# Assessing the impact of El Nino-induced drought on farmers' livelihoods in Binga district: resilience, adaptation, and coping strategies

**A dissertation submitted in partial fulfilment of the requirements for the Master of Science Degree in Food Security and Sustainable Agriculture**
**(Policy)**


**Bindura University of Science Education**

**Faculty of Agriculture and Environmental Science**
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# APPROVAL FORM

The undersigned certify that they have supervised and recommended to the Bindura University of Science Education for the acceptance of the dissertation titled '**Assessing the Impact of El Nino-Induced Drought on Farmers' Livelihoods in Binga District: Resilience, Adaptation, and Coping Strategies'** submitted in partial fulfillment of a Master of Science Degree in Food Security and Sustainable Agriculture.

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## DECLARATION

I hereby declare that the research project entitled "**Assessing the Impact of El Nino-Induced Drought on Farmers' Livelihoods in Binga District: Resilience, Adaptation, and Coping Strategies**" submitted to Bindura University of Science Education, Department of Agricultural Economics, Education and Extension is a record of original work done by me under the supervision of Dr A.C Mujeyi and this work is submitted in partial fulfilment of the requirements for the award of a Master of Science Degree in Food Security and Sustainable Agriculture. The results embodied in this thesis have not been submitted to any University or Institute for the award of any degree or diploma.

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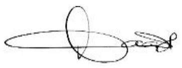
**Signature:** 

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## DECLARATION

The undersigned certify that they have read the research project and have approved its submission for marking in relation to the department's guidelines and regulations.

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# DEDICATION

I dedicated this work to my family and colleagues

## ACKNOWLEDGEMENTS

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## ABSTRACT

*This study evaluated how the drought brought on by El Niño affected farmers' livelihoods in Zimbabwe's Binga district during the 2023–2024 period. In order to improve farmers' adaptability and food security, the study sought to assess the sustainability and efficacy of their coping mechanisms, resilience, and adaptation. A mixed-methods strategy was used to accomplish this goal, integrating key informant interviews, focus groups, and household surveys. A thorough grasp of how El Niño-induced drought affects farmers' livelihoods was obtained by gathering data from 252 homes. The results show that the two significant impacts of El Niño-induced drought on farmers' livelihoods are reduced crop yields and animal deaths. Farmers use a various coping and adaptation strategies, such as crop and revenue diversification, planting and harvesting schedules, forecasting, and the use of farming technology. To investigate the factors impacting the selection of resilient adaptation tactics, a Multivariate Probit model (MVP) was used. The findings indicate that the choice of adaptation options is significantly influenced by agricultural training, farm size, education, availability to financing, livestock management, and information.*

*In order to improve and expand farmers' resilience and adaptive ability in the face of climate-related shocks, researchers, policymakers, and practitioners should take note of the study's significant implications. In order to help farmers implement climate-resilient adaptation measures, the study highlights the need for focused interventions. Furthermore, in order to improve farmers' resilience and ability for adaptation, the research emphasizes the need of giving them access to markets, loans, and knowledge. All things considered, this research advances knowledge of how El Nino-induced drought affects farmers' livelihoods and the effectiveness and sustainability of their coping, adaptation, and resilience strategies.*

.

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## KEYWORDS

El Niño-induced drought; Farmers' livelihoods; Resilience; Adaptation; Coping strategies Climate change; Climate Information Services

## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AGRITEX | Agricultural Technical and Extension Services Department |
| AGW | Anthropogenic Global Warming |
| CCA | Climate Change Adaptation |
| CFA | Cloud Formation and Albedo |
| CLRM | Classical Linear Regression Model |
| CPU | Civil Protection Unit |
| CPU | Civil Protection Unit |
| DFID | Department for International Development |
| EPA | Environmental Protection Agency |
| FAO | Food and Agriculture Organisation |
| FGDs | Focus Group Discussions |
| GDP | Gross Domestic Product |
| GEF | Global Environment Facility |
| HH | Household Head |
| IIA | Independence of Irrelevant Alternative |
| IKS | Indigenous Knowledge Systems |
| INGOs | International Non-Governmental Organisations |
| IPCC | Intergovernmental Panel on Climate Change |
| ISO | Intra-seasonal Oscillation |
| KIIs | Key Informant Interviews |
| MLE | Maximum Likelihood Estimators |
| MNL | Multinomial Logit |
| MoECTH | Ministry of Environment, Climate, Tourism and Hospitality |
| MoLAWRD | Ministry of Land, Agriculture, Fisheries Water and Rural Development |
| MSD | Meteorological Services Department |

| | |
|---|---|
| MVP | Multivariate Probit |
| NASA | National Aeronautics and Space Administration |
| NGOs | Non-Governmental Organisations |
| OLS | Ordinary Least Squares |
| SDGs | Sustainable Development Goals |
| SLF | Sustainable Livelihoods Framework |
| SPSS | Statistical Package for Social Sciences |
| SST | Sea Surface Temperature |
| UN | United Nations |
| UNDP | United Nations Development Programme |
| WBG | The World Bank Group |
| ZimStat | Zimbabwe National Statistical Agency |
| ZimVAC | Zimbabwe Vulnerability Assessment Committee |
| ZimLAC | Zimbabwe Livelihood Assessment Committee |
| ZNCCRS | Zimbabwe's National Climate Change Response Strategy |

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# CHAPTER ONE
# INTRODUCTION

## 1.0 Introduction

The periodic changes in ocean temperatures in the equatorial Pacific caused by the El Niño-Southern Oscillation (ENSO) phenomena have a significant influence on weather occurrences all around the globe, including global climate patterns (Alizadeh, 2022; Cane, 2005). The resulting changes in local agro-climate factors, including temperature and particularly in sensitive and susceptible areas like Southern Africa, precipitation patterns have a significant impact on food security and agricultural productivity (Herring et al., 2018; Nhamo et al., 2019). Unusual high ocean temperatures linked to El Niño occurrences often result in less rainfall and longer dry spells in this area, making the problems encountered by rural populations and the agricultural industry even more severe (Mason et al., 2016; Udmale et al., 2019). Southern Africa's Zimbabwe is especially vulnerable to El Niño's negative consequences; previous occurrences have had catastrophic repercussions on food security, agricultural production, and rural livelihoods (Nhamo et al., 2019; Mupangwa et al., 2017). For example, the 2015–2016 El Niño episode caused extreme drought conditions that resulted in major crop failures, animal mortality, and financial losses for rural communities (Herring et al., 2018). The effects of El Nino-induced drought on Zimbabwean farmers' livelihoods must be investigated because of the nation's reliance on rain-fed agriculture and the vulnerability of its rural inhabitants to climate-related shocks.

**El'Nino Mechanisms and its Influence on Rainfall patterns in Zimbabwe.**

Weather patterns in Zimbabwe are greatly influenced by the El Niño-Southern Oscillation (ENSO), according to Baudoin et al. (2017). Variations in sea surface temperatures (SSTs) and air pressure over the tropical Pacific Ocean are hallmarks of the ENSO meteorological phenomena (Fiedler, 2006). There are two main ENSO phases: El Niño and La Nina. In an El Niño phase, the eastern and central equatorial Pacific experience warmer-than-normal SSTs (Alizadeh, 2022). In contrast, the La Nina phase is characterized by cooler-than-normal SSTs in the same region (Trenberth, 1997). Figure 1 shows anomalies in the Nino 3.4 area from 1982 to 2023 to show the recurrent pattern of ENSO states and to emphasize the frequency of El Niño episodes (Climate Prediction Centre, 2023). This figure illustrates how El Niño episodes have occurred sporadically since 1950, occurring every two to six years (Wang et al., 2012). The top five El Niño episodes during the last 40 years are shown in Figure 1 (NOAA, 2023).

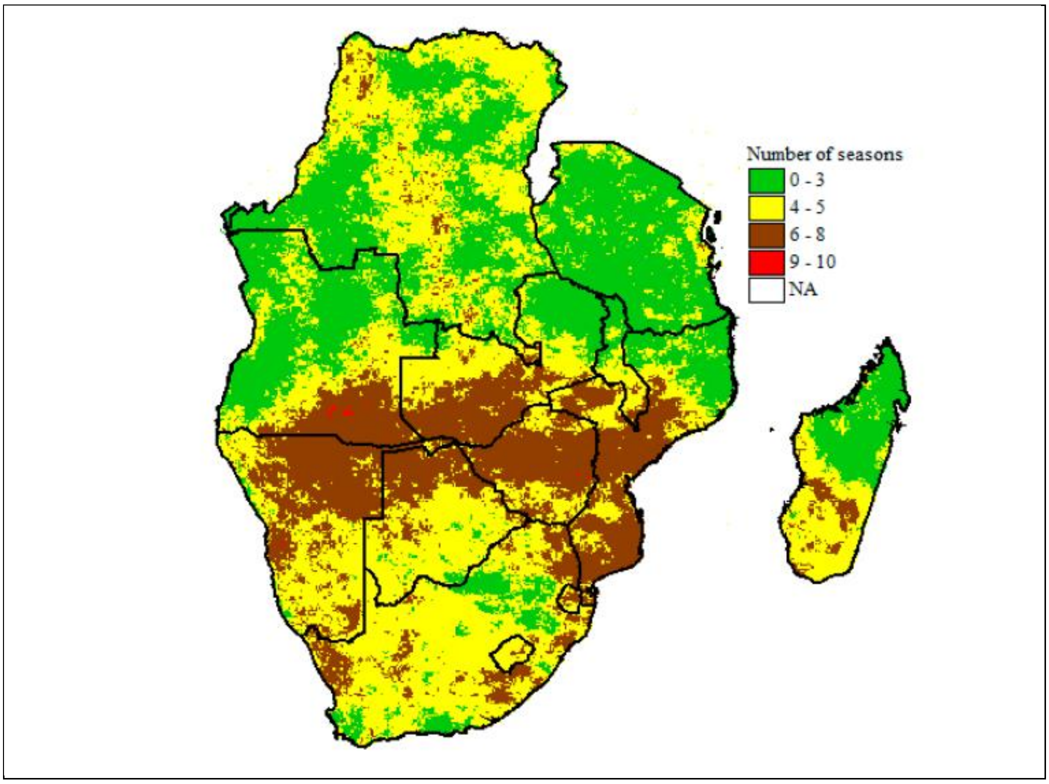



*Figure 1.1: Number of El Niño DJFM Season*
***Source:*** *World Bank Data*

According to Samu and Kentel (2018), Zimbabwe had severe and widespread agricultural droughts throughout three of these five El Niño seasons—1982/83, 1991/92, and 2015/16—and a drought in the country's southern and eastern regions during the fourth, 2009/10. Because of a typical regional climate, Zimbabwe did not endure the widespread dry conditions customary with El Niño periods during the fifth season (Reason and Jagadheesha, 2005).The sixth event of El'Nino was experienced again in the season 2023/24 which affected mostly southern African countries (World Meteorological Organisation, 2023; IPCC, 2021).

### 1.1 Background of the study

Zimbabwe like the rest of the Southern African region, has been experiencing strong El Nino weather conditions since 2023 bringing severe drought by disrupting rainfall patterns. These effects intensified later that year and are expected to continue into early 2025 (Guthiga et al, 2024). The disaster affected the 2023/24 agriculture season in Zimbabwe, Malawi, and Zambia leading to below-average rainfall (SADC, 2023; FEWS NET, 2024). Food insecurity resulted from the drought caused by El Nino, which impacted the 2023–2024 cropping season, requiring food aid for about 5 million people (WFP, 2023; FAO, 2023). Zimbabwe's Binga District is situated in the semi-arid Matabeleland North Province, which is marked by infrequent droughts and little rainfall (Brown et al., 2015). The majority of the district is rural, and the local economy is based mostly on agriculture (ZIMSTAT, 2020). According to Mavhura et al. (2017) and Chivenge et al. (2019), Binga's smallholder farmers are mostly dependent on rain-fed agriculture, which leaves them susceptible to climate-related shocks, especially droughts and El Nino occurrences, which worsen food insecurity. Droughts have far-reaching consequences for farmers' livelihoods, including reduced crop yields, livestock deaths, and decreased household food security (Mashingaidze et al., 2020). Limited access to loans, irrigation, and other support services often makes the effects of droughts worse (Mutyasira et al., 2018). In order to lessen the consequences of droughts, smallholder farmers in Binga District, like many others in Africa, have created a variety of coping mechanisms, adaptation techniques, and resilience (Mavhura, 2017). It is unclear, therefore, how effectively these tactics work to improve farmers' lives (Gukurume et al., 2020). According to the Ministry of Lands, Agriculture, and Rural Resettlement's 2024 maize output prediction, production levels would be much lower than those of 2023 cropping season.

