may deplete resources. These factors can limit the resources available for investment in productive activities, conversely affecting household livelihood sustainability. This finding substantiates observations by Ahmed et al., 2018 in Bangladesh, where dependency ratio negatively impacted farmers' livelihood diversification, an important component of household livelihood sustainability.

The relationship between migration and livelihood sustainability was positive and significant at 0.05 (Models 1, 2 & 3) and at 0.01 (Model 4) (Table 6.13). This means that households with members who have migrated increase their livelihood sustainability more than households with no migrants. The likelihood of migrants remitting families left behind is relatively high, and often rural households depend on remittances for improved livelihoods and resilience (Samal, 2007). Remittances in the form of cash, farm inputs and other household items enable receiving farming households to pursue diversified farming and off-farm activities and investments in healthcare and education of members. In addition, remittances provide prospects for asset accumulation and wealth, which enables households to build physical, natural, human, social and financial capital (Mishi, 2014; Samal, 2007; Xing, 2018).

Furthermore, the regression results established a negative but significant relationship between household type (nuclear or extended) and livelihood sustainability at a significant level of 0.01 (Models 1, 2, 3 & 4), suggesting that livelihood sustainability reduces in extended households

than nuclear households possibly because extended family households spend more on household needs and welfare, potentially depleting available resources.

Largely, the regression results have revealed the various drivers of livelihood sustainability of smallholder households. The models showed that adaptation practices implemented by smallholder farmers stimulated the livelihood sustainability of their households. Thus, livelihood prospects seem favourable for both male-headed and female-headed households based on the adaptation strategies they implemented. In addition to adaptation practices, children dependents (6-17 years), household income per capita, migration and household type proved valuable to the sustenance of farming households' livelihoods.

6.6 Conclusions

This chapter examined smallholder households' adaptation practices and the livelihood sustainability prospects in Ward 11. Key highlights emerged regarding smallholder households' adaptation decisions and behaviours. Adaptation decisions and behaviours in Ward 11 depended on the household head's demographic characteristics (gender, age, asset holding) and other external processes such as community land governance and institutional support. Within the context of the SLF and FPE theory, these factors shape the choice of livelihood activities engaged in by households. Smallholder farming households utilised their assets to implement adaptation strategies (zero-tillage, mulching, crop staggering, crop rotation, shift planting, tree planting, irrigation, off-farm activities, crop stop, intercropping, mixed farming, and hybrid varieties).

Both male and female farmers implemented similar strategies but at different intensity levels. Gender differences in adaptation were observed, with male and female farmers showing differential preferences in their choice of strategies. Similarly, barriers to adaptation were

experienced by all farmers, even though female farmers seemed to be more constrained by climatic barriers than their male counterparts. The main drivers of adaptation in Ward 11 were household size, age, physical and financial capital endowment, access to extension services, access to community lands, community involvement and indigenous knowledge.

The SLF recognises that enhanced livelihood outcomes stimulate livelihood sustainability. Given the results presented in this chapter, some key factors supporting the transformation and sustainability of livelihoods, such as food security and household income, performed poorly. Though households had access to food most of the time, they were essentially food insecure, based on the adopted measurements of food security in this study (months of adequate household food provisioning and the household food insecurity access score). Both male and female-headed households were at risk of food insecurity. Significant disparities in average household income observed between male and female farmers implied varied sources of income between the two groups. Even though most of the income for both male and female farmers was derived from farming, female farmers had less diversified income sources. Low income and food insecurity can affect adaptation behaviours and decisions and, in the long term, livelihood sustainability.

In Ward 11 farming households, livelihood sustainability was stimulated by the implemented adaptation strategies, children dependents (6-17 years), household income, household type and migration. Of critical importance is the realisation that adaptation practices contributed to the sustainability of farmers' livelihoods. Additionally, adaptation strategies by male-headed and female-headed households showed a positive inclination to livelihood sustainability. This implies that implemented adaptation practices in Ward 11 farming households help in building farmers' resilience by enabling them to thrive and build human, natural, social, physical, and financial capital. This also means that by implementing adaptation, households can buffer

additional stresses and shocks, thereby reducing climate change vulnerability. The results in this chapter have thus demonstrated and supported the assumptions of the SLF and FPE in terms of the linkages between asset ownership, livelihood strategies, outcomes, and livelihood sustainability.

The next chapter summarises the thesis by highlighting the key findings, theoretical and conceptual relevance, concluding remarks and recommendations.

CHAPTER SEVEN

SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

This chapter summarises, draws conclusions, and suggests policy recommendations based on the key findings of the study. Global debates informed the conceptual and theoretical foundations of the research on the linkages between gender, climate change adaptation and livelihood sustainability. These debates have focused on gendered vulnerability to climate change impacts, perceptions and experiences of climate change between men and women and other important categories such as age and education. Further focus has been on adaptation, but little attention has been given to gendered adaptation and livelihood sustainability connections. Male-headed and female-headed farming households have varied asset holdings, suggesting that they manage their resources and farming activities differently, leading to different livelihood outcomes. These debates served as the entry points for this study by exploring gender, climate change perceptions and experiences, adaptation behaviours and livelihood sustainability in smallholder farming households in Ward 11 of the Goromonzi district, Zimbabwe.

7.2 Methodological Approach

A mixed-method research approach was employed in the study, informed by a pragmatic philosophical lens. The sampling of the 256 surveyed farming households was random in 15 villages, which were also randomly selected. In total, 147 (57%) households with male heads and 109 (43%) households with female heads were sampled for the household survey. Households and key informants for the qualitative component of the study were purposively selected. They constituted 13 participants (six female and seven male heads of households) and

six key informants (four males and two females). The key informants were village headmen (two males), an Environment Management Agency monitor (one male), Extension Officer (one male), Farmer's Union Coordinator (one female) and District Forest Commissioner (one female). Data were collected using a household survey, in-depth interviews, and key informant interviews. STATA was used for the quantitative data analysis, including frequencies, percentages, chi-square tests, and Poisson and OLS regressions. The qualitative data were thematically analysed and used to support the quantitative results.

7.3 Theoretical and Conceptual Relevance

The study integrated the FPE theory and the SLF to address the research problem. The FPE theory questions the role of gender and other categories of social differentiation, such as age, education, race, social class and indigeneity, in environmental governance. It emphasises power dynamics, access to and control over productive resources that shape climate change adaptation and sustainable livelihoods. The theory is also concerned with how men and women can be integrated into ecological issues, including climate change, and how to implement interventions more efficiently. The FPE theory was integrated into the study's conceptual framework to analyse smallholder farmers' vulnerability to the impacts of climate change, adaptive decisions and behaviours and livelihood sustainability outcomes, on the premise that climate change affects individuals differently based on their social identities and power relations. Male and female farmers' experiences and responses to climate change differ due to differential power relations and resource endowment between the groups.

The SLF emphasises the value of access to and command over productive resources. Determining the function of livelihood assets and how smallholder farmers deploy these assets to pursue livelihood strategies, including climate change adaptation, was crucial to this study. It was also important to establish the relationship between livelihood capital, adaptation, and

sustainability. The FPE theory and the SLF converged on the fact that gender relations in the context of resource access and control mediate the adaptation pathways in farming households, which in turn influence households' livelihood sustainability.

The conceptual framework explained farmers' vulnerability context and farmers' experiences of climate change impacts (droughts, rainfall variability, extreme heat, pest, and diseases etc.) on their livelihoods. The framework depicted how the vulnerability context in which households are positioned affects their capacity to use assets. Farming households' strategies for securing their livelihoods included a wide range of simultaneous response activities to climate change. Furthermore, the framework described the livelihood capital (human, natural, physical, social and financial) in farming households and how these assets can be deployed to implement adaptation. As presented in the SLF, the livelihood capitals are deployed by farming households to generate strategies for sustainable livelihoods (Ellis, 2000; Scoones, 1998). Finally, the framework explained the livelihood outcomes and sustainability of farming households in the context of the implemented adaptation strategies. Gender was incorporated in the conceptual framework as a key variable of analysis because it influences resource ownership and control between male and female farmers, adaptation decisions and behaviours and, consequently, the livelihood sustainability of farming households.

7.4 Linking Climate Change Perspectives, Vulnerability and Gender

This study looked at perspectives and the vulnerability presented by climate change on farming households' livelihoods. Key findings indicated that smallholder households, regardless of the gender, age and educational level of the household head, were aware of the changing climate. The identified indicators of change in the past 5 to 10 years were consistent across both male and female farmers. All categories of farmers highlighted local indicators of climate change including plant phenology, animal behaviour and meteorological signs, which serve as a body

of indigenous knowledge used by farmers to predict weather patterns and plan for farming activities.

The causal attributions of climate change, which include a violation of traditional norms, burning of fossil fuels, God's will and sin and desecration of holy places and objects varied by gender, age and educational level of the households but were not statistically significant. Climate change effects on crop and animal production were widespread impacting all farmer categories (male and female, youth, adults and elderly farmers). However, the effects on household welfare varied based on the gender of the household head suggesting that gender influences how a household's welfare is impacted by climate change effects. Reasons for the impacts on household welfare were cited as scaling down on farming activities, exodus of large-scale commercial farmers, and engagement in 'any kind of work', which have all curtailed extra income generating opportunities to augment income from agriculture.

7.5 Patterns of Asset Ownership in Farming Households

The livelihood capital/assets required for adaptation and livelihood sustainability of farming households were profiled, and the results indicated that both male-headed and female-headed households possessed all the essential assets (human, physical, natural, social and financial). However, apart from human capital, farming households of all categories underperformed across the natural, financial, and physical capital as assessed by the developed indices. Social capital which was measured by group membership and community participation showed that while group membership was limited, community engagement was very inclusive in the study area.

Three distinct types of households emerged when categorised into groups based on asset endowment. These were low-asset, medium-asset and high-asset household categories. Both

male-headed and female-headed farming households were predominant in the low-asset category in addition to households with a head without formal education, those headed by the elderly and extended family households. This is an issue of concern because within the SLF and FPE contexts, farmers' agency in the adaptation process can be hampered by inadequate assets or resources and power dynamics.