**1.2 Overview of Livelihoods in Binga District**

By analysing how the drought brought on by El Niño has affected farmers' livelihoods in Binga District and measuring how well their coping, adaptation, and resilience have worked, this research seeks to close this information gap. In addition to identifying methods for improving smallholder farmers' drought resilience, the research will provide light on the difficulties they encounter in the area. The results will help create evidence-based policies and interventions to help farmers become more resilient to shocks associated to climate change (Adger et al., 2005; IPCC, 2014). The bulk of the agricultural population in Binga district is made up of smallholder farmers, who are especially at risk from climate change because they have less access to resources, information, and funding (Below et al., 2012). These farmers, according to Morton (2007), are particularly vulnerable to climate risks in areas with little potential for adaptation (Antwi-Agyei et al., 2013). It has been discovered that the growing unpredictability of weather conditions in Binga causes significant livelihood stress for smallholder farmers (Chivenge et al., 2019). Insufficient access to markets, financing, and insurance programs that might assist reduce climate risks exacerbates smallholder farmers' economic vulnerability, according to Mubaya et al. (2014) (Deressa et al., 2009; Hassan & Nhemachena, 2008). As a result, rural families' food security is threatened by declining agricultural revenues (FAO, 2017; World Bank, 2018).

**1.3 Problem Statement.**

Despite the government of Zimbabwe's efforts to promote sustainable agricultural production and reduce food insecurity through various development programs, Binga district in Matabeleland North Province remains severely affected by El Nino-induced drought, with 62% of households experiencing food insecurity. In Binga district, smallholder farmers use adaptation measures to reduce the effects of El Nino-induced drought, but little is known about their long-term sustainability and effectiveness. Furthermore, it is unclear how agricultural extension services help smallholder farmers in the area develop resilient livelihoods and support adaptation plans. To address food insecurity and poverty, this information gap hinders efforts to design and implement a focused interventions that might improve smallholder farmers' resilience and ability for adaptation.

## 1.4 Research Gap

The resilient lifestyles and adaptation techniques used by farmers in the Binga region to lessen the effects of El Nino-induced drought are still little understood. For these solutions to be investigated, evaluated, and their sustainability in guaranteeing food security to be ascertained, empirical data is required. This study fills this information gap by investigating the adaptation and resilience tactics used by smallholder farmers in the Binga district and analyzing how they affect livelihood outcomes. In the end, this research helps develop evidence-based solutions for improving food security and resilience.

## 1.5 Objectives of the study

### 1.5.1 Main Objective

To assess the impact of El Niño-induced drought on farmers' livelihoods in Binga District, and evaluate the sustainability and effectiveness of their resilience, adaptation, and coping strategies to enhance their adaptability and food security during the 2023-2024 period

### 1.5.2 Specific Objectives

a) To assess the impact of El Niño-induced drought on farmers' livelihoods, including crop yields, livestock productivity, and household income in Binga District
b) To identify resilience and adaptation strategies employed by farmers in Binga district in response to El Nino-induced drought including determinants for such.
c) To investigate the coping strategies employed by farm households in Binga District to reduce the effects of El'Nino-induced drought, including the importance of social networks, credit facilities, and government support programs.
d) To investigate the constraints on the adoption of climate-resilient adaptations strategies and identify policy and practical recommendations that can enhance resilience and adaptive capacity in Binga.

### 1.6 Research Questions

1. What are the impacts of El Niño-induced drought on farmers' livelihoods, including crop yields, livestock productivity, and household income in Binga District?
2. In response to drought caused by El Nino, what adaptation and resilience strategies, are used by farmers in the district including the determinants for such?
3. What coping strategies are used by farmers in Binga District to mitigate the effects of El'Nino-induced drought?
4. What are the constraints on the adoption of climate-resilient adaptation strategies among farmers in Binga, and what policies and practical recommendations can enhance resilience and adaptive capacity?

### 1.7 Research Hypothesis

The research study will use the following hypothesis to unpack the effects of El'Nino droughts in Binga District

$H_0$: El Niño-induced drought significantly reduces crop yields and livestock productivity in Binga District.

$H_1$: Other factors (economic, political, and social) are responsible for the reduction in crop yields and livestock production.

### 1.8 Significance of the study

Because it will advance knowledge of how smallholder farmers in drought-prone regions adjust to shocks brought on by climate change, the research "Assessing the Impact of El Nino-Induced Drought on Farmers' Livelihoods in Binga District: Resilience, Adaptation, and Coping Strategies" is relevant. This information is crucial for efforts to adapt to climate change and increase resilience. In the rural Binga District in northwest Zimbabwe, where most people rely on agriculture as their main source of income, this research focuses. Because the area relies so significantly on rain-fed agriculture, it is especially vulnerable to climatic unpredictability and drought. In order to improve resilience, adaptability, and coping mechanisms among rural families in the face of climate-related shocks, this research project is to examine the effects of El Nino-induced drought on farmers' livelihoods in Binga District. In order to improve and build farmers' resilience and adaptive ability in the face of climate-related shocks in Zimbabwe and elsewhere, the study's results will be helpful to practitioners, policymakers, and academics. Furthermore, the study will provide recommendations for enhancing food security and reducing poverty in Binga district, which is essential for improving the well-being of farming households.

Also, the study's conclusions will influence Zimbabwe's agricultural programming and policy, especially with regard to social protection initiatives, agricultural extension services, and climate change adaptation. All things considered, this research advances knowledge of how El Nino-induced drought affects farmers' livelihoods and the stability and efficacy of their coping, adaptation, and resilience techniques.

### 1.9 Delimitations of the study

The Binga district in the province of Matabeleland North is the subject of the research. Crop yields in Binga District were reduced by 50% as a consequence of the El Niño phenomenon in 2015–2016. In the district, more than 60% of smallholder farmers do not utilize irrigation.  The district has experienced a 20% increase in poverty rates due to climate-related shocks. The study focuses on rural farming households who make almost 98% of the total households in the district. Livelihoods focused on as adaptation or coping strategies are not limited to agro-based but all livelihoods adopted by farmers will be considered in this research. This research excludes all the other districts and urban cities in Mat North and wards in Binga district where provision of agricultural extension services exists.

### 1.10 Limitations of the study

The research, titled "Assessing the Impact of El Nino-Induced Drought on Farmers' Livelihoods in Binga District: Resilience, Adaptation, and Coping Strategies" has significant drawbacks. One of the main limitations is its geographic location and scope, which is confined to the Binga district in Zimbabwe. This can limit the chance of generalising the findings to other areas or provinces. In addition, the study depend on surveyed and self-reported data subject to potential biases, limitations and outliers such as respondent fatigue, recall bias or social desirability bias.

Additionally, there may be limitations to the study's sample and representativeness, which might compromise the validity and dependability of the findings. Additionally, since the research only looks at the years 2023–2024, it may not fully represent the long-term impacts of El Nino-induced drought on farmers' livelihoods. Establishing causality and attribution between El Nino-induced drought and farmers' livelihood outcomes may also be challenging. The study may also have limited consideration of external factors that could influence farmers' livelihoods, such as government policies, market trends, or social and cultural factors. Finally, the study's methodology, including data analysis and statistical techniques, may have limitations that could affect the validity and reliability of the findings.

The study is cross-sectional, and the dynamic nature of climate change and resilient-livelihood strategies may not be fully captured. The study may be affected by the availability of quality secondary data on effects on El'Nino drought, climate change adaptation and agricultural livelihoods in the area of study.

# CHAPTER TWO
# LITERATURE REVIEW

## 2.0 Introduction

This chapter examines resilience, adaptation, and coping strategies in the face of climate change by providing a thorough analysis of the opinions of several academics and empirical data on the effects of El Nino-induced drought on farmers' livelihoods. The chapter also looks at the factors that influence rural farming communities' decisions on climate change adaptation techniques, as well as the policies and practical recommendations that improve farmers' ability to withstand and adjust to drought brought on by El Nino. The literature review provides a snap shot of existing research, though it is by no means exhaustive.

## 2.1 Overview of El'Nino on Global scale and Southern Africa

According to Kiladis and Diaz (1989), El Niño is a local warming of surface waters that affects the global atmospheric circulation and occurs over the whole equatorial zone of the central and eastern Pacific Ocean along the Coast of Peru. Usually occurring every 2–7 years and lasting 12–18 months, La Niña is the cold counterpart of El Niño (CPC, 2005; Wang et al., 2012). In the central equatorial Pacific, a high Oceanic Niño Index (ONI), which is based on deviations from the average Sea Surface Temperature (SST), is indicative of an El Niño event. Sea surface temperatures that are consistently higher than normal and regular variations in wind and precipitation patterns are indicators of an El Niño phase (Figure 1) (Ropelewski & Halpert, 1992; IRI, 2013). Although they occur often and sporadically, El Niño periods do not follow a deterministic pattern with uniform intensity and predetermined occurrence intervals. However, stochastic models have been developed to predict the occurrence and severity of El Niño event. Some atmospheric disturbances can either increase or decrease the intensity of an El Niño event and, thus, its impact on weather patterns, making it difficult to predict how severe an El Niño episode will be, even though these models are fairly accurate at predicting when it will start (CPC, 2005).

The Southern Oscillation is a balance of air masses between the Pacific and Indo-Australian regions that occurs from east to west. The Southern Oscillation Index (SOI) tracks it, and it is relatively synchronized with El Niño and typical wind patterns (Parker, 1983). The Southern Oscillation is the atmospheric component, whereas El Niño is the oceanic component. It is this combination that gives rise to the term ENSO (El Niño-Southern Oscillation). Despite the imperfect correlation between El Niño and the Southern Oscillation in terms of minor variations, warm events are associated with large negative values of the SOI. Despite not having a mandate in the geophysical components of the El Niño phenomenon, FAO is interested in how severe positive and negative climatic events that might be triggered by El Niño affect agriculture and, therefore, food security (FAO, 2013). El Niño-induced severe droughts may destroy agricultural systems, as seen by the 2015–2016 El Niño episode in Southern Africa. According to the FAO (2016), this incident caused widespread crop failure, resulting in a 25% decrease in Zimbabwe's maize output, which had a major impact on the region's food security. The southern and eastern regions of Zimbabwe were most affected by El Niño, as drought conditions were exacerbated by high temperatures and water scarcity.

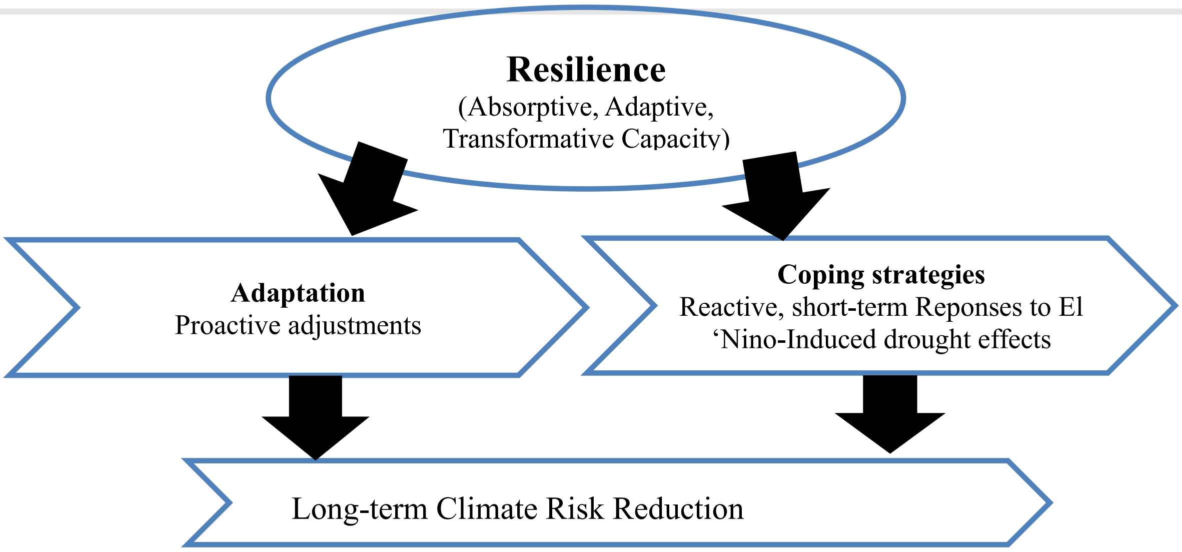
**2.2 Climate Change and Agricultural Livelihoods**

Temperature increases, more severe weather events, and changed precipitation patterns are all predicted effects of climate change that might have an immediate effect on agricultural production. Crop yields are impacted by disruptions to planting and harvesting schedules caused by variations in rainfall timing, intensity, and dependability. Rainfall fluctuations, which make farming unpredictable, are the main cause for worry in sub-Saharan Africa in addition to the overall warming trend. Mendelsohn et al. (2000), for instance, pointed out that in southern Africa, an area that mostly relies on maize as a staple crop, variations in rainfall patterns would probably result in output reductions of up to 30%. In Zimbabwe, Chikodzi et al. (2014) pointed out that farmers are finding it challenging to sustain steady output due to crop failure and decreased water availability for irrigation as a result of decreased rainfall. Heatwaves, floods, and droughts are becoming more common and severe due to rising temperatures and shifting rainfall patterns. Crop output, livestock, and general agricultural productivity are all directly at danger from these severe weather events. Studies have shown that droughts are becoming more common in Zimbabwe, and the El Niño-caused drought of 2015–2016 led to significant food shortages (Pindula, 2017). Particularly in rural regions that depend on rain-fed agriculture, the lack of water for irrigation during extended dry periods lowers agricultural production. Extreme occurrences often disturb rural families' socioeconomic circumstances, especially in economies that rely heavily on agriculture, according to Smit et al. (2000).The social and economic impacts of climate change are not just limited to crop failures. In Zimbabwe, for example, climate variability has contributed to the displacement of rural communities, especially in regions such as the lowveld and the Mashonaland provinces, where water scarcity has become a serious problem (Makunike, 2018). Climate-related migration often disrupts social networks and exacerbates poverty in urban and peri-urban areas.

Reilly et al. (2001) observed that the negative effects of climate change on agriculture are also linked to broader socio-economic challenges, including increased poverty, food insecurity, and reduced access to resources for adaptation.

### 2.3 Interactions between Resilience, Adaptation, and Coping Strategies

These three concepts of resilience, adaptation, and coping are interconnected but operate at different temporal and spatial scales. Resilience sets the foundation for both adaptation and coping. The capacity of a system, society, or person to endure, bounce back from, and adjust to shocks and pressures connected to climate change is known as resilience (IPCC, 2014). In agriculture, resilience involves maintaining or restoring agricultural productivity and Livelihoods despite climate-related disruptions (FAO, 2017). A resilient system is better positioned to adapt over time and to cope effectively in the short term. For instance, a resilient community may have both adaptive capacity (ability to shift agricultural practices) and coping strategies (community support in times of crisis). Adaptation is a long-term process, and it contributes to building resilience (Pindula, 2017). However, while adaptation seeks to transform or adjust systems for the future, coping strategies are more immediate and short-term, often dealing with current or acute climate impacts. Coping strategies in turn, help to bridge the gap when resilience and adaptation are insufficient to prevent or minimize harm from climate events (Nhamo et al., 2019). Coping mechanisms are crucial in the aftermath of disasters or climate shocks, providing short-term relief and enabling systems to rebuild or recover.Chikodzi et al. (2014)




Source: *Own Research, 2024*

*Figure 2.1: Conceptual Framework - Community Resilience, Copying and Adaptation Strategies*

Resilience sits at the core, as it underpins both adaptation and coping strategies. Adaptation is shown as a proactive, long-term strategy for reducing vulnerability. Coping strategies are reactive and short-term, addressing the immediate impacts of climate stress. Responses to climate change are dynamic and interdependent, as this approach emphasizes. Coping mechanisms, resilience, and adaptation are all components of a comprehensive response to a changing environment, not separate solutions (Herring S. et al., 2018). By improving adaptation and coping skills, resilience building paves the groundwork for long-term climate risk management and sustainable development.

### 2.4 Sustainable Livelihoods Framework

The skills, material and social assets, and survival strategies that people and communities will use are all included in the Sustainable Livelihoods framework (SLF) (UNDP, 2015; Chambers & Conway, 1992). According to the framework's emphasis on sustainability, people or communities may endure stressors and shocks like natural catastrophes and/or crises like conflicts while preserving or even enhancing their present and future assets and abilities without depleting their natural resource base (DFID, 2000). In its most basic version, the framework shows stakeholders having access to certain assets while functioning in a vulnerable environment (Kollmair and Gamper, 2002). For individuals seeking their own self-defined good livelihood outcomes, this setting has a significant impact on their livelihood tactics (Bebbington 1999). The framework outlines key factors and processes and offers a checklist of significant concerns (Scoones, 1998). Meanwhile, it highlights key factors and processes and their many interrelationships with livelihoods (Carney, 1988). By having a direct effect on families' asset position, the vulnerability context shapes the external world in which they live and acquire significance (Devereux, 2001). It includes themes including government, resource, and population developments (Dercon, 2002).

The vulnerability context also includes natural disasters like earthquakes or floods, economic shocks, conflicts like national or international wars, and shocks that affect the health of people, animals, or crops (Adger, 2000; Moser, 1998). Lastly, it contains seasonality, which includes seasonality in items, pricing, and job openings. The primary focus of the SFL strategy is people. To analyze how individuals try to turn their assets into profitable life outcomes, it is essential to have a realistic and accurate grasp of their capabilities (Bebbington, 1999). A variety of assets are needed by people to accomplish their own objectives, and no one capital endowment is enough to provide the intended results (Carney, 1998). With its continually varying pentagon forms, the asset pentagon (see Figure 1 below) provides a tool to visualize these settings and show dynamical changes over time, as the relevance of the individual categories alters in relation to the local situation. (DFID, 2000). The pentagon shape may be used to graphically depict the disparity in people's access to resources (DFID, 2000; UNDP, 2015). According to this theory, the pentagon's outside perimeter denotes greatest access to assets, while the center, where the lines converge, indicates zero access (Bebbington, 1999; Shankland, 2000). Accordingly, various pentagon shapes may be created for various communities or socioeconomic groupings within communities (UNDP, 2015). It is crucial to remember that a single physical asset might provide many advantages (Carney, 1998). Since they may utilize the land as collateral for loans as well as for direct productive activity, those who have secure access to land (natural capital) may also have a lot of financial capital (Conway, 1992). Likewise, cattle may help owners build social capital (prestige and community connections). (DFID, 2000) while continuing to function as natural capital in and of itself and being used as productive physical capital (see animal traction) (Dercon, 2002). It is vital to consider cultural norms and the kinds of institutions and procedures that "transform" assets into livelihood outcomes in order to get an understanding of these intricate linkages (UNDP, 2015).

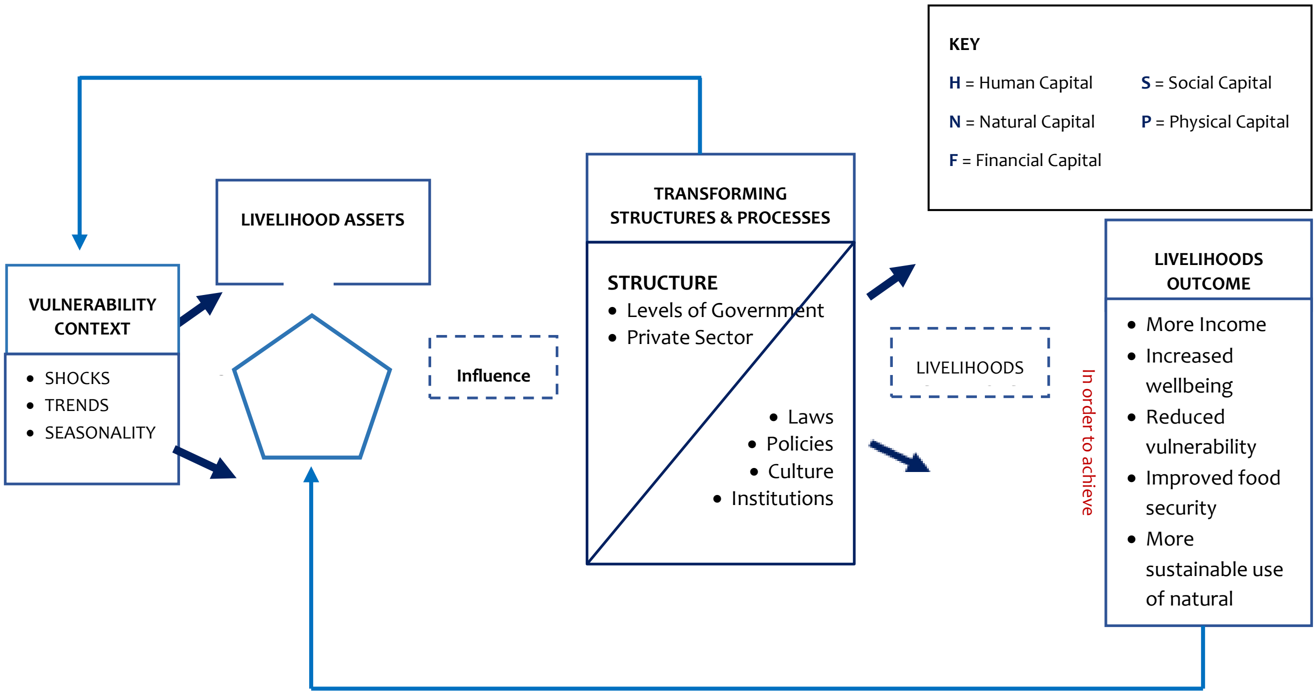



*Figure 2.2: Sustainable Livelihoods Framework*

**Source:** *UNDP (2015)*

The institutions, organizations, laws, and policies that influence livelihoods are represented by transformative structures and processes (Gamper et al., 2002). Since they function at all levels and efficiently dictate access, terms of trade between various forms of capital, and returns to any particular livelihood approach, they are crucial (Shankland, 2000; Keeley, 2001). Organizations, both public and commercial, "that set and implement policy and legislation, deliver services, purchase, trade, and perform all manner of other functions that affect livelihoods" are referred to as structures (DFID, 2000). Sustainable development is often hampered by the lack of effective frameworks. When unfavorable arrangements prevent access to a particular livelihood approach, it makes basic asset building challenging (DFID, 2000; UNDP, 2015). It is crucial to assess these structures' effect on climate change adaptation via sustainable livelihoods if farmers have access to them (Devereux, 2001; Dercon, 2002).

According to Kolllmair and Gemper (2002), livelihood strategies are the variety and mix of actions and decisions individuals make in order to reach their livelihood objectives. They must be seen as an ever-changing process where individuals mix activities to satisfy their diverse demands at different times and on different economic or geographic levels; they may even vary within a family (Scoones, 1998). Their place within the framework makes it evident how directly they are dependent on asset condition and changing structures and processes (DFID 2000). Depending on the institutions and rules in place, a shifting asset status may help or hurt other efforts. In order to develop practical solutions to deal with an upcoming shock or trend that impacts their livelihoods, farmers need robust institutions and long-term resources (UNDP, 2015). According to DFID (2000), livelihood outcomes include increased income (e.g., cash), improved well-being (e.g., non-material goods, such as health status, self-esteem, access to services, and a sense of inclusion), decreased vulnerability (e.g., increased resilience through an increase in asset status), improved food security (e.g., increased financial capital to purchase food), and more sustainable use of natural resources (e.g., appropriate property rights) (Kollmair and Gemper, 2002; DFID, 2000). Results show us what drives stakeholders to take certain actions and what their priorities are, which aids in our understanding of the output of the present configuration of elements inside the livelihood framework. They may help us choose which performance metrics to employ to evaluate support activities and how individuals are likely to react to new opportunities (Carney, 1998). A fresh beginning point for further tactics and results is provided by livelihood outcomes, which have a direct impact on the assets and dynamically alter their level (the pentagon's shape).

### 2.5 Vulnerability Framework

Vulnerability, according to Turner et al. (2003), is the likelihood that a system would suffer damage as a result of being exposed to a hazard (Adger, 2006; Brooks, 2003). the extent to which a system is vulnerable to or incapable of handling the negative consequences of climate change, such as climatic extremes and variability (IPCC, 2001; Smit & Wandel, 2006). Vulnerability depends on a system's sensitivity, adaptive capability, and the kind, amount, and pace of climate change it is exposed to (IPCC, 2001; Fussel & Klein, 2006). Many scholars have made a distinction between internal and external vulnerability, particularly with regard to environmental threats (O' Brein et al., 2004). These words are often used to differentiate between the external stresses that a community or system encounters and the internal elements that govern how those stressors affect that system (Fussel, 2007). Physical factors (Cutter et al., 2003) describe the exposure of vulnerable elements within a region; economic factors (Dercon, 2002) describe the economic resources of individuals, population groups, and communities; social factors (Moser, 1998) describe non-economic factors that determine the well-being of individuals, population groups, and communities, such as degree of education, security, access to basic human rights, and good governance; and environmental factors (IPCC, 2001) describe the state of the environment within a region (Kasperson et al., 2005).

Research on the effects of El Nino on the Binga community is informed by these elements, which also reflect internal characteristics of the susceptible population (UN, 2004; IPCC, 2001). Contrary to the United Nations (2004), another view of vulnerability takes into account elements that are not part of the vulnerable system, such the stressor's features and the anticipated degree of outside support. Three aspects of climate change vulnerability are identified by Moss et al. (2001). The damage brought on by El Nino is explained by the physical-environmental dimension (Schmidhuber & Tubiello, 2007). These include the biophysical effects of climate change, such shifts in agricultural output or the spread of disease vectors, as well as the climatic circumstances in a nation or area (Patz et al., 2005). A region's ability to bounce back from severe occurrences and adjust to change in the long run is referred to as its socioeconomic dimension (Brooks, 2003). The third factor, external help, refers to the extent to which an area might receive support in its efforts to adjust to change from its commercial partners and allies, diasporic groups in other regions, and international aid agreements (Moss et al., 2001; Fussel, 2007). The kind of risk encountered has a significant impact on the link between a human system's vulnerability and adaptability (Adger, 2003). When evaluating adaptive capacity, it is crucial to take into account external barriers to adaptation as well as connections between scales, as a system's ability to adapt may be impeded by processes that originate outside the system (Brooks, 2003)

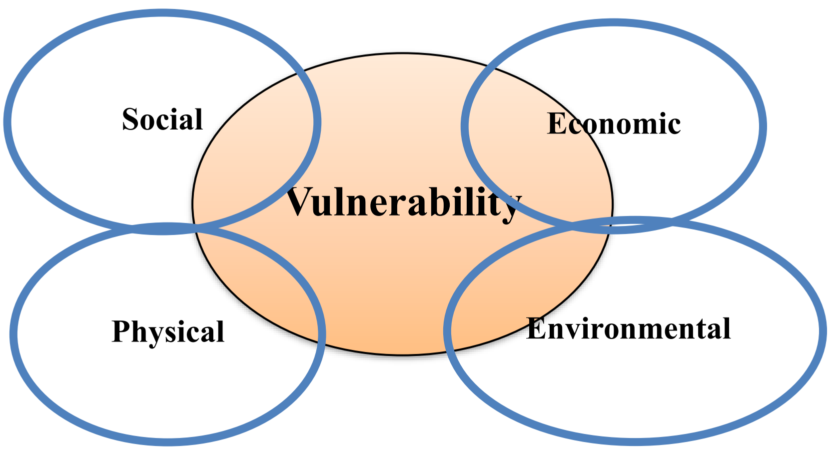



*Figure 2.3: Dimensions of Vulnerability*

Geographical, temporal, and socioeconomic factors influence how climate vulnerabilities and the resulting effects vary among sectors and situations (Alam, 2016; Ayanlade et al., 2018; Jurgilevich, 2017). In response, the context-specific approach considers the complex historical and current context of the action being done, as well as the possible impact and involvement of the activity on that context (Ayanlade et al., 2018). The evaluation of the interplay of physical, geographical, social, economic, political, and resource or livelihood capital aspects is thus necessary to describe a particular context of a research region (Klein et al., 2003).