7.6 Gender, Adaptation Pathways and Harnessing Livelihood Sustainability

In light of the experienced climate change impacts by smallholder farmers in Ward 11, several response strategies were implemented. The widely practised strategies were zero tillage, mixed farming, shifting of planting dates, off-farm activities, crop staggering, crop rotation, tree planting, mulching, water harvesting, irrigation, discontinuation of crops (that were laborious or poor performing) and planting hybrid seed varieties. These adaptation strategies were implemented at different intensities in male-headed and female-headed farming households with female-headed households dominating in the implementation of zero tillage, intercropping, and discontinuing crops, while male-headed households dominated in the implementation of mulching, hybrid varieties, off-farm activities, tree planting, mixed farming, shifting of planting dates and crop staggering, among others. Adaptation practices also differed based on the age of the household head and asset holdings. All farmers of different age groups employed adaptation, but older farmers had the highest proportions of farmers who implemented most of the identified strategies. In a similar vein, farmers who were in the medium and high-asset household categories had the highest proportions of implemented strategies.

Identified constraints to adaptation included labour demands, climatic barriers, a lack of farm implements, and gender roles, which hindered farmers' adaptation efforts. Although a statistical association could not be established, more female-headed households encountered climatic

related barriers and reproductive responsibilities such as gathering firewood and fetching water. The Poisson regression analysis indicated that smallholder farmers' adaptation intensity was influenced by household size, physical capital, financial capital, the age of the household head, community involvement, indigenous knowledge of climate change, and access to extension services.

Both male-headed and female-headed farming households were at risk of food insecurity as assessed by the two measurements of food security adopted in this study. These measurement were the Months of Adequate Household Food Provisioning (MAHFP) (Swindale & Bilinsky, 2010) and the Household Food Insecurity Access Score (HFIAS) (Coates et al., 2007).

The sources of household income, which included crop and livestock sales, non-farm wage employment, non-farm self-employment, remittances, and other transfers, as well as household income per capita, varied by the gender of the household head. Male-headed households had an average annual income per capita of US$354.52, while female-headed households had an average of US$137.40 annually. These differences were statistically significant, indicating that gender affects how a household generates income and its annual income per capita. The findings showed that male farmers had more diversified income-generating options, leading to better income outcomes. Despite the significant differences in per capita income between male-headed and female-headed households in Ward 11, the overall income is generally low. Since income is crucial for household welfare and livelihood sustainability, this raises concerns about the households' ability to manage climate change impacts and build resilience.

A composite livelihood sustainability index was generated using the five livelihood capitals (human, natural, physical, social, and financial) to ascertain the livelihood prospects of farming households in the study area. Overall, all farming household categories in Ward 11 performed poorly on the livelihood sustainability index. The OLS regression results for the determinants

of livelihood sustainability in farming households showed that adaptation strategies implemented by smallholder households increased their livelihood sustainability. This finding suggests that increased adaptation boosted farmers' ability to sustain livelihoods. Specifically, adaptation strategies dominant in both male-headed and female-headed households positively and significantly contributed to the livelihood sustainability of these households. Other predictors of livelihood sustainability in farming households were income per capita, children dependents (6-17 years), migration status of the household and household type.

7.7 Conclusions

The broader debates on gender and its influence on climate change perceptions and vulnerability influence have been inconclusive, with some studies finding a connection and others not. In the current study, the diversity of smallholder farming households in terms of demographic characteristics has no influence on farmers' perceptions of climate change in terms of awareness, observed indicators of change, sources of information and impacts on crop and animal production. Thus, the study has established that gender does not significantly affect how smallholder farmers perceive climate change or how they are impacted by it. Furthermore, the hypothesis that women are more affected by climate change than men has been rejected, as both male-headed and female-headed households face similar vulnerability to its impacts. Based on the findings from this study, a conclusion can be drawn that climate change perceptions and vulnerability to its impacts are gender neutral in Ward 11 of the Goromonzi district of Zimbabwe.

The capacity of both male and female farmers to withstand and adapt to climate change is influenced by their ability to access assets or resources without compromise. However, gender dynamics and power relations significantly affect their ability to access and control these critical productive resources. Insufficient assets can limit the adaptive capacities of both male-

headed and female-headed farming households. In Ward 11, both male and female farmers faced asset constraints, challenging the notion that women are more resource-constrained than men. Context may play a role in this outcome, presenting different opportunities and constraints for various categories of farmers. Access to land was available to both male and female farmers, contrary to common literature suggesting that women's limited access to land hinders their ability to manage climate change effects.

The interplay of gender, education, age and asset ownership influence climate change decisions and behaviours in Ward 11's farming households. Adaptation practices and livelihood outcomes differ between male-headed and female-headed households, highlighting the gender dimension of adaptation and livelihood sustainability. This aligns with the body of literature that has established that adaptation is gendered and shaped by several factors including resource access. It is therefore necessary to understand how households manage climate change impacts while maintaining their ability to secure a sustainable livelihood. The study concludes that in Ward 11, adaptation practices and livelihood sustainability are interlinked and gendered. Critical elements in households' livelihood sustainability include children dependents, income per capita, the type of household (extended or nuclear) and the migration of the households (whether a household member had migrated and remit the household).

While research often overlooks the relationship between adaptation outcomes and household's livelihood sustainability, it has been demonstrated in this study that adaptation can in fact enhance the asset base of farmers, which is crucial for enabling farmers to live fulfilling and successful lives. Most importantly, this sheds light on how adaptation to climate change can be used as a tool for achieving the Sustainable Development Goals. Therefore, climate change adaptation can be integrated into poverty alleviation and gender equality initiatives, which can address food insecurity, poverty and gender inequalities. Initiatives that give both male and

female farmers equal opportunities are a necessity in ensuring access to adaptation technologies and assets for all farmer categories. Again, implementing climate-resilient livelihoods for farmers can enhance their livelihood outcomes. This is a key focal point of the Sustainable Livelihood Framework which emphasises the ability of farmers to cope with adversities and recover from shocks while maintaining their asset base.

7.8 Recommendations

The results of this study raise important considerations for practitioners such as extension officers, policymakers and smallholder farmers and suggest exploration in several areas, including public-private sector collaboration. This study established that smallholder farming households in Ward 11, regardless of the gender and other socio-economic characteristics of the household head, were asset constrained. In particular, the households performed poorly in the physical, financial and social capital in the asset profiling. These assets are important for climate change adaptation and livelihood sustainability. This finding implies that building the adaptive capabilities of farming households by enhancing their assets is a necessity. Of particular importance is financial capital because, without money, farming households are constrained in making investments on their farms. Boosting the financial capital of smallholder farmers in Ward 11 and Goromonzi district large would enable farmers to increase their investments in adaptation and secure their livelihoods. Scholars have argued that an enhancement in one asset reflects positively on other assets implying that an improvement in financial capital will stimulate physical, social, human, and natural capital as well.

Public-private collaboration is critical in ensuring that smallholder farmers in Ward 11 get access to credit. Introducing cooperatives that allow farmers to collectively operate farms, gardens, and animal production enterprises like poultry, pig farming, sewing and carpentry shops can enhance farmers' income. Farmers can organise to purchase farm equipment to

produce on a large scale through cooperatives, increasing their chances of securing high income. This would address a lack of farm implements which was identified as a major constraint to adaptation by both male-headed and female-headed farming households. Another barrier related to climatic conditions can be offset by the opportunities for diversified income created by the establishment of these cooperatives and projects, off-farm work opportunities such as these could allow farming households to diversify their income sources and not rely solely on on-farm income. Loans and grants to support such projects can be sourced from the government (e.g. AgriBank), non-governmental partners (e.g. World Vision) and even individuals seeking to invest in agriculture. These bodies can partner with agricultural extension officers to implement the interventions.

The findings from this study showed that farmers implemented several adaptation strategies, and these strategies contributed to their livelihood sustainability. It is important that both male-headed and female-headed farming households get more support to intensify adaptation strategies and build resilience. Another key element in enhancing and intensifying adaptation is enabling easy access to climate information by both farmer categories in Ward 11. This is crucial because when farmers possess climate information and are aware of the changes and consequences of climate change, they are more likely to take measures to mitigate the effects and safeguard their livelihoods. This would contribute to more equitable and sustainable outcomes in all farming households.

The suggested approach includes collaboration between key stakeholders like the AGRITEX department, the Environment Management Agency (EMA) and the Farmers' Union to organise workshops and agriculture schools to provide a platform for farmers to learn how to implement strategies such as zero tillage, mulching and crop staggering among others effectively. There is also the need to focus on key strategies, for example, extension officers, together with the

farmers should identify a few key adaptation strategies out of the thirteen identified in the studied villages. This approach allows for a more targeted and effective implementation with a higher likelihood of positive outcomes. The ultimate goal is to promote livelihood sustainability in farming households. By successfully implementing adaptation strategies, farming households can enhance their income and food security, reduce vulnerability to climate change and create self-sustaining households.

Food insecurity was identified as a significant concern in the studied villages, with households headed by both male and female farmers experiencing it. To address this issue and improve the welfare of farming households, it is essential to provide support for intensifying production where necessary. For example, the study found that zero-tillage significantly improved crop yields and has the potential to harness food security. However, farmers expressed concerns about the labour-intensive nature of this strategy, limiting its widespread adoption. Encouraging the implementation of zero-tillage and exploring approaches to alleviate labour burdens is crucial for achieving food security. Promoting the concept of 'Ubuntu' that emphasises communal support among farmers can stimulate collective labour efforts and address the challenges associated with zero-tillage. This initiative can be led by the extension officers, farmers' union, and traditional leaders, particularly village headmen. Additionally, food security can be enhanced by promoting the cultivation of early-maturing, pest and disease-resistant hybrid seed varieties. The government, in collaboration with extension officers and seed companies such as SeedCo, Pannar and 'Zadzamatura' should play a role in ensuring the availability and accessibility of these seed varieties to all farming households.

Finally, the importance of policy in harmonising all these initiatives must be considered. Policy initiatives can enable smallholder farmers to access funding through loans, cash transfers and subsidies, training and education, alternative sources of employment, and farm machinery (e.g.

irrigation systems) that could strengthen their capacities to manage climate change effects. Currently, Zimbabwe only has a draft Comprehensive Agriculture Policy Framework yet to be implemented. The successful implementation of this policy framework could see smallholder farmers benefitting from funding, education and production systems and inputs such as irrigation. Nonetheless, the policy should explicitly define the various packages accessible to different types of farmers and how they will benefit before its implementation. Therefore, it is necessary for the government of Zimbabwe and the relevant stakeholders, particularly the Climate Change Management Department (Ministry of Environment, Water and Climate), to accelerate the implementation of this framework. The Zimbabwe Farmers' Union could also continuously lobby for the implementation of this agriculture policy to ensure that the challenges faced by farmers in agriculture are addressed and their ability to adapt to climate change enhanced.

7.9 Contribution to Knowledge

This study has successfully established the connections between gender-specific adaptation and household livelihood sustainability, which have been missing in the literature. These connections were made by evaluating the livelihood sustainability of male-headed and female-headed smallholder households through their asset portfolios, including human, natural, physical, financial, and social assets, and comparing them with the adaptation strategies they implemented. This study therefore fills a gap in the existing literature by linking adaptation practices with farmers' livelihoods, leading to enhanced sustainability, which in this study was found to be positive and significant. Recognising the synergy between climate change adaptation and livelihood sustainability in male-headed and female-headed farming households is of paramount importance if the targets set forth in the Sustainable Development Goals are to be achieved. This is particularly important for SDGs 1, 2 and 3 which seek to address the

eradication of poverty in all its forms and hunger and gender equality and the empowerment of women and girls, all of which are fundamental pillars of sustainable development globally.

7.10 Areas for Further Research

Various unanswered questions from this study open possibilities for additional investigation. To begin with, the problems farmers face and how they respond differ based on geographic and socioeconomic conditions. It is thus important to undertake exploratory comparative studies across all the country's agroecological zones and in the different smallholder farming settings such as A1 farms, resettlement areas (RA) and communal areas (CA), to examine climate change impacts, adaptation decisions and behaviours and livelihood sustainability from a gender perspective. This would inform broader policy recommendations to improve agriculture and farmers' welfare. Additionally, it is important to note that this study primarily focused on inter-household analysis.

Conducting an intra-household analysis and comparing it with the inter-household data would provide valuable insights into how gender dynamics operate within both households. This would shed light on the specific roles and experiences of men and women in relation to climate change adaptation and livelihood sustainability. Furthermore, considering the impacts of the Covid-19 pandemic on livelihood sustainability in the smallholder sector would be intriguing. Exploring such questions as how the pandemic affected asset investment patterns in smallholder farming communities, how it altered the livelihood activities of farmers and the subsequent effect on the asset endowment of farming households could provide valuable insights into the intersection of climate change and pandemic-related challenges. This would shed light into the additional vulnerabilities and adaptations required in the face of compounding crises.

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APPENDICES

APPENDIX 1: PCA Components

Table 1A: Sample sizes by village

Village	Population	Sample
Gore	50	27
Chikodzonga	-	25
Timuri	44	14
Maendesa	22	1
Zavare	40	5
Mambera	50	14
Chiwhape	30	19
Cheuka	45	20
Chiringa	-	15
Maonera	39	22
Mavhudzi	-	20
Bungu	-	18
Mabreza	47	19
Ngoshi	71	25
Mavhaza	54	12
Total		256

Table 1B: Indices (variables) computed using principal component analysis (PCA)

Variables (indices)	Index components	Measurement of components	Kaiser-Meyer-Olkin (kmo) statistics
Human capital	Household Size Education Use of hired labour	Normalized variables from zero (0) to one (1)	0.50
Sustainable livelihood index	Physical capital Financial capital Social capital Human capital Natural capital	Normalized and index variable with values 0 - 1	0.50

APPENDIX 2: Post Estimation Tests for OLS Regression

Table A: Model Specification Test

sust_livhd	Coef.	Std.Err.	T	P>t	[95%Conf.	Interval]
_hat	0.918	0.234	3.92	0.002	0.457	1.379
_hatsq	0.103	0.27	0.38	0.702	-0.427	0.633
_cons	0.011	0.037	0.32	0.747	-0.061	0.085

Table B: Omitted Variable Test

Ramsey RESET test using powers of the fitted values of sust_livhd
Ho: model has no omitted variables
F(3, 243) = 3.61
Prob > F = 0.014

Table C: Variance Inflation Factor for Multicollinearity

	VIF	1/VIF
Adaptation Intensity	1.11	.897
Income per capita	1.12	.889
Infant dependents (0-5yrs)	1.08	.928
Children dependents (6-17yrs)	1.07	.932
Food security	1.06	.947
Gender of HHH	1.07	.934
1.Extension service access	1.11	.90
1.Migration Status	1.04	.96
2.Household Type	1.14	.879
Mean VIF	1.09	.

Table D: Heteroscedasticity Test

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of sust_livhd
chi2(1) = 6.42
Prob > chi2 = 0.0113

APPENDIX 3

Table 3A: Socio-demographic characteristics of household heads who participated in the IDIs

Village Name	Gender	Size	Age	Education level	Date of Interview
Bungu	Female	4	56	Primary	14/03/2022
Bungu	Male	6	37	Primary	16/03/2022
Chikodzonga	Female	4	68	Primary	16/03/2022
Chikodzonga	Male	5	31	Secondary	18/03/2022
Timuri	Female	4	44	Secondary	19/03/2022
Mambera	Male	2	73	Primary	19/03/2022
Mambera	Female	5	65	Primary	17/03/2022
Mambera	Male	3	25	Secondary	17/03/2022
Gore	Female	5	48	Secondary	18/03/2022
Gore	Male	3	30	Primary	18/03/2022
Chiringa	Male	3	36	Tertiary	17/03/2022
Ngoshi	Female	3	72	Primary	15/03/2022
Ngoshi	Male	1	69	Secondary	20/03/2022

Table 3B: Have you noticed any key local signs of climate change?

Variable	Male	Female	Total
Yes	94 (63.95)	57 (52.29	151 (58.98)
No	41 (27.89)	42 (38.53)	83 (32.42)
Don't Know	12 (8.16)	10 (9.17)	22 (8.59)
Total	147 (100)	109 (100)	256 (100)

Table 3C: Crop Types in Ward 11 by Gender of Household Head

Crops Grown	Freq. (%)	Gender	
		Male	Female
Maize	239 (93.36)	135 (91.84)	104 (95.41)
Sugar beans	11 (4.3)	6 (4.08)	5 (4.59)
Sorghum	4 (1.56)	3 (2.04)	1 (0.92)
Millet	7 (2.73)	4 (2.72)	3 (2.75)
Groundnuts (nzungu)	130 (50.78)	71 (48.3)	59 (54.13)
Bambara beans (nyimo)	42 (16.41)	21 (17.01)	17 (15.6)
Cow peas beans (nyemba)	11 (4.3)	9 (6.12)	2 (1.83)
Sweet potato	7 (2.73)	5 (3.4)	2 (1.83)
Potatoes	1 (0.39)	1 (0.68)	-
Soy beans	3 (1.17)	-	3 (2.75)
Sunflower	9 (3.52)	4 (2.72)	5 (4.59)
Pumpkins	2 (0.78)	2 (1.36)	-
Other	24 (9.38)	18 (12.24	6 (5.5)
Total	490 (191.41)	283 (192.52)	207 (189.91)
Chi2 (Pr)			**37.7828/0.303**

Table 3D: T-Test Results for Physical Capital

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
1. Male	147	.0360554	.0078236	.0948557	.0205933	.0515174
2. Femal	109	.0291401	.0073711	.0769564	.0145293	.0437509
combined	256	.033111	.0054742	.0875875	.0223305	.0438914
diff		.0069153	.0110844		-.0149137	.0287443

diff = mean(1. Male) - mean(2. Femal) t = 0.6239

Ho: diff = 0 degrees of freedom = 254

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

Pr(T < t) = 0.7334 Pr(|T| > |t|) = 0.5333 Pr(T > t) = 0.2666

Table 3E: Off-farm Activities by Gender and Age Category of Household Head

Off-farm Strategy	Gender		Age Category			Full Sample
	Male	Female	Youth (18-35yrs)	Adults (36-60yrs)	Elderly (60+ yrs)	
Migration	6 (4.08)	11 (10.09)	-	8 (5.97)	9 (9.09)	17 (6.64)
Trading	27 (18.37)	20 (18.35)	10 (43.48)	23 (17.16)	14 (14.14)	47 (18.36)
Use of NTFP (foraging)	8 (5.44)	7 (6.42)	2 (8.70)	9 (6.72)	4 (4.04)	15 (5.86)
Carpentry	1 (0.68)	-	-	1 (0.75)	-	1 (0.39)
Commercial transport	2 (1.36)	-	-	2 (1.49)	0	2 (0.78)
Equipment hiring	4 (2.72)	6 (5.50)	1 (4.35)	4 (2.99)	5 (5.05)	10 (3.91)
Cowboy services	6 (4.08)	4 (3.67)	-	6 (4.48)	4 (4.04)	10 (3.91)
Casual Labour	26 (17.69)	24 (22.02)	4 (17.39)	27 (20.15)	19 (19.19)	50 (19.53)
Masonry	23 (15.65)	3 (2.75)	2 (8.7)	18 (13.43)	6 (6.06)	26 (10.16)
Beer brewing	7 (4.76)	4 (3.67)	1 (4.35)	4 (2.99)	6 (6.06)	11 (4.30)
Fuel sale	4 (2.72)	2 (1.83)	-	5 (3.73)	1 (1.01)	6 (2.34)
Traditional healing	1 (0.68)	-	-	1 (0.75)	-	1 (0.39)
Prophetic consultations	3 (2.04)	1 (0.92)	1 (4.35)	2 (1.49)	1 (1.01)	4 (1.56)
Hairdressing/Sewing	3 (2.04)	4 (3.67)	2 (8.70)	3 (2.24)	2 (2.02)	7 (2.37)
Pit latrine & well digging	7 (4.76)	3 (2.75)	-	6 (4.48)	4 (4.04)	10 (3.91)
None	49 (33.33)	43 (39.45)	5 (21.74)	40 (29.85)	47 (47.47)	92 (35.94)
Total	177 (120.41)	132 (121.1)	28 (121.74)	159 (118.66)	122 (123.23)	309 (120.7)
Pearson Chi2		**Pr = 0.258**			**Pr = 0.298**	

Table 3F: Means and Standard Deviations for Livelihood Capital Variables

Variable	Human	Natural	Physical	Financial
Male (N=147)				
Mean	0.51	0.18	0.04	0.19
Standard Dev	0.21	0.17	0.09	0.3
Female (N=109)				
Mean	0.50	0.19	0.03	0.16
Standard Dev	0.19	0.19	0.08	0.3
Full Sample (N=256)				
Mean	0.50	0.19	0.02	0.18
Standard Dev	0.2	0.18	0.08	0.3

Source: Fieldwork, 2022 [0 - 0.25 (low); 0.26 – 0.75 (moderate); 0.76 – 1.00 (high)]

APPENDIX 4

ETHICAL CLEARANCE

UNIVERSITY OF GHANA
ETHICS COMMITTEE FOR THE HUMANITIES (ECH)

P. O. Box LG 74, Legon, Accra, Ghana

My Ref. No…ECH 286/ 21-22 …

March 08, 2022.