According to O'Brien (2007) and Thornton (2014), climate change phenomena such as El Nino impacts will alter the biophysical characteristics of the environment and have an impact on the interactions between many factors that control it. Recognizing the context is important, but so is determining which context should be taken into account when creating adaptation strategies at different levels (Birkmann, 2007; Dow, 1992).

Context-specific methodology was used in our research (Fig. 2.3). A useful technique for defining and describing the setting is context identification. In this research, we characterize livelihoods' exposure to climate risk on a context and consequence basis after identifying the context (Thornton, 2014). While taking into account the availability and use of different capital resources for creating and disseminating livelihood strategies, this step entails assessing the sensitivity of livelihood activities (Huq et al., 2004; Campbell-Lendrum et al., 2023). Government and non-profit institutional planning for repairing the virtue and connectedness to capital assets are some stages to accessing adaptive capacity (Cutter et al., 2008;Manyena, 2006).

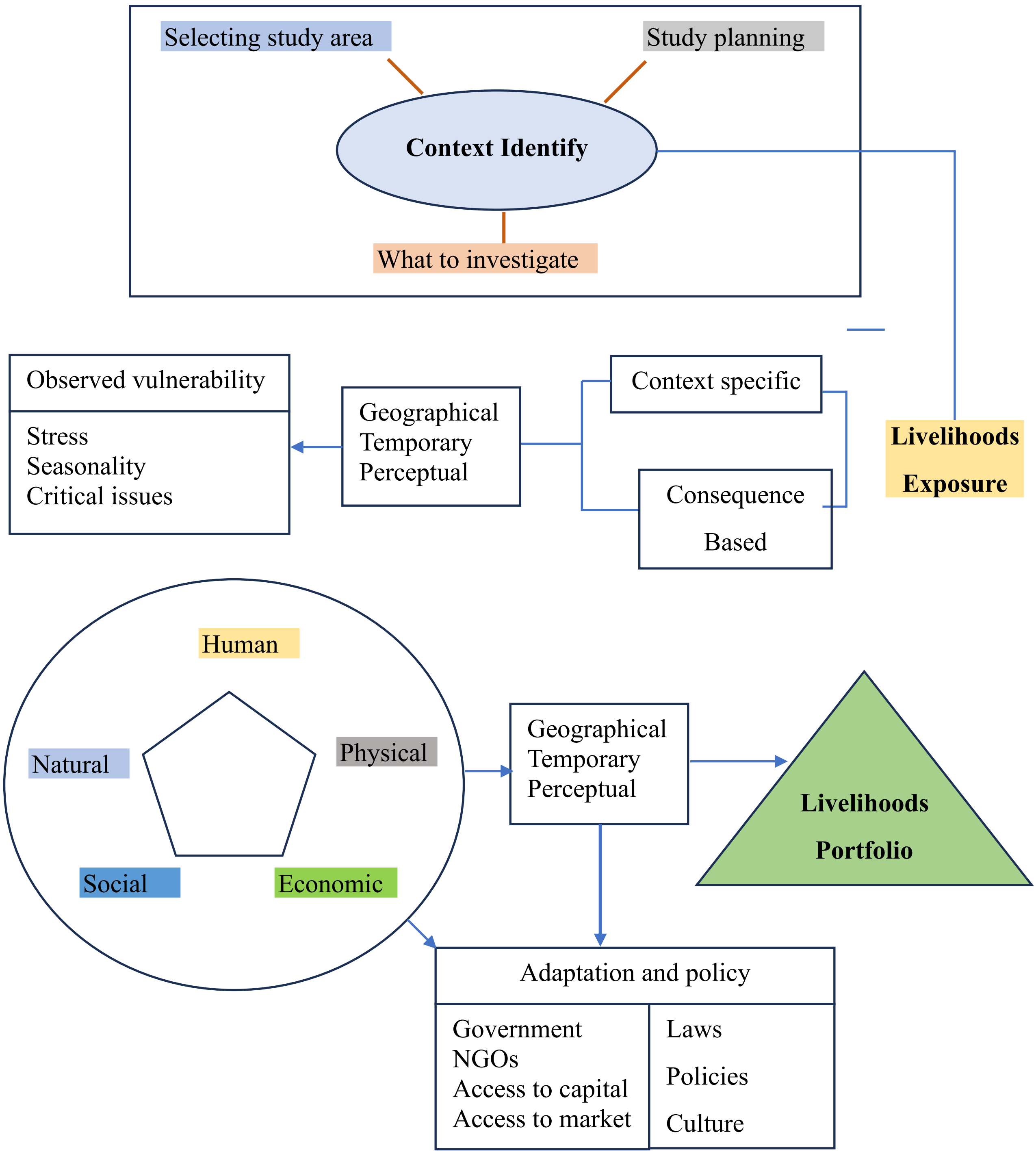



*Figure 2.4: A Concept-Specific Livelihoods Vulnerability Framework*

Adapted from: UNDP, 2015)

The integrated Approach of the framework provides a holistic view of livelihood vulnerability, including exposure to climate hazards (like El Niño), sensitivity (how susceptible farmers are to those hazards), and adaptive capacity (how well they can cope and adjust). This is essential in understanding the broader socio-economic and environmental conditions that shape farmers' ability to respond to drought. Applying the Vulnerability Framework, the research systematically explores the multi-dimensional factors influencing farmers' livelihoods in Binga District, leading to more effective policy recommendations for building long-term resilience to climate shocks.

### 2.5 Resilience, Adaptation and Coping Strategies for Agricultural Livelihoods

Adaptation strategies reduce sensitivity to climate change by implementing both long-term adjustments in agricultural systems and short-term coping measures. Systems that adapt to climate change by implementing new procedures, tools, or behaviors to lessen susceptibility and increase resilience are referred to as adaptation (IPCC, 2014) However FAO, 2017 defined adaptation as a process that involves modifying farming practices, such as crops varieties, irrigation systems, or planting dates, to better cope with climate-related stresses. Farmers in Zimbabwe have used a number of adaption strategies to address climate threats. To improve soil moisture retention, they include using crop types resistant to drought, adjusting planting dates, and using conservation agricultural practices like mulching and limited tillage (Chikodzi et al., 2014). In addition, Smit and Skinner (2002) emphasize the role of agroforestry and water conservation techniques, which can help farmers adapt to both droughts and floods. Many farmers in Zimbabwe are also increasingly engaging in diversifying their livelihoods, moving beyond crop production to include small-scale livestock farming or non-agricultural activities like trading (Mubaya et al., 2014).

Coping strategies in response to immediate climate stresses include emergency food aid, migration, and the selling of livestock or assets to meet basic needs during periods of crisis. For instance, the 2015-2016 drought in Zimbabwe led many farmers to sell livestock to cover the costs of food and other essentials (Pindula, 2017). While coping strategies provide short-term relief, Morton (2007) emphasizes that over-reliance on them can further undermine long-term resilience by depleting assets and reducing future adaptive capacity. Adger (2003) highlights that coping strategies must be linked to building resilience, which involves not only responding to crises but also strengthening the underlying capacity of communities to withstand future shocks. For instance, farmers in Zimbabwe are working to enhance water storage through the establishment of small-scale dams and are exploring weather insurance schemes to hedge against crop failure due to extreme weather (Mubaya et al., 2014). Combining short-term coping strategies with long-term adaptation measures is necessary to increase agricultural resilience to droughts brought on by El Niño. Below are explanations of some of the most important tactics found in the literature.

*2.5.1 Diversification of Livelihoods***:**

Farmers are increasingly using a variety of livelihood options, such as crop diversification and non-agricultural revenue-generating pursuits including chicken farming, selling, and small-scale business ownership (Mastrorillo et al., 2016). These strategies provide backup income and reduce reliance on maize, the staple crop that is most susceptible to drought.

Diversification of crops and livelihoods activities is one of the primary strategies for building resilience to El Niño induced droughts. Mubaya et al., (2014) argue that crop diversification can buffer farmers against the risk of total crop failure during droughts. For instance, farmers may switch to drought-tolerant crops such as millet, sorghum, or groundnuts, which are more resilient to dry conditions than maize. Livelihood diversification, such as incorporating livestock farming or small-scale businesses, can provide additional sources of income during drought years.

*2.5.2 Adoption of Drought-Resistant Crop varieties*

The introduction and adoption of drought-tolerant crop varieties have been critical in adaptation. Research conducted by Sones et al, (2018) emphasizes increased adoption of varieties that require less water, improving resilience against erratic rainfall. Adoption of drought-resistant crop varieties has been widely recognized as a key adaptation strategy. Chikodzi et al., (2017) discuss the introduction of drought-resistant maize varieties in Zimbabwe, which can tolerate low rainfall conditions and reduce crop failure. Furthermore, Walker and Rowell (2009) suggest that such crops can improve yields and provide food security during dry years.

*2.5.3 Improved Water and Soil Management Practices:*

According to Gumbo et al. (2015), farmers are using water-saving measures such mulching, rainwater collection, and soil conservation methods to improve moisture retention. One successful tactic to reduce the danger of drought is the use of small-scale irrigation technology. In drought-prone regions, Patt et al. (2009) emphasize the value of water management and conservation techniques such effective irrigation systems and rainwater collection as adaptive measures. Rainwater collection methods, such as building small reservoirs and using water-efficient irrigation systems, have been used by farmers in Zimbabwe. By providing crops with a more consistent source of water during dry seasons, these techniques help lessen the effects of depression. Maintaining agricultural output in the face of changing climate circumstances requires the use of soil conservation measures. Speranza et al. (2014) highlight the role of soil conservation techniques, such as mulching, reduced tillage, and agroforestry, in enhancing soil moisture retention and preventing erosion during periods of drought. In Zimbabwe, conservation agriculture practices that promote soil fertility and water retention are increasingly being adopted by smallholder farmers to combat the effects of El Niño-induced droughts.

*2.5.4 Community-Based Approaches:*

Farmers often rely on collective efforts to cope with drought. Community sharing of resources, information, and experiences enhances resilience. Participatory approaches can empower communities to develop localized solutions to cope with climate variability (Mastrorillo et al., 2016).

**2.6 Community-Based Adaptation and Early Warning Systems**

Adaptation to El Niño-induced droughts is not only about individual farming strategies but also about community-level efforts. Mendelsohn et al. (2000) highlights the significance of community-based adaptation, where farmers share knowledge, pool resources, and adopt collective approaches to managing climate risks. In Zimbabwe, local communities have formed farmer cooperatives to share information and resources on coping with droughts and other climate impacts. Early warning systems are also crucial for building resilience. Klein et al. (2005) note that early warning systems that provide timely and accurate weather forecasts can assist farmers make better and sound decisions pertaining planting, irrigation and harvesting. Early drought warnings are sent by Zimbabwe's Meteorological Services Department, and NGOs often teach farmers on how to react to climatic data. Farmers may improve their agricultural practices by having improved access to climatic information via local organizations and extension services (Zhou et al., 2021). Climate adaptation-focused training and workshops are essential for promoting knowledge transfer.

**2.7 Climate Change Policy and Institutional Support**

Climate change adaptation in agriculture requires strong institutional frameworks, policies, and support systems. In Zimbabwe, the government has adopted various climate change policies aimed at improving resilience in the agricultural sector, such as National Climate Policy (2017) and the Climate-Smart Agriculture Policy (2017), which encourage sustainable practices and technologies for climate adaptation. Effective governance and strong institutional frameworks are essential for providing the support needed for adaptive strategies. Programs aimed at improving access to credit and insurance can bolster farmers' capacity to cope with drought impacts (Mastrorillo et al., 2016) Resource limitations, lax enforcement, and restricted access to pertinent technologies, however, make it difficult to put these rules into practice (Chikodzi et al., 2014). The World Food Programme (WFP), the United Nations Development Programme (UNDP), and other non-governmental organizations have played a significant role in assisting adaptation efforts by offering financial support for agricultural projects, technical assistance, and climate information services (Makunike, 2018).