Petronella Munemo
Department of Social Work
University of Ghana
Legon

ETHICAL CLEARANCE
(ECH 286/ 21-22)

The protocol title below has been reviewed and approved by the ECH Committee.

TITLE OF PROTOCOL**: The GENDERED DIMENSIONS OF CLIMATE CHANGE ADAPTATION AND SUSTAINABILITY OF SMALLHOLDER FARMERS IN ZIMBABWE**

PRINCIPAL INVESTIGATOR**: PETRONELLA MUNEMO**

Please note that the final review report must be submitted to the Committee at the completion of the study. Your research records may be audited at any time during or after the implementation. Any modification of this research project must be submitted to ECH for review and approval prior to implementation.

Please report all serious adverse events related to this study to ECH within seven (7) days verbally and in writing within fourteen (14) days.

This certificate is valid till March 07, 2023. You are to submit annual reports for continuing review.

Please accept my congratulations.

Yours Sincerely,

Professor C. Charles Mate-Kole
ECH Chair

Cc: Professor Dzodzi Tsikata, Institute of Statistical, Social and Economic Research, UG
Professor Joseph A. Yaro, Department of Geography and Resource Development, UG
Dr. Fred M. Dzanku, Institute of Statistical, Social and Economic Research, UG

Tel: +233-303933866 Email: ech@ug.edu.gh

APPENDIX 5

RESEARCH INSTRUMENTS

A: CONSENT FORM

Research Title: Gendered Dimensions of Climate Change Adaptation Practises and Livelihood Sustainability of Smallholder Farming Households in Zimbabwe

You are invited to participate in a research on the above topic aimed at examining the gendered dimensions of climate change adaptation practises and livelihood sustainability of smallholder farming households in the Goromonzi district of Zimbabwe.

About the Researcher

My name is Petronella Munemo, a PhD student of Development Studies at the Institute of Statistical, Social and Economic Research (ISSER), University of Ghana. My broad research interests include gender, climate change and adaptation, migration, reproductive health, intimate partner violence and vulnerability.

Purpose of the Research

The goal of this research is to examine the gendered dimensions of climate change adaptation and sustainability of smallholder farmers' livelihoods. The study will provide insight into Zimbabwe's climate change policy landscape, household assets and their relationship to farming households' adaptation arrangements, as well as gendered patterns of cultural systems prevalent in the Goromonzi district and their impact on livelihood sustainability. The research is purely for academic purposes and is expected to contribute toward the award of a PhD in Development Studies by the University of Ghana. You are expected to answer some questions about your livelihood assets and activities, adaptation practices and outcomes, as well as constraints to adaptation. The time required to complete the survey and interviews is between 45-90mins. Focus group discussions and questionnaire administration will be done at your convenience in an open area

Participation

Your participation in this study is voluntary, you have the right to choose not to answer questions you are not comfortable with and also the right to withdraw from the study anytime you feel any discomfort during the data collection process. Should you decide to withdraw from the study, the data provided by you will be destroyed. You will not be penalised for terminating your participation, please, feel free to discuss any concerns you might with me in this regard.

Confidentiality

Audio-recording will be done during the focus group discussions and key informant interviews to help me to accurately record all the information you will be giving me as a participant in this study. The recorded information will be stored on my computer in a secured folder and can only be accessed by me and the other collaborators. All personal identifiable information about you will be kept private and not included in the thesis. To maintain anonymity, any quotations used in reporting the findings will not include names or any other identifiable information. All recordings and transcripts will only be accessible to me and those assisting in the research process. Study findings will be submitted to the University of Ghana as a thesis and may be published as journal articles.

Risks and Benefits
You may feel exposed by disclosing personal information, such as your income, during the study. However, you are assured of confidentiality and therefore encouraged to speak freely with the researchers.

This study has no direct benefit to you however, findings are expected to enhance our understanding of climate change adaptation and related issues in Zimbabwe. This would be beneficial to policymakers to be able to initiate interventions to aid adaptation which would stimulate livelihood sustainability in the smallholder sector. Again, the research would contribute to gender and climate change scholarship, as well as smallholder farmer-targeted policies and initiatives.

Compensation
No compensation, incentives or tangible reward will be given to you for your participation.

COVID 19 Awareness
All covid 19 protocols will be observed according to the state's regulations, particularly the wearing of nose masks and hand sanitising.

Contact
If you have any questions about the study or the procedures involved, you may contact me on Whatsapp Number 00233246892050
Email: petmunemoocloo@yahoo.com.

Consent to Comply with COVID 19 Protocols
I have agreed to comply with all laid down covid-19 protocols

Participant's Signature……
Date…….

Consent
I have read or I understand what has been read to me. I have received a copy of this form and have agreed to participate in this study

Participant's Signature.....
Date.....
Researcher's Signature.....
Date.....

Consent to use quotations
I consent to the researcher using my quotes in reporting the findings.
Participant's Signature.....
Date.....

B: Survey Questionnaire

SECTION 1: HOUSEHOLD ASSETS

1.1 Human Capital

Household size, composition and Structure

No.	QUESTION	RESPONSE OPTIONS	CODE
1	Name of respondent (to be made confidential)		
2	Local name		
3	Gender of interviewee	Male	1
		Female	2
		Other (specify)	97
4	Age of interviewee ENTER YEAR		
5	Marital Status	Married	1
		Divorced	2
		Single	3
		Separated	4
		Widowed	5
		Cohabiting	6
		Other (specify)	97
6	Education Level Completed	None	1
		Primary	2
		'O' Level	3
		'A' Level	4
		Vocational	5
		College/Poly-T	6
		University	7
		Other (specify)	97
		Don't Know	98
7	Main economic activity	Self employed (agric)	1
		Self emplyed (non-agric)	2
		Wage employed (public)	3
		Wage employed (private)	4
		NGO/Civil Society	5
		Volunteer	6
		None	7
8	Secondary economic activity	Self employed (agric)	1
		Self emplyed (non-agric)	2
		Wage employed (public)	3
		Wage employed (private)	4
		Volunteer	5
		None	6
9	Is the respondent head of the household?	Yes	1
		No	2
10	If not, relationship to household head	Wife/husband	1
		Mother/father	2
		Son/daughter	3
		Sister/brother	4
		Brother/sister in-law	5
		Grandchild	6
		Grandparent	7
		Niece/nephew	8
		Cowboy/maid	9
		Other (specify)	97
11	Name of household head ENTER NAME		

12	Gender of household head	Male	1
		Female	2
13	Age of household head ENTER YEAR		
14	Education level of household head	None	1
		Primary	2
		'O' Level	3
		'A' Level	4
		Vocational	5
		College/Poly-T	6
		University	7
		Other (specify)	97
15	Employment status of household head	Employed	1
		Unemployed	2
		Other (specify)	97
16	Type of household	Nuclear	1
		Extended	2

Household Composition

17	Age	Total		Number of HH members working on farm		Number of household members working off-farm	
		Male	Female	Male	Female	Male	Female
	0 -5yrs (infants)						
	6-17yrs (children)						
	18-60yrs (adults)						
	60yrs and above (aged)						

Housing Characteristics

18	Dwelling type	Kitchen only	1
		Kitchen separate from bedroom	2
		Kitchen and bedroom together	3
		Self contained (kitchen, bedroom, toilet and bath together)	4
		Other (specify)	97
19	What is the current tenancy arrangement of this dwelling?	Owned	1
		Bequethed (inherited)	2
		Rented	3
		Caretaking	4
		Other (specify)	97
20	Number of rooms (excluding kitchen, toilet and bathroom) ENTER NUMBER AS MENTIONED	_____	

Hired Labour

21	Do you use hired labour in your farming activities?	Yes >>Q23	1
		No >>Q22	2
		Don't know >>Q28	98
22	Why do you not use hired labour? RECORD ALL MENTIONED	No money/resources to pay for labour	1
		Enough household members to work on farm	2
		Farm size small	3

		Labour not required	4
		Other (specify)	97
23	How frequently do you use hired labour?	Permanent	1
		Occassionally	2
		Both	3
		Don't know	98
24	Has there been any change in the number of hired labour you use in the past one year?	Yes	1
		No >>Q28	2
		Don't know >>Q28	98
25	How has this change been?	Increased number of hired labour >>Q26	1
		Decreased number of hired labour>>Q27	2
26	Reasons for increased labour RECORD ALL MENTIONED	Farm size increased	1
		Reduction in household members working on the farm due to migration	2
		Reduction in household members working on the farm due to illness or death	3
		Extra money to pay labourers	4
		Increment in farm inputs (seeds, fertiliser)	5
		Availability cheap labour	6
		Other (specify)	97
27	Reasons for decreased labour RECORD ALL MENTIONED	Reduction in farm size	1
		Increase in household members working on the farm	2
		No money to pay labourers	3
		Reduction in farm inputs (seeds, fertiliser)	4
		Scarce labour	5
		Other (specify)	97

Out-Migration

28	Have any members of this household moved out in the past year?	Yes	1
		No >>Q34	2
		Don't know >> Q34	98
29	How many moved out ENTER NUMBER AS MENTIONED	_____	
30	Where did they travel travel to? MULTIPLE RESPONSES ALLOWED	Different household same village	1
		Different village same District	2
		Different District (Urban)	3
		Different district (rural)	4
		Out of Zimbabwe	5
		Don't know	98
31	Why did they travel? MULTIPLE RESPONSES ALLOWED	Environmental issues (climate change)	1
		Poor returns from economic activities	2
		To work in the informal sector (Domestic service, trade, commercial farms)	3
		To work in the formal sector	4
		To study	5
		Political insecurity	6
		Vacation/rest/pleasure	7
		Family responsibilites (caregiving etc)	8
		Other (specify)	97
32	Do they send any assistance back home?	Yes	1

		No >>Q34	2
		Don't know >>Q34	98
33	What form of assistance do they provide?	Food	1
		Cash	2
		Clothes	3
		Farm inputs (seeds, fertiliser etc)	4
		Livestock/animals	5
		Other (specify)	97

In-Migration

34	Have any members moved into this household in the past two years?	Yes	1
		No >> Q38	2
		Don't know >> Q38	98
35	How many moved in? ENTER NUMBER AS MENTIONED	_____	
36	Where was their last place of residence? RECORD ALL THAT APPLY	Different household, same community	1
		Different village same district	2
		Different district (urban)	3
		Different district (rural)	4
		Out of Zimbabwe	5
		Other (specify)	97
37	Why did they move in?	Lost job	1
		Illness	2
		Caregiving	3
		Help on the farm	4
		Family issues (divorce etc)	5
		Completed school but no job	6
		Unemployment at last place of residence	7
		Political insecurity at last place of residence	8
		Other (specify)	97

1.2: Natural Capital

Land size, Quality, Use and Tenure

38	What is the land tenureship practice in this village	Communal	1
		Resettlements	2
		Freehold	3
		Government owned	4
		Other (specify)	97
39	How much total (acres/hectares) of land does your household possess? ENTER NUMBER AS MENTIONED	_____ Acres/Hectares	
		Don't know	98
40	How did you acquire these lands? (MULTIPLE RESPONSES)	Because I am an indegene (communally)	1
		Inherited	2
		Permission to use	3
		Rented	4
		Purchased	5
		Other (specify)	97
41	If it is possible to sell all your lands you possess or cultivate on, how much would you sell? ENTER AMOUNT IN US$	US$	
42	How many acres of these total lands are fertile and suitable for agriculture? ENTER AS MENTIONED	Acres/hectares	

43	How many of these acres of lands are you farming on? ENTER NUMBER AS MENTIONED	Acres/hectares	
44	Have you rented or given out any of your agricultural lands out?	Yes	1
		No >> Q47	2
45	How much total agricultural land has your household rented out or given out? ENTER AS MENTIONED	____Acres/Hectares	
46	Reasons for renting out?	Land was lying fallow for a while	1
		Needed extra income	2
		Lack of inputs for farm on it	3
		Threats from poachers	4
		Other (specify)	97
47	Do women have equal access to land-use rights as men in this household?	Yes >> Q49	1
		No >>Q48	2
		Don't know >>Q49	98
48	Why do they not have equal access to land? MULTIPLE RESPONSES ALLOWED	Lack of resources (money etc)	1
		Lack of decision making power	2
		Patriarchy	3
		No rules and regulations governing land ownership for women	4
		Weak implementation of policies	5
		Other (specify)	97
49	How do women access land-use rights in this household? MULTIPLE RESPONSES ALLOWED	Access through marriage	1
		Access through inheritance	2
		Access through male kin	3
		Other (specify)	97
		Don't know	98

Water

In this section I will be asking you questions regarding water use in the household; for DRINKING, COOKING, BATHING, WASHING CLOTHES AND OTHER HOUSEHOLD USES.

50	What are the source of water for the household for drinking, cooking, washing, cleaning, bathing and other household uses? RECORD ALL THAT APPLY	Piped	1
		Well on property	2
		Borehole on property	3
		Well away from property	4
		Borehole away from property	5
		River/stream	6
		Dam/Stagnant water	7
		Rainwater (Harvested)	8
		Other (specify)	97
51	Does the household have to fetch and carry water to the house each day?	Yes, all the time	1
		Sometimes	2
		No >>Q57	3
		Other (specify)	97
52	About how far away is the water that has to be fetched?	Less than 100m (within the compound)	1
		100m - less than 500m	2
		500m - less than 1km	3
		1km - less than 5km	4
		More than 5km	5
		Don't know	98
53	Who in the household USUALLY fetches water? RECORD ALL THAT APPLY	Female children	1
		Male Children	2
		Female adults	3
		Male adults	4

		Other female household members	5
		Other male household members	6
		Other (specify)	97
54	On typical day, how many trips do they usually make? ENTER NUMBER OF TRIPS		
55	How long does each round trip take on average? ENTER HOURS AND MINUTES	Hrs/Mins	
56	How do you transport the water to the house? RECORD ALL THAT APPLY	By head/shoulder/hands	1
		By wheelbarrow	2
		By scotch cart	3
		Vehicle (tractor, truck etc)	4
		Other (specify)	97

Fuel-Energy Source

57	Is the house connected to an electricity supply?	Yes	1
		No	2

Please indicate your main and second source of energy for each of the different household activities listed below:

58	Source of energy	a Cooking		b Lighting		c Heating Water		d Entertainment-Radio/TV		Heating Space	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
	Wood										
	Paraffin										
	Gas (LPG)										
	Electricity										
	Charcoal										
	Coal										
	Solar										
	Crop and animal residue										
	Petrol or diesel generator										
	Other (Specify)										

If wood has been mentioned, who fetches the firewood in the household?

659	Who fetches firewood for these activities? RECORD ALL THAT APPLY	Female children	1
		Male Children	2
		Female adults	3
		Male adults	4
		Other female household members	5
		Other male household members	6
		Other (specify)	97
60	In typical week, how many trips do they usually make? ENTER NUMBER OF TRIPS		
61	How long does each round trip take on average? ENTER HOURS AND MINUTES	Hrs/Mins	

1.3: PHYSICAL CAPITAL

Farm equipment and household tangible assets

62. Does any household member own any of the assets listed below? Please indicate the quantity owned and current resale price or current market value, if you are to sell the item:

Indicate which of the assets you own, the quantitates and resale value

Assets	Quantity Owned	Resale Value-US$
Tractor plough		
Ox-drawn plough		
Scotch-cart		
Harrow		
Cultivator		
Ridging plough		
Car/truck		
Motorbike		
Bicycle		
Wheel barrow		
Axes		
Hoes		
Planter		
Ripper		
Spray pump		
Rake		
Irrigation equipment		
Water tanks/storage		
Stores		
Poultry house		
Piggery house		
Water pump		
Borehole		
Power saw		
Solar panels		
Sofas		
Beds		
Dining table		
Room divider		
Sewing machine		
Kitchen unit		
Wardrope		
Dressing table		
Kitchen utensil		
Jewelery		
Television		
Mobile phone		
Radio		
Commercial business/building		

63	Have you sold any of these assets in the last 2 years?	Yes	1
		No >>Q65	2
		Don't know >>Q65	98
64	What was the reason for selling these assets? RECORD ALL MENTIONED	To buy food and household supplies	1
		School fees/ materials	2
		Healthcare (hospital bills, medicines, tests etc)	3
		Social obligation (funeral, celebration, lobola etc)	4
		Investments	5
		Covid 19 related issues	6
		To buy farm equipment and inputs	7
		To repay debt	8
		Others (specify)	97

1.4. FINANCIAL CAPITAL

Bank savings and stores of value

65	Has any member of this household saved money in the last year?	Yes >>Q66	1
		No >>Q67	2
		Don't know >>Q67	98
66	Where was the money saved? RECORD ALL THAT APPLY	At home	1
		With a cooperative	2
		With a bank	3
		On Eco-cash	4
		Informally (Relative, trader etc..)	5
		Other (specify)	97

Cash credit

67	In the last 12 months, has any member of your household borrowed any money?,	Yes >>Q69-72	1
		No >> Q68	2
68	Why did you not borrow any credit for the household? >>Q73	Didn't need credit	1
		Didn't want debt	2
		Interest on repayment rate high	3
		Lack of collateral/guarantor	4
		Other (specify)	97
69	Where did you get the credit/loan from?	Trader/shopkeeper	1
		Relative/kin	2
		Informal lending group	3
		Friends	4
		Hire purchase	5
		Credit group	6
		Bank	7
		Other (specify)	97
70	What did you use the credit/loan for? RECORD ALL THAT APPLY	To buy food and household supplies	1
		Buy farm inputs (seed, fertilizer etc)	2
		Buy farm equipment	3
		Buy livestock	4
		Pay debt	5
		Medical expenses	6
		Education (fees)	7
		Capital for off-farm business	8
		Social obligations (Funeral, party etc)	9
		Other (specify)	97
71	What is the loan repayment status?	Fully repaid	1
		Partly repaid	2
		Not yet due for payment	3
		Unable to pay (defaulted	4
		Don't know	98
72	How much did you borrow in total? ENTER AS MENTIONED in US$	US$	
73	Has your household lent out any money to others in the last 12 months?	Yes	1
		No >>Q75	2
		Don't Know >> Q75	98
74	How much in total did you lend out ENTER AMOUNT IN US$	US$	

1.5: SOCIAL CAPITAL

Groups

In this section I'll be asking you about the groups, organisations, networks and associations you or any household member belong. These could be formally organised groups or just groups of people who get together regularly to do an activity:

75	Does any member of your household belong to any group, organisation or association?	Yes	1
		No >>Q81	2
76	What type of group is it? RECORD ALL THAT APPLY	Self-help/cooperative	1
		Association	2
		Credit group	3
		Faith-based	4
		NGO-based	5
		Family-based	6
		Women's group	7
		Men's group	8
		Other (specify)	97
77	How will you describe your involvement in the group in the past 2 years	Increased >>Q78	1
		Same >>Q80	2
		Decreased >>Q79	3
78	Reasons for increased participation in the group or organisation your household is mostly involved RECORD ALL THAT APPLY	We have benefitted from the group (farm inputs, credit, other services etc)	1
		Unity in the group (social cohesion)	2
		Group well organised	3
		Mutual respect	4
		Good leadership	5
		Member responsibility	6
		Other (specify)	97
79	Reasons for decreased participation in the group or organisation your household is mostly involved in RECORD ALL THAT APPLY	Group is not beneficial	1
		Group not functional	2
		Group has been politicised	3
		Poor leadership	4
		Lack of unity	5
		No respect	6
		Disagreements (fights, gossip etc)	7
		Covid 19 related issues	8
		Other (specify)	97
80	In what ways has your household benefitted from the groups/organisations you belong to? RECORD ALL THAT APPLY	Funeral/illness support	1
		Food/household items	2
		Education or training support	3
		Health services (medicines, check ups, tests etc)	4
		Water supply and sanitation services	5
		Credit or savings (loans, round etc)	6
		Farm inputs	7
		Farm equipment	8
		Climate change/weather information	9
		Technology	10
		Other (Specify)	97