**2.8 Factors Influencing Resilience, Adaptation, and Coping Strategies**

In Zimbabwe's Middle Zambezi Biosphere Reserve (MZBR), Kupika et al. (2021) investigated the livelihood patterns and variables impacting adaptation among small-scale subsistence farmers. Between August 2015 and October 2016, the research collected data using key informant interviews, focus groups, and a mobile home survey (Kupika et al., 2012). The livelihood activities and assets of smallholder farmers were defined using the Department for International Development's Sustainable Livelihood Approach Framework (DFID, 200); Carney, 1998 Smallholder farmers cited the cultivation of crops and cattle as their primary source of income (Morton, 2007; Scoones, 1998), according to Kupika et al. (2021). To support themselves and their families during droughts, however, these farmers mostly relied on household income-based activities (Devereux, 2001; Davies, 1993). According to the findings of the study, which employed a Multinomial Regression Analysis, these farmers' household consumption patterns were adversely affected by their location in a resettlement area, and they withdrew their children from school during times of food shortage (Kupika et al., 2021; WFP, 2017). On the other hand, food shortages during droughts had a positively substantial impact on family income diversification (Barrett et al., 2001; Ellis, 2000). The study's findings also show that in order to cope with the shifting rainfall patterns and harsh temperatures, the respondents modified the planting dates, planted drought-resistant crops, varied their crop choices, and used water-saving measures (IPCC, 2014; Kupika et al., 2021). According to these results, biosphere reserves encourage smallholder farmers to adopt adaptive management practices, which strengthen socio-ecological systems' resistance to climate change (Kupika et al., 2021; Folke et al., 2005).

To improve the resilience of the agricultural sector and address the immediate and long-term effects of El Niño, Mugiyo et al. (2023) provided policymakers, researchers, and agricultural stakeholders with guidance for proactive measures. The coefficient of determination (R2) between yield and ENSO was employed in the study. There was a substantial correlation between El Nino's impacts and lower maize yields in Zimbabwe, as shown by the findings that 11 out of 13 El Niño seasons had a negative detrended yield anomaly (Mugiyo et al., 2023; IPCC, 2014). The relationship between ONI and yield is indirectly impacted by the R2 between rainfall and yield (39%) and the Oceanic Nino Index (ONI) and rainfall (43%). (Mugiyo et al., 2023; Trenberth and al., 1998). The study suggested a set of strategic, tactical, and operational decision-making recommendations that the agriculture sector should adhere to in order to protect farmers' livelihoods and enhance their readiness for droughts in future agricultural seasons (Mugiyo et al., 2023). It was emphasized how crucial it is to provide farmers access to meteorological and climate data as well as advice on drought and heat stress. This includes tactics like planting robust crop types, selecting resilient livestock, and putting in place sufficient fire safety precautions (Koliba et al., 2022).

In Oshipya District, Etayi Constituency, Omusati Region, northern-central Namibia (NCN), Shiimi et al.'s research from 2023 sought to determine the variables influencing the drought adaptability and susceptibility of smallholder subsistence farmers. Using a standardized questionnaire, 80 randomly chosen smallholder farmers provided information on their sociodemographic traits and coping strategies for drought both before and after it occurred. A Rasch model (Rasch, 1960) was used to evaluate the levels of drought resistance and vulnerability. A principal component analysis was used to estimate wealth scales, and a multivariate cluster analysis approach was employed to classify farmers based on their asset ownership (Hair et al., 2014). Additionally, variables influencing household susceptibility and resistance to drought shock variability were evaluated using a general linear model. Farmers' drought resilience levels were strongly impacted by factors such as farm size, type of agricultural operations, marital status, household head gender, and participation in a farming organization (Below et al., 2012). The amount of drought adaptation rose with farm size, years of farming experience, and participation in a farming association, whereas combined crop-livestock producers were more resilient than either livestock or crop farmers (Thornton et al., 2018). In contrast, vulnerability levels were strongly influenced by family size, with larger families being more vulnerable to the impacts of drought (Deressa et al., 2009). We advise farmers to join agricultural organizations to learn about drought mitigation, diversify their farming operations, and diversify their sources of income (FAO, 2017). Additionally, by developing infrastructure, training, and support services, smallholder farmers may become more self-sufficient and lower government spending on drought relief initiatives (World Bank, 2018).

According to research by Moran et al. (2014), most people in Amazonia use a variety of strategies to predict, deal with, and adjust to drought occurrences. They also acknowledge the potential financial losses as well as the loss of forests due to unintentional fire spread (p.12). El NiÜno-related drought occurrences pose a significant danger to the livelihoods of the region's poorest farmers (Hansen et al., 2019). Observations show that all Amazonian farmers would benefit from greater access to better forecast information pertinent to their area and existing agricultural practices, since their susceptibility is exacerbated during severe climatic events (IPCC, 2014). In the agricultural areas surrounding the cities of Altamira and Santar´em in Parôa State, Brazil, their study looked at the availability and use of forecasts, the frequency of unintentional fires and methods to prevent fire-related losses, and coping mechanisms for dealing with drought caused by El Nino (Moran et al., 2014). To raise awareness of the region's and farmers' property's precipitation variability, the study suggested distributing an El Nino Prediction Kit and holding a number of workshops that could improve local knowledge of rainfall variability and establish a farmer-maintained grid of collecting stations (Kolstad et al., 2009). Agricultural drought resilience, adaptation and coping mechanisms, and its impact on the cattle industry's sustainability were evaluated by Bahta et al. in 2021. A principal component analysis was performed on data from 217 smallholder livestock producers in order to estimate the agricultural drought resilience index as an outcome variable versus factors related to social welfare, economic result, environmental variable, and adaptive ability (Bahta et al., 2021, p.18). According to the findings, 21% of families who raised animals sold them as a coping mechanism and adaptation. However, 20% of farming households adapted and coped by using alternative land use; 17% requested household animal feed; 6% looked for work; 6% moved; 5% kept drought-tolerant breeds; 3% received relief grants; 2% used their savings and investments; and 1% leased their farms. (Page 20, Bahta et al., 2021).

The agricultural drought resilience of families was favorably and substantially affected by the three pillars of sustainability—natural, economic, and social—when considered as a resilience process. This suggested that smallholder farmers' resistance to agricultural drought increased with their involvement in social networks and cooperatives. (Page 40 of Bahta et al., 2021). Furthermore, families' adaptation ability and resistance to agricultural drought increase with the amount of resources, income, land, water, credit, and other farming activities they have (Folke et al., 2005, p. 442). Therefore, strengthening the resilience and flexibility of smallholder livestock producers requires adherence to the three pillars of sustainability (Deressa et al., 2009, p.134). In order to lessen agricultural drought susceptibility, the research suggests that government assistance facilitate access to agricultural loans and promote farmers' participation in cooperatives and social networks (World Bank, 2018). To increase smallholder farmers' resistance to agricultural drought, the government should also expand their access to land and water rights (FAO, 2020). This might be accomplished by all role players working together and coordinating.

### 2.9. Factors Contributing to Farmers' Vulnerability to El Niño-induced Drought

Extreme droughts are a common occurrence in many parts of the world, including southern Africa, as a result of El Niño-Southern Oscillation (ENSO) phenomena, especially El Niño episodes. Zimbabwe, a country heavily reliant on rain-fed agriculture, suffers significant difficulties during these weather occurrences. Improving resilience in agricultural communities requires an understanding of the elements that make farmers vulnerable and the adaptive techniques they use.

*2.9.1 Dependence on Rain-fed Agriculture*

Since most Zimbabwean farmers depend on rain-fed farming, they are very vulnerable to El Niño-induced changes in precipitation (Kandji et al., 2006). More than 80% of smallholder farmers rely on natural rainfall, which becomes erratic during El Niño years, according to a research by Nyanga et al. (2012).

*2.9.2 Socioeconomic factors*

Socioeconomic vulnerability plays a significant role. Many farmers face poverty, limited access to financial resources, and inadequate infrastructure, which hampers their ability to adopt necessary technologies or diversify their livelihoods (Mastrorillo et al., 2016). The rural poor often lack insurance or safety nets to manage crop failure effectively.

*2.9.3Limited Access to Information and Resources*

Farmers are made more vulnerable by a lack of timely and reliable meteorological information. Forecasts that may assist them in making well-informed choices on planting and harvesting are not provided to many smallholder farmers (Zhou et al., 2021). Additionally, limited accss to improved seed varieties, irrigation facilities and agricultural extension services exacerbates their vulnerability.

*2.9.4 Land Degradation and Soil Fertility Decline*

Land degradation and declining soil fertility hinder agricultural productivity. Recurrent droughts, coupled with poor land management practices, lead to diminished yields and make recovery from drought conditions more difficult (Mapfumo et al., 2013).

*2.9.5 Gender Dynamics*

Women in Zimbabwe often encounter extra obstacles, such as uneven access to land and finance, which hinders their capacity to adjust to drought circumstances (Mastrorillo et al., 2016). This makes gender roles a part of vulnerability. The effects on food security usually affect women the most, and they are also less likely to have access to services that might help them adjust effectively. In Zimbabwe, a complex interaction of ecological, economic, and societal variables makes farmers vulnerable to drought caused by El Niño. Adaptation tactics, such as diversification and better water management, show how resilient these farmers are, but maintaining these initiatives requires continued assistance from legislative frameworks, as well as access to resources and knowledge.

Subsequent investigations have to concentrate on assessing the enduring efficacy of adaption tactics and include collaborative methodologies that integrate indigenous expertise and customs.

### 2.10 Impacts of El Nino-Induced Drought on Agriculture and Livelihoods

Those who depend on climate-sensitive industries like agriculture are especially at risk from climate change, which is a serious danger to people's livelihoods worldwide (Hertel et al., 2010; IPCC, 2014). According to Chambers and Conway (1991) and Serrat (2017), a livelihood is the set of skills, resources, and activities necessary to earn a living. It is deemed sustainable if it can endure and bounce back from shocks and strains, as well as maintain or enhance its resources, capabilities, and activities both now and in the future without endangering the base of natural resources. Climate shocks have a variety of effects on livelihoods, according to UNDP (2007). They devastate buildings and assets, hike food costs, reduce work opportunities, destroy crops, and leave people with little alternatives (Lowder et al., 2021). Due to their direct reliance on agriculture, marginal and small farmers suffer greatly from any decrease in agricultural production in terms of their well-being, income, nutrition, and security of food and livelihood (Hertel et al., 2010).

There are more than 608 million farms in the world, and according to Lowder et al. (2021), small farmers (those who cultivate between one and two hectares) control 14% and 4% of the land, while marginal farmers (those who cultivate less than one hectare) control 70% and operate 7% of all agricultural land (Figure 1). Only 12% of all agricultural land is managed by marginal and small farmers, who together account for over 510 million farms worldwide (Bahta et al., 2012). Smallholder farmers, who own land up to two hectares, are the backbone of the farming industry, especially in low-income nations. They produce over 80% of the food consumed in most of the developing world (Ahmed, 2019; United Nations Environment Programme, 2013) and about 35% of the food consumed worldwide (Lowder et al., 2021). Despite their important contributions to global nutrition and food security, small farmers are responsible for the great majority of the world's hungry and impoverished. Ahmed (2019) and Fan and Rue (2020).

According to Verma and Sudan's (2021) study on how climate change affects the livelihoods and adaptation strategies of marginal and small farmers, these farmers are particularly vulnerable to climate change and variability because of their marginalized status, direct reliance on agriculture for a living, and lack of resources and adversity-coping skills. According to the study, climate change is negatively affecting marginal and small farmers' livelihoods through decreased crop and animal yields, crop failures, outbreaks of crop and animal diseases, livestock mortality, and a shortage of pasture and water for livestock. These factors all contribute to food insecurity, lower farm income, and a decline in social and economic indicators like well-being, health, and education. Planned or policy-driven adaptation practices are necessary because marginal and small farmers are constrained by various social, economic, and institutional factors, even though they use a range of coping and adaptation strategies, some of which are climate-smart (Verma and Sudan, 2021).

## 2.11 Policy and Institutional Responses to El Niño Drought in Zimbabwe

In Zimbabwe, El Niño-induced droughts provide serious obstacles to food security and agricultural output, especially in areas with high sensitivity like Binga District. This review examines the policies and institutional responses to droughts in Zimbabwe, emphasizing the specific context of Binga District. It also assesses the effectiveness of these responses in supporting farmers' livelihoods.

### *2.11.1 National Drought Mitigation Policy*

The Zimbabwean government has instituted a National Drought Mitigation Policy, under the Food Deficit Mitigation Strategy Program (FDMS) which is designed to coordinate responses to drought and enhance resilience (Government of Zimbabwe, 2016). This policy emphasizes water management, food security, and the promotion of drought-tolerant crop varieties. However, its effectiveness has been challenged by inadequate implementation at community level and insufficient resources allocated in support of smallholder farmers.

### *2.11.2 Zimbabwe Agricultural Sector Strategy*

This long-term strategic framework aims to improve agricultural productivity and sustainability. It emphasizes enhancing the access to agricultural inputs, including drought-resistant seeds and irrigation systems, especially for vulnerable farming communities (Ministry of Agriculture, 2019). While this strategy aims to support farmers, its execution often faces hurdles related to funding and infrastructure limitations.

### *2.11.3 Emergency Response Programs*

In response to severe droughts, the Zimbabwe Livelihood Assessment Committee (ZimLAC) provides critical information on food security and vulnerability, which informs targeted interventions (ZimLAC, 2023). These include cash transfers, food distribution, and livestock support programs. However, criticisms have been made about the adequacy and timeliness of these responses, especially during high-need periods.