Social Exclusion and Inclusion

81	Are there any community activities in which you are unable to participate?	Yes	1
		No >>Q84	2
82	Which activities are you unable to participate in? CHECK ALL THAT APPLY	Village meetings	1
		Agriculture Fairs	2
		Programmes by extension officers	3
		Communal labour (Humwe)	5
		Village courts	6
		Programmes by NGOs and other institutions	7
		Other (specify)	97
83	What prevents you from participating in these activities? MULTIPLE RESPONSES ALLOWED	Because of my gender	1
		Because of my marital status	2
		Because of my age	3
		Religion	4
		Political affiliation	5
		Illness/disability	6
		Because I am not a native/indigene	
		Other (specify)	97

SECTION 2

2.1 LIVELIHOODS AND MAJOR ECONOMIC ACTIVITIES

In this section I will ask you questions on the livelihood activities you engage in to sustain your household:

84	Please indicate by Yes or No, which livelihood activities your household engages in. RECORD ALL MENTIONED

Agriculture/Farming	Yes =1	No=2
Crop farming for consumption and sell		
Livestock/Poultry rearing		
Mixed farming-both crop and livestock		
Fruit farming		
Gardening (Leafy greens i.e. rape, covo, spinach, tsunga; tomatoes, onions, carrots etc)		
Other (specify)		
Trade (buying and selling)		
Firewood sales		
Gas sales		
Paraffin sales		
Household items		
Clothing, shoes, bedding etc sales		
Mopane worms		
Other (specify)		
Individual Business/Service		
Water carrying		
Grinding mill		
Hairdressing		
Gold panning		

Traditional healing		
Prophetic consultations and healing		
Pit latrine and well digging		
Scotch cart hiring		
Cattle hiring		
Plough hiring		
Cowboy services		
Transport short distance		
Brick production and sale		
Building		
Carpentry		
Thatching		
Other (specify)		
Alcohol brewing (1 day; 7 days)		
Peanut butter processing and selling		
Other (specify)		
Employment		
Formal salaried employment		
Local agriculture labour		
Local non-agriculture labour		
Migration for agriculture labour		
Migration for non-agriculture labour		
Domestic service		
Other (specify)		
Rents		
Money lending		
Share cropping		
Renting out farming land		
Other (specify)		

Crop and Animal Production

85	Please indicate which crops were grown by your household in the last cropping season RECORD ALL THAT APPLY	Maize	1
		Sugar Beans	2
		Rice	3
		Sorghum	4
		Rapoko	5
		Millet	6
		Groundnuts (nzungu)	7
		Bambara beans (nyimo)	8
		Cow peas beans (nyemba)	9
		Sweet potato	10
		Potatoes	11
		Soy beans	13
		Sunflower	13
		Pumpkins	14
		Other (specify)	97

86. Please indicate in the table below, five major crops grown by your household in the last cropping season.

ENTER THE QUANTITIES IN SACKS (MASAGA)/KGs; AND SPECIFY AMOUNT IN US$

Food Crop	Quantity harvested Sacks/masaga/kgs	Quantity consumed Sacks/masaga/kgs	Quantity sold Sacks/masaga/kgs	Quantity lost Sacks/masaga/kgs	Price per sack US$
Maize					
Sugar Beans					
Rice					
Sorghum					
Rapoko					
Millet					
Groundnuts (nzungu)					
Bambara beans (nyimo)					
Cow peas beans (nyemba)					
Sweet potato					
Potatoes					
Soy beans					
Sunflower					
Pumpkins					

Livestock

87	Do you own livestock?	Yes	1
		No >>Q96	2
88	Kind of livestock RECORD ALL THAT APPLY	Cow	1
		Goats	2
		Sheep	3
		Pigs	4
		Chickens	5
		Guinea fowls	6
		Turkeys	7
		Rabbits	8
		Donkeys	9
		Other (specify)	97
89	What is the total number birds you have? ENTER NUMBER AS MENTIONED	_____	
90	If it is possible to sell all these birds, how much would you sell?ENTER AMOUNT AS MENTIONED	US$	
91	Total number of other animals? ENTER NUMBER AS MENTIONED	_____	
92	If it is possible to sell all these other animals, how much would you sell? ENTER AMOUNT AS MENTIONED	US$	
93	Did you lose any livestock in the past 2 years?	Yes	1
		No >>Q96	2
94	How did you lose your animals? RECORD ALL THAT APPLY	Sold some	1
		Household consumption	2
		Death/sickness	3
		Theft	4
		Gift	5
		Social obligations (lobola, celebrations, funeral etc)	6
		Other (specify)	97
95		To buy food and household supplies	1

	If you sold your animals what was the reason for selling? RECORD ALL THAT APPLY	School fees/materials	2
		Healthcare (hospital bill, medicines, tests etc)	3
		Investments	4
		Social obligations (lobola, celebrations, funeral etc)	5
		Covid 19 related issues	6
		To buy farm equipment or inputs	7
		To repay debt	8
		Other (specify)	97

SECTION 3

3.1 HOUSEHOLD INCOME AND FOOD SECURITY

Source of income

96	Which of these are your sources of income? RECORD ALL MENTIONED	Sale of crops (grains, groundnuts, cowpea, soy, sunflower, cotton etc)	1
		Sale of livestock/livestock products (cows, goats, chickens, turkeys, guinea fowls, pigs, eggs, milk, meat etc)	2
		Sale of other products (firewood, trees, Mopane worms, gas, paraffin, household items etc)	3
		Regular employment (formal salary worker etc)	4
		Casual employment (maricho, domestic work, local agric labour, local non-agric labour, etc)	5
		Running individual businesses (grinding mill, hairdressing, dressmaking, building, traditional and prophetic healing & consultations, beer brewing etc)	6
		Remittances (from elsewhere)	7
		Gold panning	8
		Gardening (sale of produce e.g. Leafy greens i.e. rape, covo, spinach, tsunga; tomatoes, onions, carrots etc)	9
		Rents (money lending, share cropping, renting farm lands)	10
		Other (specify)	97
97	Who gets the income?	Household head	1
		Daughter/son	2
		Grandchild	3
		Niece/nephew	5
		Other (specify)	97

98. What is the estimated amount you got in the last 12 months from the following sources? SPECIFY AMOUNT IN US$

Source	Amount US$
Sale of crops (grains, groundnuts, cowpea, soy, sunflower, cotton etc)	
Sale of livestock/livestock products (cows, goats, chickens, turkeys, guinea fowls, pigs, eggs, milk, meat etc)	
Sale of other products/Trading (firewood, trees, Mopane worms, gas, paraffin, household items, bricks etc)	
Regular employment (civil servant, professional job etc)	
Casual employment (maricho, domestic work, etc)	
Running individual businesses (grinding mill, hairdressing, dressmaking, building, traditional and prophetic healing & consultations, beer brewing etc)	
Remittances (from elsewhere)	

Gold panning	
Gardening (sale of produce e.g. leafy greens i.e. rape, covo, spinach, tsunga; tomatoes, onions, carrots etc)	
Other (specify)	

Household Food Security

99	In the past 12 months were there months you did not have enough food to eat?	Yes	1
		No	2

IF NO, >>Q101

100. Which of the months in the last 12 months you did not have enough food to meet your household needs?

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
1=Yes 2=No											

Assessment of Household Food Security in the past 4 weeks

Please, in the following questions I will be asking you about food eaten in in your household in the past 4 weeks and whether you were able to afford the food you needed or not.
Read list and circle only one answer for each question

9-item 4-week food security access scale

101	In the past four weeks, did you or any household member worry that there would not be enough food?	Yes	1
		No >>Q102	2
101a.	How often did this happen?	Rarely (once or twice a week)	1
		Sometimes (3-10 times a week)	2
		Often (more than 10 times a week)	3
102	In the past four weeks, did you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	Yes	1
		No >>Q103	2
102a.	How often did this happen?	Rarely (once or twice a week)	1
		Sometimes (3-10 times a week)	2
		Often (more than 10 times a week)	3
103	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	Yes	1
		No >>Q104	2
103a.	How often did this happen?	Rarely (once or twice a week)	1
		Sometimes (3-10 times a week)	2
		Often (more than 10 times a week)	3
104	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	Yes	1
		No >>Q105	2
104a.	How often did this happen?	Rarely (once or twice a week)	1
		Sometimes (3-10 times a week)	2
		Often (more than 10 times a week)	3
105	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	Yes	1
		No >>Q106	2
105a.	How often did this happen?	Rarely (once or twice a week)	1
		Sometimes (3-10 times a week)	2
		Often (more than 10 times a week)	3
106		Yes	1

	In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?	No >>Q107	2
106a.	How often did this happen?	Rarely (once or twice a week)	1
		Sometimes (3-10 times a week)	2
		Often (more than 10 times a week)	3
107	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	Yes	1
		No >>Q108	2
107a.	How often did this happen?	Rarely (once or twice a week)	1
		Sometimes (3-10 times a week)	2
		Often (more than 10 times a week)	3
108	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	Yes	1
		No >>Q109	2
108a.	How often did this happen?	Rarely (once or twice a week)	1
		Sometimes (3-10 times a week)	2
		Often (more than 10 times a week)	3
109	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	Yes	1
		No	2
109a.	How often did this happen?	Rarely (once or twice a week)	1
		Sometimes (3-10 times a week)	2
		Often (more than 10 times a week)	3
SCALE SCORE (DRY/HUNGRY SEASON): This household's Food Security Status is: (1) Food Secure; (2) Mildly Food Insecure; (3) Moderately Food Insecure; (4) Severely Food Insecure.			