*2.11.4 Community-Based Approaches*

Local governance structures, including traditional leaders and community-based organizations, play vital roles in coordinating disaster response at the grassroots level in Binga District. Community resilience programs often involve participatory planning processes to adapt responses to local needs (Mastrorillo et al., 2016). Such community-driven initiatives have been more effective when complemented by support from external agencies and NGOs.

*2.11.5 International and NGO Involvement*

Many international organizations and NGOs, such as the World Food Programme (WFP) and Oxfam, provide essential support through agricultural training, food aid, and cash assistance during drought periods (Oxfam, 2020). These interventions have proven effective in alleviating immediate food insecurity; however, they are often criticized for being reactive rather than proactive and sustainable.

## 2.12 Effectiveness of Responses in Supporting Farmers' Livelihoods

*2.12.1 Food Security and Livelihood Support*

The effectiveness of policies and institutional responses in supporting farmers' livelihoods can be gauged through their impacts on food security and income stability. Studies show that targeted food aid during severe droughts has mitigated acute hunger but has not led to long-term improvements in agricultural resilience (ZimVAC, 2021). While cash transfer programs have improved household food security temporarily, they are not sustainable long-term solutions without accompanying agricultural support.

*2.12.2 Access to Inputs and Resources*

Programs aimed at enhancing access to drought-tolerant seed varieties and irrigation technologies have been beneficial. However, the implementation remains inconsistent, particulary in remote areas like Binga District, characterized by poor infrastructure and high transport costs (Mastrorillo et al., 2016). A lack of extension services limits farmers' knowledge about these technologies, reducing potential agricultural gains.

*2.12.3Community Involvement and Local Adaptation*

Community-based responses have shown effectiveness in improving farmers' adaptive capacities. Participation in decision-making processes tends to increase the relevance of interventions to local needs, fostering a sense of ownership and accountability among community members (Mastrorillo et al., 2016). These approaches often utilize traditional knowledge and build on local capacities, which can lead to more sustainable outcomes.

#### *2.12.4 Challenges of Coordination and Implementation*

Despite the presence of various policies and programs, coordination between national and local levels is often lacking, leading to disruptions in timely and efficient aid delivery. A study by Chikozho (2016) highlights that bureaucratic inefficiencies and lack of communication between different government departments impede effective drought response implementation.

The policy and institutional responses to El Niño-induced drought in Zimbabwe, particularly in Binga District, reflect a multi-faceted approach that combines national strategies with local initiatives. While efforts such as emergency response programs and community-based adaptation have improved the immediate resilience of farming communities, the effectiveness of these interventions varies significantly. Ultimately, for policies to be more effective in supporting farmers' livelihoods, there needs to be a focus on enhancing the sustainability of interventions, improving coordination among stakeholders, and ensuring the active participation of communities in decision-making processes.

### 2.13 Conclusion

The chapter looked at the existing literature and theories on climate change, specifically the El' Nino drought. The chapter used vulnerability and sustainable livelihoods framework to assess the assets the community has for copying and adaptation to El Nino. The frameworks will also inform the study of how the communities are ready to respond to El Nino and other climate hazards. The literature highlights coping and adaptation strategies used by smallholder farmers in different parts of the world. This study will further unpack how the farmers decide to choose these adaptation strategies.

# CHAPTER THREE
# METHODOLOGY

## 3.0 Introduction

This chapter outlines the study techniques used to assess how the drought brought on by El Niño affected the lives of farmers in Binga District. The study employs a mixed-approaches strategy, integrating qualitative and quantitative research techniques to provide a comprehensive grasp of the problems smallholder farmers encounter. The study area, research design, sample procedures, data collecting techniques, and analytical methodologies are covered in this chapter. The chapter aims to guarantee the validity and reliability of the results while successfully achieving the research goals by outlining these methodological features.

## 3.1 Study Area

Zimbabwe's Matabeleland North province contains the district of Binga. The main sources of income for the people of Binga are agriculture, fishing, and natural resources. The majority of families in Binga are involved in subsistence farming, which is the foundation of the community's economy (Mushayavanhu, 2017). The main crops grown include maize, sorghum, and millet, which are adapted to the dry and sandy soils of the area (Moyo et al., 2013). Fishing is another important livelihood activity in Binga, particularly on Lake Kariba (Makwara et al., 2016) . The fishing industry provides employment and income for many households, as well as a source of protein for local consumption. Livestock production is also practised in Binga, with many households keeping cattle, goats, sheep, chicken and guinea fowl (Moyo et al., 2013). Livestock provides a source of income, meat, and milk, as well as draught power for farming. The Majority depend much on natural resource-based livelihoods as the district is rich in natural resources, including forests, wildlife, and minerals (Mushayavanhu, 2017) Many households in Binga engage in natural resource-based livelihoods, such as charcoal production, hunting, and gathering.

Despite these livelihood opportunities, households in Binga face several challenges. Climate change is affecting agricultural productivity and livestock health in Binga (Moyo et al., 2013). Poverty is widespread in Binga, with many households struggling to access basic necessities like food, water, and healthcare (Mushayavanhu, 2017). Many households in Binga have limited access to markets, making it difficult for them to sell their products and access income (Makwara et al., 2016).

Latitude 27.000°N and longitude 18.600°E are the coordinates of Binga. Its landmass is estimated to be 63.82 square kilometers. The average annual temperature never drops below 27°C, while the annual rainfall varies from 1016 to 1524 mm. November through March is when the rainy season occurs. From April to October, the dry season is characterized by very hot summer months from September to November and mild winter months from April to August. According to the 2022 population census, Binga's population is around 159,982, which is 2544 more or less than the 2012 national population census (ZIMSTAT, 2012; 2022). Farming is the main profession of the people living in the rural region, which is made up of 25 wards on the outskirts of the big town (ZimVAC, 2022).

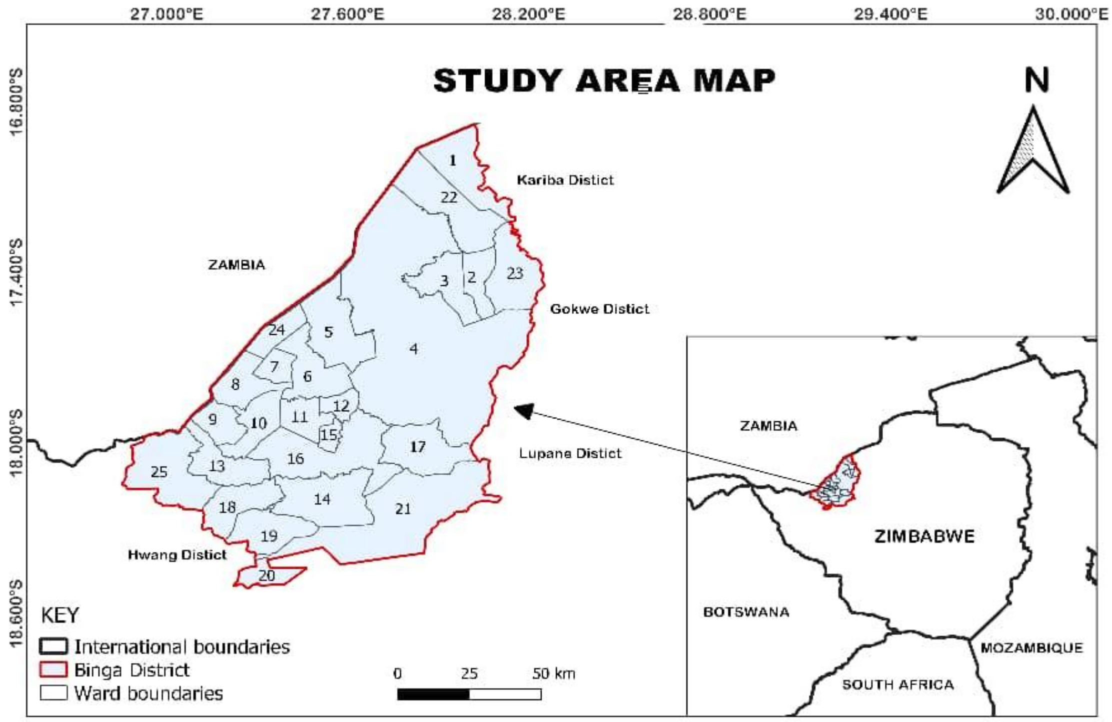



***Figure 3.1**: Study Area Map*

**Source:** *Binga RDC Planning Dept. 2024*

### 3.2 Research Design

The research design for this study was a mixed-methods, combining quantitative and qualitative techniques. Qualitative techniques are those that use a more philosophical style of operation, less formalized processes, and a less delimited scope (Mouton and Marais, 1992). In-depth interviews and focus groups with smallholder farmers were part of the qualitative component in order to better understand their perspectives, experiences, and methods of subsistence in the context of climate change. A household survey was used as part of the quantitative component to collect data on livelihood activities, asset ownership, household demographics, and adaption strategies and effects of climate change. This research used both qualitative and quantitative approaches, including an in-person survey where information was gathered using checklists and questionnaires (Maree, 2007). Macmillan and Schumacher (2001) define a survey research design as the use of questions or interviews to evaluate the current status, opinions, beliefs, and attitudes of a known population. In terms of the behaviors, opinions, and observations of a particular study topic, a survey aims to describe and comprehend the current situation.

### 3.2.1 Sampling Procedure

In order to guarantee a representative and varied sample of farmers in Binga District, the study used a variety of sampling techniques based on the research objectives. Purposive, stratified, and multistage sampling were used in the research to choose participants for data collection.

#### *3.2.1.1 Multi-stage Sampling*

The study area was sampled in three different stages from district to household level. In the first stage, the representative sample of wards were randomly selected, the second stage was selection of representative villages and the last stage was random selection of households to be interviewed in each of these villages. To capture different adaptation and coping strategies used across the district, the respondents were not treated as the same across. Stratified sampling grouped farmers using factors like; crop type grown by the farmer (e.g., maize, cotton, tobacco), livestock ownership (e.g., cattle, goats, chickens), and farm size (e.g., small, medium, large)

#### *3.2.1.2 Purposive sampling*

The researcher randomly selected farmers who have experienced El Niño-induced drought and have implemented resilience, adaptation, and coping strategies.

### 3.2.2 Sampling Techniques and Instruments

The 2022 census data from Zimbabwe was used to determine the sample size. Of the 39 495 families in Binga, 38 250 reside in rural regions and engage in small-scale farming, according to ZIMSTAT (2022). Farmers from six wards, which have a combined population of around 8187 homes, were the subject of this study.

**Table 1**: *Total Households per Sampled Ward*

| Ward | Total Population | Total Households |
|---|---|---|
| 2 | 6 257 | 1 610 |
| 5 | 5 218 | 1 357 |
| 7 | 5 128 | 1 701 |
| 13 | 6 225 | 1 291 |
| 19 | 4 727 | 1 338 |
| 22 | 5 979 | 890 |
| **Grand Total** | **31 780** | **8 187** |

*Source: ZimStat 2022*

The formula below was used to compute the sample size of households to be interviewed:

$$n = \frac{z^2 pq}{e^2}$$

Where,

*z* -is the 95% confidence interval's *z*-score; *p*- is the target population's share of the overall population; $q = (1 - p)$; and e is the margin of error.

Therefore, $$n = \frac{1.96^2 * \left(\frac{8187}{39495}\right) * \left[1 - \left(\frac{8187}{39495}\right)\right]}{0.05^2}$$

$= \mathbf{252}$

### 3.2.3Determining sample size at ward level

Kothari's proportional allocation formula (C. R. Kothari, 2004) was used to determine the sample size at the ward level.The sample size was proportionally allocated to the six wards as shown in the table using the formula:

$$ni = \frac{Ni * n}{N}$$

The sample size for Ward 2, Nabusenga, was determined as follows: $ni = \frac{1610*252}{8187}$ = 50

where *ni* is the total population of each stratum or sector, n is the study's total sample size, N is the overall population size, and ***ni*** is the sample size taken from each stratum or sector.

The sample size and proportional sample size for each ward in the different agro-ecological zones are shown in Table 3.2. Households were approximated as a proportion of sample household heads to total households.

**Table 2**: *Proportional Sample Size per Ward*

| Ward | Sample Households |
|---|---|
| 2 | 50 |
| 5 | 42 |
| 7 | 52 |
| 13 | 40 |
| 19 | 41 |
| 22 | 27 |
| Grand Total | **252** |

**Source:** *Research Results 2025*

252 households made up the study's sample size. The homestead settlement pattern in the district is unstructured; individuals choose to reside wherever they wish, taking into consideration water supplies, schools, health services, and space for farming and grazing. The district's data was gathered by stratified random sampling. Stratified random sampling is a version of random sampling, according to Saunders et al. (2009), where the population is divided into two or more relevant and homogenous strata according to the number of characteristics. A sample that is proportionately representative of each stratum is ensured by dividing the population into suitable strata.

Because the research only looked at six wards, each ward was a stratum, according to Cochran (1997). Data from every part of the ward was gathered by dividing the wards into villages. A consistent number of residences were sampled in each ward by dividing the sample size by the number of wards. Villages within the ward were then distributed to the 32 homes in proportion (Fink, 2003). Every hamlet in the ward had a household chosen at random. No more than five homes per village were questioned.