SECTION 4

4.1 CLIMATE CHANGE KNOWLEDGE, PERCEPTIONS AND IMPACTS

Knowledge

110	Do you know if the climate is changing?	Yes	1
		No >>Q114	2
		Don't Know >>Q114	98
111	How did you initially know that the climate is changing	Radio	1
		Television	2
		Extension officers	3
		Farmers' groups	4
		Newspaper	5
		Other villagers	6
		Don't Know	98
		Other (specify)	97
112	What local term is used to describe climate change in your community? ENTER TERM AS MENTIONED		
113	What do you think are the causes of the observed changes in the climate? RECORD ALL MENTIONED	Burning of fossil fuel e.g. coal, petrol etc	1
		Deforestation	2
		Desacration of sacred trees, forests, rivers, days of the weeks etc	3
		Violation of traditional norms	4
		Other (specify)	97

Perception of Climate Change

114	Which of these changes/indicators in the climate have you observed in the past 5 to 10 years? CHECK ALL THAT APPLY	Increased temperatures/ very hot summers (heat waves)	1
		Prolonged and colder winters	2
		Drought incidences	3
		Delays in the onset of rain seasons	4
		Early arrival of rains	5
		Early cessation of rain	6
		Late cessation of rain	7
		Reduced rainfall	8
		Increased rainfall	9
		Changes in the months rains start	10
		Changes in the months rains end	11
		Floods	12
		Floods and droughts in the same season	13
		Unpredictable wind movements resulting in cyclones and storms	14
		More diseases and pests	15
		Other (specify)	97
115	Have you observed any key local signs that indicate that the climate is changing?	Yes	1
		No >>Q117	2
		Don't Know >>Q117	98
116	What are they? CHECK ALL THAT APPLY	Disappearance of indigenous fruits	1
		Presence or absence of some insects	2
		Disease and pest incidences/outbreaks	3
		Drying up of rivers, streams and wetlands	4
		Disappearance of wild animals	5
		Disappearance of some herbs and wild vegetables	6
		Other (specify)	97

Climate Change Impacts

117	To what extent have changes in climate conditions affected you?	Very high	1
		High	2
		No effect	3
		Low	4
		Very low	5
118	How have change changes in climate impacted your farming activities? CHECK ALL THAT APPLY	Reduced crop yield	1
		Deaths of livestock	2
		Loss of seed due to delayed rains	3
		Pest and disease outbreaks	4
		Reduced household income	5
		Loss of plants due to heavy rains or extreme heat	6
		Inability ot buy farm inputs	7
		Reduced ability to provide daily meals	8
		Increased post-harvest losses	9
		Poor germination of seeds	10
		Other (specify)	97
119	What are the impacts of the changing climate on your other livelihood activities? CHECK ALL THAT APPLY	Loss of income	1
		Reduced work	2
		Loss of work/jobs	3
			4
			5
		Other (specify)	97

Specific Adaptation Arrangements to Observed Climate Change Threats

Please indicate how you have adapted to the following climatic incidences:

120	Rainfall variability (delayed rains, early cessation of rains, increased & reduced rainfall) CHECK ALL THAT APPLY	Plant as soon as rains start	1
		Plant fewer crops	2
		Plant legumes	3
		Plant hybrid crops (list):	4
		Exchanged labour for food, cash, or clothing (Maricho)	6
		Stored up more food in granary	7
		Received food aid	8
		Prayed to God or ancestors	9
		Shifted planting dates	10
		Diversified to off-farm activites	11
		Livestock rearing	12
		Fertiliser application	13
		Gardening	14
		Migration	15
		Did not adapt (did nothing)	16
		Pestcide and weedicide application	17
		Other (specify)	97
121	Drought incidences CHECK ALL THAT APPLY	Plant as soon as rains start	1
		Plant fewer crops	2
		Plant legumes	3
		Plant drought resistant crops (list):	4
		Exchanged labour for food, cash or clothing (maricho)	5
		Stored more food in the granary	6
		Prayed to God or ancestors	7
		Shifted planting dates	8
		Diversified to off-farm activities	9
		Received food aid	10
		Fertiliser application	11
		Livestock rearing	12
		Gardening	13
		Migration	14
		Did not adapt (did nothing)	15
		Pesticide and weedicide application	16
		Other (Specify)	97
122	Floods CHECK ALL THAT APPLY	Relocate house	1
		Relocate farm	2
		Construct drains	3
		Reinforce the house	4
		Planted crops that require more water (list)	5
		Prayed to God	6
		Diverted water	7
		Moved house to higher ground	8
		Fertiliser application	9
		Livestock rearing	10

		Gardening	11
		Migration	12
		Did not adapt (did nothing)	13
		Pesticide and weedicide application	14
		Other (Specify)	97
123	Increased or decreased temperatures CHECK ALL THAT APPLY	Plant as soon as rains start	1
		Plant fewer crops	2
		Plant legumes	3
		Plant drought resistant crops (list):	4
		Exchanged labour for food, cash or clothing (maricho)	5
		Stored more food in the granary	6
		Prayed to God or ancestors	7
		Shifted planting dates	8
		Diversified to off-farm activities	9
		Received food aid	10
		Fertiliser application	11
		Livestock rearing	12
		Migration	13
		Did not adapt (did nothing)	14
		Gardening	15
		Pesticide and weedicide application	16
		Other (Specify)	97
124	Did you stop growing any crops?	Yes	1
		No >>Q126	2
125	Why did you stop growing these crops	Crops were not growing well due to too much rain, little rain or high temperatures	1
		Crop yield was poor	2
		Crop was prone to pests and diseases	3
		Crop was labour intensive	4
		Other (specify)	97

4.2 ON-GOING CLIMATE CHANGE ADAPTATION STRATEGIES

126	In the last few planting seasons, have you ever done intercropping? (grow different crops in spaces between other crops)	Yes	1
		No >>Q128	2
		Don't know >>Q128	98
127	Which crops did you intercrop?	Maize	1
		Groundnuts (nzungu)	2
		Cowpeas	3
		Soy beans	4
		Bambara beans (nyimo)	5
		Millet	6
		Rapoko	7
		Sunflower	8
		Rice	9
		Sweet potato	10
		Cotton	11
		Pumpkins	12
		Mapudzi	13
		Okra	14
		Sugar beans	15
		Vegetables (leafy greens i.e. covo, rape, tsunga, spinach; tomatoes; onion etc)	16

		Other (specify)	97
128	In the last few planting seasons, have you ever rotated your crops?	Yes	1
		No >>Q130	2
		Don't know >>Q130	98
129	Which crops did you rotate?	Maize	1
		Groundnuts (nzungu)	2
		Cowpeas	3
		Soy beans	4
		Bambara beans (nyimo)	5
		Millet	6
		Rapoko	7
		Sunflower	8
		Rice	9
		Sweet potato	10
		Cotton	11
		Pumpkins	12
		Mapudzi	13
		Okra	14
		Sugar beans	15
		Vegetables (leafy greens i.e. covo, rape, tsunga, spinach; tomatoes; onion etc)	16
		Other (specify)	97
130	In the last few planting seasons have you ever staggered planting dates of your crops? (Planting the same crop at different times in the growing season)	Yes	1
		No >>Q132	2
131	Which crops did you stagger? CHECK ALL THAT APPLY	Maize	1
		Groundnuts (nzungu)	2
		Cowpeas	3
		Soy beans	4
		Bambara beans (nyimo)	5
		Millet	6
		Rapoko	7
		Sunflower	8
		Rice	9
		Sweet potato	10
		Cotton	11
		Pumpkins	12
		Mapudzi	13
		Okra	14
		Sugar beans	15
		Vegetables (leafy greens i.e. covo, rape, tsunga, spinach; tomatoes; onion etc)	16
		Other (specify)	97
132	In the last few planting seasons, have you grown short seasoned plant varieties?	Yes	1
		No >>Q134	2
133	Which varieties did you grow? CHECK ALL THAT APPLY	Maize	1
		Groundnuts (nzungu)	2
		Cowpeas	3
		Soy beans	4
		Bambara beans (nyimo)	5
		Millet	6
		Rapoko	7
		Sunflower	8
		Rice	9
		Cotton	10
		Sugar beans	11

		Mapudzi	12
		Pumpkins	13
		Okra	14
		Vegetables (leafty greens i.e. covo, tsunga, rape, spinach; tomatoes; onion etc)	15
		Sweet potato	16
		Other (specify)	97
134	Have you ever used indigenous practices to aid crop production	Yes	1
		No >>Q136	2
135	Which of the practices have you employed? CHECK ALL THAT APPLY	Mulching	1
		Growing of traditional grains (millet, sorghum etc)	2
		Crop rotation	3
		Intercropping	4
		Agro-forestry	5
		Manure application	6
		Other (Specify)	97
136	Have you ever built a water harvesting facility?	Yes	1
		No	2
		Don't know	98
137	Have you ever implemented soil conservation techniques?	Yes	1
		No >>Q139	2
		Don't know >>Q139	98
138	What soil conservation techniques did you do? To improve soil fertility (CHECK ALL THAT APPLY)	Crop residue incorporation	1
		Manure Application	2
		Agro-forestry	3
		Contour ploughing	4
		Zero tillage (No till farming)	5
		Crop rotation	6
		Conservation agriculture (pfumvudza)	7
		Mulching	8
		Other (Specify)	97
		Don't know	98
139	Have you ever planted trees?	Yes	1
		No >>Q141	2
		Don't know >>Q141	98
140	What types of trees did you plant? CHECK ALL THAT APPLY	Fruit trees	1
		Indigenous trees	2
		Exotic tress	3
		Other (Specify)	97
		Don't know	98
141	Have you ever irrigated your crops?	Yes	1
		No >>Q144	2
142	Which crops did you irrigate (List which crops)	Maize	1
		Groundnuts (nzungu)	2
		Cowpeas	3
		Soy beans	4
		Bambara beans (nyimo)	5
		Millet	6
		Rapoko	7
		Sunflower	8
		Rice	9
		Cotton	10
		Sugar beans	11
		Mapudzi	12

		Pumpkins	13
		Sweet potato	14
		Okra	
		Vegetables (leafy greens i.e. covo, rape, tsunga, spinach; tomatoes; onion etc)	15
		Other (specify)	97
143	How did you irrigate your crops?	Canals	1
		Bucket/Watering can	2
		Other (Specify)	97
		Don't know	98
		No	2
144	Overall, how effective has the strategies you implemented been?	Very effective	1
		Effective	2
		Not effective	3
		Don't know	
145	Has your crop yield improved as a result?	Yes	1
		No	2
146	Which livestock specific adaptation have you employed? CHECK ALL THAT APPLY	Seasonal herd migration	1
		Rearing of drought resistant ruminants	2
		Rearing a variety of domestic animals	3
		Rearing more birds	4
		None	5
		Other (specify)	97
147	What are the constraints/difficulties you face in crop farming? CHECK ALL THAT APPLY	Crop failure	1
		Frequent droughts	2
		Prolonged mid-season dry spells	3
		Lack of access to farm implements e.g seeds, fertilisers etc	4
		Poor soil fertility	5
		Increased climate variability	6
		Lack of markets	7
		Low prices for output	8
		Lack of extension services	9
		Pests and diseases	10
		Limited access to draught power	11
		Lack of access to credit	12
		Limited land to farm	13
		Taboos	14
		Tenure insecurity	15
		Lack of agricultural information	16
		Other (specify)	97
148	What are the constraints/difficulties you face in livestock farming? CHECK ALL THAT APPLY	Declining grazing lands	1
		Low availability of fodder	2
		Deaths	3
		Pests and disease attacks	4
		Lack of improved breeds	5
		Lack of ready market	6
		Lack of extension services	7
		Limited water availability	8
		Lack of drugs and medicines	9
		Taboos	10
		Other (specify)	97
149		Cheap cost of implementation	1