**3.3 Data collection methods**

Both primary and secondary sources of data were used in the investigation. A questionnaire with semi-structured questions served as the main study instrument. According to Dirwai and Gwimbi (2003), a questionnaire should be created such that it specifically meets the study's goals. This implies that the researchers' primary attention was on pertinent topics. The identical questions were posed to different responders in a questionnaire. In order for enumerators to utilize the questions during interviews, they were prepared in simple English. The socioeconomic features of the farmers who were questioned, their experiences with El Nino, and their opinions about the sustainability and efficacy of their adaptation plans in Binga District were all included in the questionnaire. Field observations, focus group discussions (FGDs), and key informant interviews (KIIs) were used to gather qualitative data. To guarantee clarity, four research assistants or enumerators received training on the procedures for gathering data and were acquainted with the instruments. Data was gathered using Android handsets, and the home questionnaire was submitted to the Kobo Collect platform. A hands-on gimmick exercise was used to teach the data gathering workers on all tools. Over the course of two weeks, in-person interviews were done with a few chosen farmers and other KIIs. For analysis, the data was imported into STATA 15.0 after being obtained in Excel format from KoboCollect.

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### 3.4 Data Analysis Methods

This study's data was analysed using descriptive, qualitative, regression (multivariate probit model), and spatial analysis. A descriptive analysis was conducted to evaluate how El Niño-induced drought affected farmers' livelihoods in Binga District, including crop yields, livestock productivity and household income. To summarize changes in agricultural yields, livestock production, and income, the researcher examined the mean, median, and standard deviation of the years under study. The research used a hybrid approach of qualitative and quantitative analysis to determine the factors that influence farmers' resilience and adaptation tactics in Binga District in response to drought brought on by El Nino.

A frequency distribution of techniques, such as agricultural diversification, irrigation, migration, and savings, was used in the research. A Multivariate Probit Model (MVP) was used to determine the factors that influence choice of adaption strategies. Since farmers may adopt multiple strategies, MVP was an appropriate model to use. The MVP model $Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon$ where: $Y_i$ = Different adaptation strategies (binary: 1 = adopted, 0 = not adopted) and $X_n$ = Determinants (for instance, education, income, land size, and access to credit)

The study further investigated the coping mechanisms used by farmers in Binga District to mitigate the effects of El Nino-induced drought, including the role of social networks, credit facilities, and government support programs. Descriptive analysis of coping strategies involved frequencies and percentages of different strategies employed (for instance, selling assets, and reducing food intake). Qualitative analysis from (KIIs & FGDs) data was used through thematic analysis of social networks' role, government response, and credit facilities.

The policy-driven objective on identifying policy and practical recommendations for enhancing resilience and adaptation used expert interviews and focus group discussions by engaging policymakers, NGOs, and farmers and thematic coding for best practices & gaps in policy. The study further employed the SWOT Analysis (Strengths, Weaknesses, Opportunities, and Threats) to analyze existing policies (for instance early warning systems, climate-smart agriculture, social protection programs) and identify gaps & opportunities for improvement.

#### 3.4.1 Descriptive Statistics

According to Field (2018), descriptive statistics are statistical methods for organizing, summarizing, and interpreting data. These statistics, which provide graphical representations and numerical summaries, aid researchers in comprehending the fundamental characteristics of the data (Weiss, 2016). Measurements of dispersion (range, variance, standard deviation), measurements of central tendency (mean, median, mode), and measures of distribution shape (skewness, kurtosis) are the primary categories of descriptive statistics (Tabachnick & Fidell, 2019). The median is a superior option when data is skewed since the mean, also known as the arithmetic average, is sensitive to outliers and is hence the most often used measure of central tendency (Gujarati & Porter, 2020). According to Field (2018), the standard deviation quantifies the degree of variability in data points by measuring their difference from the mean. While a large standard deviation denotes a wider range, a low standard deviation implies that data points are around the mean (Weiss, 2016). Furthermore, the distribution's asymmetry is evaluated by skewness, where a positive skew denotes a right-tailed distribution and a negative skew denotes a left-tailed distribution (Tabachnick & Fidell, 2019). Conversely, kurtosis characterizes the "peakedness" of a distribution; lower kurtosis suggests a flatter shape, whereas high kurtosis indicates a steep peak (Gujarati & Porter, 2020). In several disciplines, such as economics, the social sciences, and health research, descriptive statistics are often employed to condense big datasets prior to inferential analysis (Field, 2018).

### 3.4.2 Multivariate Probit Model

Many variables might affect farmers' coping strategies and adaptability to El Nino, but the multivariate probit (MVP) model was considered suitable since it made use of many chains of bivariate probit estimators. The facores that affect farmers' decisions about resilience, coping, and adaptation techniques were investigated in this research. Farmers are free to copy and modify in a variety of ways as long as the technique offers them a certain amount of advantages.

The most often used strategies were socioeconomic characteristics as independent variables and dependent variables in the study sector. The multivariate probit allows for the flexible association of the measurable and unobserved factors (error terms) while modeling the impact of the collection of explanatory variables on each of the many adaptation techniques (Lin et al., 2005; Green, 2003; Golob and Regan, 2002). According to Belderbes et al. (2004), the error terms' connection may result from complementarities (positive correlations) and substitutability (negative correlations) among the various adaptation strategy possibilities. Indigenous knowledge is one example of an unobservable household-specific quality that influences the selection of numerous adaptation alternatives but is hard to measure, which is another source of positive association.

Each adaptation method may be individually modelled as a function of a shared set of explanatory factors in this research using a univariate approach, such as probit analysis for discrete choice dependent variables. The drawback of this method is that it is susceptible to biases brought on by ignoring shared traits that may be invisible and unquantifiable yet have an impact on a variety of adaptation tactics. Some combinations of adaptation methods may be seen as competitive by farmers, while others may be seen as complimentary. According to Lin et al. (2004) and Golob and Regan (2002), the univariate approach may significantly contribute to statistical bias and inefficiency in the estimates by neglecting common components, which neglects the possibility of linkage among unobserved perturbations in adaptation techniques.

An eight-endogenous discrete choice variable complicated multivariate model may be substituted with a multinomial discrete choice model. For multinomial discrete choice variables, the choice set is made up of all potential adaptation measure combinations, or 2^6=64. An estimation of a multinomial logit (MNL) model is possible for a problem of this size (64 choices and 10 explanatory variables). The drawback of this approach is how difficult it is to comprehend how the independent variables affected the choice of each of the six initial individual adaptation approaches. MNL is only useful when irrelevant alternatives (IIA) have property independence.

Large MNP and mixed logit models may have their parameters estimated using both Bayesian and non-Bayesian simulation techniques; in these situations, estimation of a multinomial probit (MNP) and mixed or random coefficients (MNL) is more suitable (Golob and Regan, 2002). A multivariate choice system's multinomial replications all struggle to assess how explanatory variables affect the initial independent adaptation strategy, which is the technique's drawback. As shown below (Lin et al., 2005), the multivariate model, in contrast to ordinary least squares (OLS), ensures statistical efficiency in the assessment of available choices.

Each participant is assumed to have a covariate vector for the research, which might include any mix of continuous and discrete variables. Each subject creates m dichotomous categories. We define $u\_m$ as the set of observed dichotomous 0/1 responses in m variables.

The $i^{th}$ subject, $i = 1 \ldots n$, $x_{im}$ be a $k_i \times 1$ vector of a covariate, $k_1 + \cdots + k_m$ and

$$X_i = \begin{bmatrix} x'_{i1} & 0 & \cdots & 0 \\ 0 & x'_{i2} & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & x'_{iJ} \end{bmatrix},$$

be a $m \times k$ matrix. The following multivariate probit model was modelled by Chib and Greenberg, (1998). Let $z_i = (z_i l \ldots z_j m)'$ denotes a $M$-variate normal vector of "response strengths" so that,

$$z_{im} = \beta X_{im} + \varepsilon_{im} \quad i = 1, \ldots, n \qquad (1)$$

Where, $z_i$, represents the dependent variables of adaptation strategies by the $i^{th}$ farmer ($i = 1, \ldots, n$). The dependent variables are polychotomous variables indicating whether the farmer will choose the adaptation strategy. The adaptation strategies to be modelled are crop diversification, growing drought tolerant crops, change in planting dates, change in harvesting dates, practicing climate agriculture and income diversification. $\beta' = (b'_1, \ldots, b'_m)$, $b_m$ is a $k_m \times 1$ unknown parameter vector, $\varepsilon_{im}$ is a $M \times 1$ vector of residual that is distributed as $N[0, \Sigma]$. The equation (1) above is a system of $m$ equations shown below in equation (5)

$$z_{1i}^{*} = \beta'_1 X_{1i} + \varepsilon_{1i}$$

$$z^*_{2i} = \beta'_2 X_{2i} + \varepsilon_{2i}$$
$$z^*_{3i} = \beta'_3 X_{3i} + \varepsilon_{3i} \qquad (2)$$
$$z^*_{4i} = \beta'_4 X_{4i} + \varepsilon_{4i}$$
$$z^*_{5i} = \beta'_5 X_{5i} + \varepsilon_{5i}$$
$$z^*_{6i} = \beta'_6 X_{6i} + \varepsilon_{6i}$$

The latent dependent variables are observed through the decision by a farming household to adopt or not ($z_{ki}$) that;

$$u_{ij} = \begin{cases} 1 \; if \; z_{im} > 0 \\ 0 \; otherwise \end{cases}, m = 1, \dots, n \qquad (3)$$

$$Y_i = 1 \text{ if } X'_i \beta_i + \varepsilon_i > 0 \qquad (4)$$

$$Y_i = 0 \text{ if } X' + \varepsilon_i < 0, \; i = 1, 2, 3, \dots n \; (5)$$

where:

$Y_i$ – represent a vector of dependent variables where each serve as an adaptation choice.

$X'$ - represent a vector of explanatory variables

$\beta_i$ - represent a vector of coefficients

$\varepsilon_i$ - represent a random error term and ***n*** –number of observations, *0*- means a unitary variance.

There are twelve probabilities, which correspond to twelve different combinations of selecting and not choosing each of the six adaption strategies. The likelihood that a household has chosen all six adoption strategies *(i)* is given as follows;

$$\Pr(X_{1i} = 1, X_{2i} = 1, X_{3i} = 1, X_{4i} = 1, X_{5i} = 1, X_{6i} = 1, X_{7i} = 1) = pr(\varepsilon_{1i} \leq \beta_{1i} X_{1i}, \varepsilon_{2i} \leq \beta_{2i} X_{2i}, \varepsilon_{3i} \leq \beta_{3i} X_{3i}, \varepsilon_{4i} \leq \beta_{4i} X_{4i}, \varepsilon_{5i} \leq \beta_{5i} X_{5i}, \varepsilon_{6i} \leq \beta_{6i} X_{6i}, \varepsilon_{7i} \leq \beta_{7i} X_{7i}, \varepsilon_{8i} \leq \beta_{8i} X_{8i}, \varepsilon_{9i} \leq \beta_{9i} X_{9i}, \varepsilon_{10i} \leq \beta_{10i} X_{6i}, \varepsilon_{6i} \leq \beta_{6i} X_{6i}) \qquad (6)$$

Therefore, the multivariate probit regression model for this research is expressed in the following form;

$$(IncmDiv = AgeHH \; Gender \; HHSize \; Educ \; Occup \; FarmExp \; AccssCrdt \; AccssCCInfo \; Training) \; (Forecast = AgeHH \; Gender \; HHSize \; Educ \; Occup \; FarmExp \; AccssCrdt \; AccssCCInfo \; Training) \; (PlantTim = AgeHH \; Gender \; HHSize \; Educ \; Occup \; FarmExp \; AccssCrdt \; AccssCCInfo \; Training) \; (HarvTim = AgeHH \; Gender \; HHSize \; Educ \; Occup \; FarmExp \; AccssCrdt \; AccssCCInfo \; Training)(CrpDiv = AgeHH \; Gender \; HHSize \; Educ \; Occup \; FarmExp \; AccssCrdt \; AccssCCInfo \; Training)(PDTC = AgeHH \; Gender \; HHSize \; Educ \; Occup \; FarmExp \; AccssCrdt \; AccssCCInfo \; Training)(FarmTech = AgeHH \; Gender \; HHSize \; Educ \; Occup \; FarmExp \; AccssCrdt \; AccssCCInfo \; Training)(Other = AgeHH \; Gender \; HHSize \; Educ \; Occup \; FarmExp \; AccssCrdt \; AccssCCInfo \; Training)$$

Where *CrpDiv* denotes crop diversification. *TlrntCrps* is growing drought-tolerant crops. *PlntngDts* is the timing or change of planting dates, whereas *HrvstngDts* is the timing or change of harvesting dates. *FrmTech* is farming technologies (for example, Climate Smart Agriculture), *IncmDiv* is income diversification, and *Frcstng* is forecasting. *AgeHH* refers to the age of the household head. *Sex* refers to the gender of the home leader. *FarmExp* is the agricultural experience of the family head. *Educ* refers to the respondent's education level. *HHSize* refers to the number of family members in a household. *FarmSize* is the size of arable land owned by a household. *AccssCrdt* refers to a household's access to credit. *AccssInfo* represents the household's access to climate change information, and *Trning* represents the household's climate change training.