	What criteria do you use in selecting any of the implemented adaptation strategies? CHECK ALL THAT APPLY	Only available strategy	2
		Good/better results	3
		Simple and easy implementation	4
		Availability of assets e.g land, money, labour, water etc	5
		No Criteria	6
		Other (specify	97

150. Who has the most access to the following resources in your community? (men or women)

Resource	Men	Women
	Yes = 1	Yes = 1
	No = 2	No = 2
Family land		
Community land		
Extension services		
Agricultural information		
Farm inputs		

4.2.1 ON-GOING OFF-FARM ADAPTATION ARRANGEMENTS (LIVELIHOOD DIVERSIFICATION)

151. What off-farm adaptation strategy have you employed to cushion your household from the impacts of climate change on farming? CHECK ALL THAT APPLY

OFF-FARM STRATEGY	Yes=1	No=2
Migration		
Trading in food, clothes and household equipment, firewood etc		
Use of non-timber forest products (foraging for wild vegetables, mushrooms, fruits, nuts, spices)		
Carpentry		
Commercial transport provision		
Equipment hiring (scotchcart, cattle, plough)		
Cowboy services		
Domestic work		
Masonry (thatching houses, building)		
Beer brewing		
Fuel selling (gas, paraffin, firewood)		
Traditional healing		
Prophetic consultations		
Hairdressing		
Pit latrine and well digging		
Other (Specify)		

4.3: CLIMATE CHANGE INSTITUTIONAL CONTEXT OVER THE PAST 3 CROPPING SEASONS/YEARS

Extension Services

152	Do you have access to extension services?	Yes	1
		No >>Q155	2
153	How often do you get services?	Every month	1
		Every 3	2
		Every 6 months	3
		Once a year	4
		Other	97
154	What kind of extension services do you get?	Crop, livestock management	1
		Improved crop varieties	2
		Water management	3
		Weed, pest and disease control	4

		Farmers groups	5
		Weather/ climate information	6
		Access to government interventions (seeds, fertiliser, animals etc)	7
		Other (specify)	97
155	Is it easy for you to get access to extension officers and services?	Yes	1
		No	2
OTHER INSTITUTIONAL SUPPORT			
156	Have you ever obtained support from any these entities? RECORD ALL MENTIONED	Government	1
		NGOs	2
		Individuals (Philanthropists)	3
		Faith-based organisations	4
		Politicians	5
		None >>Q158	6
		Other (specify)	97
157	What kind of support did you receive? RECORD ALL MENTIONED	Credit for agriculture	1
		Farm inputs (draught power etc)	2
		Farm output markets	3
		Free food	4
		Household supplies	5
		Healthcare services	6
		Subsidised fertiliser	7
		Subsidised seeds	8
		Extension services	9
		None	10
		Other (specify)	97
158	Why did you not receive support from any of the institutions? RECORD ALL MENTIONED	Because of my political affiliation	1
		Because of my gender	2
		Because of my age	3
		Because of my marital status	4
		Because of my improved financial status	5
		Other (specify)	97
159	Would you say you are SATISFIED, SOMEWHAT SATISFIED or NOT SATISFIED AT ALL about the government's response to climate change?	Satisfied	1
		Somewhat satisfied	2
		Not satisfied	3
		Don't know	98

≈END OF QUESTIONNAIRE≈

C: In-depth Interview Guide

Introduction

This interview guide is for farmers from selected smallholder households who will be selected to participate in an in-depth interview. The aim of the in-depth interview is find out knowledge, perceptions and impacts of climate change, identify livelihood activities, adaptation strategies and constraints as well as institutional support for smallholder households in the Goromonzi district.

Time Required: 90mins

A. Demographic Characteristics

1. Age, sex, marital status of household head
2. Age and sex of household members
3. Educational background of household members
4. Current employment status of household members

B. Knowledge and Perceptions of Climate Change in Smallholder Households

1. Changes noticed/observed in the climate
   (Probe for when changes were observed initially)
2. How climate change is defined in local language.
3. Major climatic events observed over a period of time in your area and their negative outcomes (extreme events) on your major livelihood activity (farming-both crop and livestock production)
   (Probe for these indicators- increased and decreased temepratures; rainfall variability; droughts; floods etc)
4. Key local signs (indegenous knowledge practices) that indicate the climate is changing.

C. Impacts of Climate Change on Livelihood Activities

1. Livelihood activities the household engages
   (probe for the major livelihood activity e. g. crop farming; livestock farming; mixed farming-both crops and livestock)
2. Crops grown and livestock reared
3. Other livelihood activities
   (probe for for off-farm activities e.g. gold panning; trading; individual businesses- beer brewing, hairdressing; formal employment)
4. Impacts of climate change on farming- for both crops and livestock
   (probe for yield, income, food availability, loss of seeds, post harvest losses etc)

D. Climate Change Adaptation and Outcomes

1. Main on-farm adaptation arrangements implemented by the household
   (probe for specific adaptation in relation to rainfall variability, floods, droughts, increased and decreased temperatures etc).
2. Off-farm adaptation strategies employed by the household (Livelihood diversification)
   (Probe for other activities such as gold panning, beer brewing, traditional and prophetic healing and consultations, trade, formal and informal employment, migration etc).
3. Criteria used in selecting a strategy/technology

(Probe for easy implementation; availability of assets to pursue a strategy, better outcomes from strategy)

4. Effectiveness of the implemented adaptation strategies for both on-farm and off-farm adaptation
   (Probe for indicators showing how household livelihoods have worsened and those showing how household livelihoods have improved e.g food availability, improved income, general wellbeing of household members, increased or decreased assets)
5. Existing cultural systems within the household and village and how they constrain or promote agricultural adaptation and livestock management
   (Probe for cultural arrangements regarding inheritance patterns, land access and ownership; taboos for women and for men etc) Discuss their implications for adaptation outcomes e.g. food security, general wellbeing, improved income trade-offs i.e. increase or decrease in assets)
6. Land access by women in household and village
   (Probe for Marriage, kinship, purchase, inheritance etc)
7. Gender specific recommendations to improve adaptation to climate change effects in the community
8. Resource ownership in the household/village
   (Probe for men and women separately)

E. Institutional Arrangements and Support

1. Support or services related to farming and adaptation from any institution or organisation; local or external (e,g government, NGO, politician, church etc)
2. Institutions or organisations from where support came
   (probe for names)
3. Types of services received household
   (probe for farm inputs-seeds, fertiliser; farming or climate change education education, subsidies; animal vaccines or drugs; food aid; credit etc)
4. Qualification to receive services/what is difficult or easy for you to qualify?
   (Probe further is participant states difficulty qualification)
5. Networks i.e. groups, cooperatives, associations household or household members belong to/ Benefits derived from membership into these groups/ associations/ cooperatives etc.
   (Probe for farm implements, credit, access to markets, extension services, climate information etc)
6. Recommendations to institutions/organisations offering support to households in your village
   (Probe for fairness; transparency etc)

≈END OF IN-DEPTH INTERVIEW GUIDE≈

D: Key Informant Interview Guide

Identified Key Officials: Village Heads; Agricultural and Technical Extension (AGRITEX) Officers; Environmental Management Agency (EMA); Farmers Union Representatives

Guidelines

- Brief explanation of the institution, including mandate on the smallholder sector in relation to climate change adaptation
- Observed impacts of climate change on smallholder households in the district-impacts on crop farming and livestock (are impacts the same for male and female farmers)
- Smallholder households' adaptation to climate change (probe for constraints to adaptation for male and female farmers)
- Cultural systems, inheritance, taboos, land tenureship and adaptation (probe for opportunities and limitations for female and male smallholder farmers)
- How is land accessed in the district, in particular in communal areas (Marriage, kinship, purchase etc)/is it the same for men and women?
- Is there anything that can be done to improve adaptation by smallholder farming households, especially gender-specific strategies in the District?
- Effectiveness of governmental policies in aiding climate change adaptation in the smallholder sector i.e. inclusivity of policies in terms of gender, age and ability
- Specific interventions implemented or facilitated by institution/organisation/ who are the targets/how are they recruited (inclusion and exclusion criteria)/ Are men and wome smallholder farmers given equal opportunities?
- Identification of target villages and households/Were both male headed and female heade households equally targeted?
- Outcomes of interventions/programmes- (probe for success stories and failures for male anf female smallholder farmers; discuss improved income; food availability; increased or decreased assets; improved household wellbeing; trade-offs)/indicators showing the successes and or failures
- Who facilitates implementation of interventions or programmes? (village heads etc)
- Challenges in rolling out programmes/interventions
- Recommendation/way forward for institutions/organisations offering support to smallholder farmers

Village Heads

- Functions as a village headmen
- Land tenure, allocation and use/how is land allocated to men vs females in the village
- Implementation of interventions and programmes in the village/do men and women get equal opportunities to qualify for programmes and interventions
- Brokering/facilitation of programmes/interventions implementation i.e. target identification, recruitment, verification of qualification into programmes/ do male heade and female headed households in your village get equal chances
- Successes and failures/do they differ for male and female smallholder households
- Challenges in programme/intervention implemetation

- Recommendations for institutions/governments offering support to smallholder households

≈END OF KEY INFORMANT INTERVIEW GUIDE≈

APPENDIX 6

Photo Gallery

Enumerator Training

First day of fieldwork

Interview with a female farmer

Interview with a male farmer

Interview with another female farmer

Interview with village headman

Interview with Farmer's Union representative

Farming household compound with maize and sweet potato farm

Farming household surrounded by maize farm

Pearl millet intercropped with maize and pumpkins