### 3.5 Measurement of Variables

The study uses adaptation strategies adopted as endogenous variables and the determinant as the independent variables. Table 3.3 shows the dependent variable and the subsequent table defines the independent variables and their expected signs.

#### 3.5.1 Dependent Variables

**Table 3.3**: *Definitions of Dependant Variables*

| Variable | Description |
|---|---|
| Crop diversification | Farmers are growing more than one crop in the same farming season. |
| Growing drought-tolerant crops | Formers are growing crops that resist dry spells and high temperatures. |
| Change in planting dates | Farmers are following the rainfall update to decide when to plant their crops |
| Change in harvesting dates | Farmers are harvesting early to avoid risks |
| Farming technology (Climate Smart Agriculture) | Farmers are adopting and using climate-smart agriculture technologies |
| Income diversification. | Farmers have other sources of income which not agricultural-related |
| Forecasting | Farmers can forecast weather patterns and make decisions |

Source: *Field Research*

The dependent variables which are adaptation strategies used by farmers are defined as 1 when the farmer adopts or uses the strategy and 0 when the farmer is not using the strategy.

### 3.5.2 Explanatory Variables

**Table 4**: *Definitions of Independent Variables*

| Variable | Description | Expected Sign |
|---|---|---|
| Age | Age of the household head (HH) ( years) | + |
| Sex | Gender of the HH (Dummy:1=Male, 0= if otherwise) | + |
| Farming Experience | Farming experience of the household head (years of farming) | + |
| Education | Level of education of household head | + |
| Household Size | Number of family members in a household who provide labour | + |
| Farm Size | Farm size (measure in hectares) | ± |
| Access to Credit | Access to credit facilities (1= for access to formal credit, 0 if otherwise), | ± |
| Access to information | Access to climate information (1=for access to, 0 if otherwise) | + |
| Trainings Received | Any training previously attained on climate change (1=HH had any training, 0 if otherwise). | + |

Source: *Field Research*

The aforementioned model was used to ascertain the importance of independent factors in determining choice of adaptation strategy in order to achieve the desired study goals. The model was empirically supported by testing the impact of explanatory factors on income using econometric analysis, a particular viewpoint on the function of economics.

### 3.5.3 Justification of Variables

The variables of the research study were justified as shown in the subsections below. These variables are subject to additions or subtraction. Variables which do not suit the study area were omitted and those that suited were added as the research was carried on. The adaptation techniques used by families (1=adopted, 0=if not, see Table 3.3) are the study's dependent variables. Information availability and prior research were taken into consideration while selecting the independent (explanatory) factors. These included factors including gender, family size, education, agricultural experience, farm size, loan availability, and household income.

**Age (AgeHH)**

The total number of years for the household head is represented by this continuous variable. The choice of certain climate change adaption techniques is likely to be positively impacted by the number of droughts and other climate change repercussions that household heads have encountered during the length of their tenure in charge. Young farmers may be more inclined to take a risk and use better agricultural methods as they are more knowledgeable about optimum farming practices (Sofoluwe et al., 2011). Similarly, a negative coefficient for farmer age was observed in a research by Opaluwa (2020) and was statistically significant at the 10% level. Accordingly, farmers were less likely to choose the adaptation strategy as they became older.

Crop diversification as an adaptation technique is thought to be less appealing to elderly farmers. Farmers' exposure to different agricultural methods, experiences, and seasons is influenced by their age. Accordingly, it is believed that a farmer's age will positively affect how they perceive climate change (Shiferaw & Holden, 1998). Age was expected in this research to influence the adoption of adaptation techniques (or climate change adaptation) in both positive and negative ways.

**Sex (Gender)**

Households with one male and one female head are represented by the values of this variable. Given their greater involvement in agriculture and other livelihood activities in rural regions, it is anticipated that families headed by women would have more adaptation options than their male counterparts. Male respondents made up the majority (70.43%) of the respondents in the research by Opaluwa et al. (2020) on factors influencing decisions on climate change adaptation techniques. Men in the sample were more engaged in farming than women, according to the research. According to this, agricultural families in the research region are dominated by men. Women make up the majority of the labor force in agriculture, hence this has implications for gender equality and demands for their mainstreaming. According to Coster and Adeoti (2015), male dominance is commonly ascribed to the harsh conditions of peasant farming, which mostly involves physical labor. Given Africa's patriarchal cultural norms, where women are seen as "inferior" and are not allowed to speak on behalf of the home head, Antube et al. (2021) found that more agricultural families were led by males.

**Farm Experience (FarmExp)**

This variable, which is continuous, is related to how long the farmer has been engaging in community farming and other rural agricultural practices. Farmers with more years of agricultural expertise are more adaptable to the impacts of climate change because they use varied techniques. As a result, the agricultural experience will favorably impact certain decisions on climate change adaptation tactics.

**Education (Educ)**

The family has attained this degree of schooling. It is anticipated that households with higher levels of education would implement more climate change adaptation methods than households with lower levels of education. Opaluwa et al. (2020) claim that a farmer's educational attainment reveals how they apply or absorb agricultural knowledge. Since educated people are better able to get information, Idrisa et al. (2012) discovered that education is essential to increasing awareness in agricultural communities. According to Deressa et al. (2008), formal education increases awareness of climate change and the likelihood of adaptation. Ojo and Baiyegunhi (2018) assert that agricultural experience and education play a significant role in determining which adaptation strategy farmers choose to use. Enhancing education and information sharing is a crucial policy tool for promoting local participation in a range of development and natural resource management initiatives, according to many studies (Glendinning et al., 2001; Dolisca et al., 2006; Anley et al., 2007; Tizale 2007). It is anticipated that teaching farmers adaptation techniques would improve their ability to make decisions.

**Household Size/Labour (HHSize)**

The total number of family members who are able to provide agricultural labor to the household unit is known as the household or family size, and it is a continuous variable. Large family households were predicted to have more people who could work on the farm and provide a variety of climate change adaptation options. Consequently, it is anticipated that family size would affect how a household adapts to the consequences of climate change. According to Opaluwa et al. (2020), the majority of households (67.83%) had one to five people, followed by those with six to ten people (24.4%) and those with eleven or more people (7.83%). In rural Nigeria, the average household size was 5.3 people, which is comparable to the national average of 5 people (NBS, 2009). For family agricultural labor on adaption tactics, this average household size may be advantageous. Given that family labor provides all of the labor needed to carry out farming and adaptation techniques, this is in line with Keil's (2001) observation that the size of the household affects farmers' decisions to use adaptation strategies. A large family size may facilitate the harmonization, perception, discussion, and sharing of climate-related observations, hence improving farmers' perceptions of climate change. A bigger family may rely more heavily on hired labor, which contributes to a negative climate change view. According to Shiferaw and Holden (1998), the size of a family may have a beneficial or negative impact on farmers' perceptions of climate change.

**Farm Size (FarmSize)**

This continuous variable indicates the amount of arable land that the household either owns or has access to for farming. The likelihood that a household will be able to adjust to the consequences of climate change is greater for households having enough and quality land holdings. A strong correlation between land holding and climate change adaptation options, such as crop diversification, was also anticipated by the research, which aims to explore the factors influencing rural farming families' decisions about adaption techniques in Binga District.

**Access to Credit (AccssCrdt)**

This speaks to the household's capacity to get loans from lenders. If the farmer has access to credit, the variable will take on a value of 1, and if not, it will take on a value of 0. Compared to farmers without access to any kind of credit facility, those who have access to loans are better equipped to adjust to the effects of climate change. Farmers who obtained credit (=1) and those who did not (=0) were the two groups into which the credit access variable was divided. Access to credit eases liquidity restrictions, which promotes the uptake of technology (Simtowe and Zeller, 2006). Therefore, it is anticipated that finance availability and the likelihood of implementing climate change adaptation measures would positively correlate.

**Access to Information (AccssCCInfo)**

More options for adaption techniques are available to farmers who have access to knowledge than to those who do not. This variable is a dummy variable that returns a value of 0 for farmers who do not have access to climate change information and a value of 1 for farmers who do. It is anticipated that farmers who have access to knowledge on climate change would be able to implement techniques such as growing drought-tolerant crops, diversifying their crop rotation, and timing planting and harvesting. It is also envisaged that farmers having access to information would be able to predict the weather and adjust their farming practices appropriately. Perception of climate change might be improved by having access to regular climate information sources like newspapers, radio, and television, and vice versa. Farmers are better equipped to adapt to changes in the environment when they have access to better climate and agricultural information (Baethgen et al., 2003). Accordingly, it is anticipated that farmers' access to extension contact would improve their perspectives of climate change, which is consistent with the research on technology adoption (Amsalu and de Graaff, 2007).

**Agriculture Training Received (AgricTrain)**

Most farmers who received training on climate change are expected to have more adaptation choices than those who did not receive any capacitation. This variable looks at how a farmer's decisions on climate change adaptation tactics are influenced by their training on the subject. A shift in the planting date was chosen as an adaptation technique after receiving training on climate change (Opaluwa, 2020). This suggests that farmers were more likely to use a shift in planting date as an adaptation strategy if they had received more training on climate change. To put it another way, farmers who get more climate change training are more likely to adopt the altered planting date as an adaptation tactic.

### 3.6 Diagnostic Tests

The researcher performed diagnostic tests on the model and variables using an econometric software. The purpose of these tests was to verify the validity of the parameters that were derived from a regression analysis. In order to determine if they exist in the model being employed, a number of econometric issues include both qualitative and quantitative data. In this study, the econometric issues of model definition and multicollinearity were examined. This was done in order to make sure that the data and the model were not in violation of previous requirements as well as economic principles and theories.

#### 3.6.1 Multicollinearity

When there is a strong but imperfect correlation between two or more variables, this is known as multicollinearity. The word originated with Frisch, a statistician, in 1934. The correlation coefficient for each pair of independent variables was determined using the correlation matrix in order to identify the existence of multicollinearity. A correlation between the two regressors of ≥0.8 indicates that the two variables are severely multicollinear. However, if the two independent variables' values are less than 0.8, multicollinearity is not severe. The study will exclude one of the collinear variables if significant multicollinearity is found. A "do nothing" strategy may be used if multicollinearity is not a severe problem, according to Blanchard (1987). It is challenging to generate coefficients with minimal standard errors as a result of multicollinearity. For the multicollinearity test, the following was the hypothesis:

$H_0$: There is no perfect linear relationship among regressors.

$H_0$: There is a perfect relationship among regressors.

In order to determine that there is no severe linear multicollinearity, we do not reject the null hypothesis if the correlation values between the independent variables are less than 0.8..

### 3.6.2 Goodness of Fit Test

Goodness-of-fit tests assess how well a statistical model explains the observed data. In the context of a Multivariate Probit (MVP) Model, goodness-of-fit measures how well the predicted probabilities of adaptation strategies match the actual choices of farmers in response to El Niño-induced drought. Since the MVP model involves multiple binary dependent variables with correlated error terms, standard fit measures (like $R^2$) used in linear regression are not applicable. Instead, specialized log-likelihood-based and classification-based goodness-of-fit tests are used (Greene, 2018).The importance of the goodness of fit test includes; assessing model accuracy by determining whether the MVP model appropriately predicts farmers' adaptation strategies, model comparison which helps select the best-fitting model by comparing different specifications, and validation of results to ensure that policy recommendations are based on a well-fitting model. The study used the Log-Likelihood Ratio Test to compare the log-likelihood of two nested models:

- Null model (restricted): Includes only the intercept (baseline model).
- Full model (unrestricted): Includes all explanatory variables.

The hypothesis for this test is as below;

$H_0$: The restricted model (no predictors) is as good as the full model.

$H_1$: The full model has a significantly better fit.

If p-value < 0.05, we reject $H_0$ and conclude that the full model is significantly better, however, if the p-value > 0.05, we fail to reject $H_0$ and conclude that the predictors do not improve model fit.

### 3.6.3 Model Specification

One of the presumptions of many regression models in econometrics is that the model being used is well described (Gujarati and Porter, 2008). The model will have specification bias if this assumption is not true. The Durbin-Watson Test and the Ramsey RESET Test are only two of the tests that may be used to look for specification problems in the model. The Wald test will be used in this investigation to see if any variables were left out of the model. If the Prob<Chi2 is less than 0.05, it indicates that certain variables were left out and the model is not properly defined. The test's hypothesis was as follows:

$H_0$: The model is correctly specified

$H_1$: The model has omitted variable

The decision rule is that we do not reject the null hypothesis if the Prob<Chi$^2$ is greater than or equal to 0.05 and conclude that the model is correctly specified.

### 3.7 Ethical Considerations

Research must take ethics into account, especially when farmers and other stakeholders are involved. Getting informed permission and maintaining secrecy to safeguard participants' names and private data are important ethical guidelines (Bless & Higson-Smith, 2000). Objectivity and the avoidance of bias in data collection and analysis are crucial to maintaining research integrity (Creswell & Creswell, 2018). Additionally, respect for local knowledge and practices ensures that the research is culturally sensitive and beneficial to the community (Smith, 2012). Transparency in reporting and disseminating findings fosters trust and accountability (Bryman, 2016). Furthermore, researchers must ensure that their work does not cause harm to participants or the environment (Israel, 2015). In line with ethical guidelines, participants' rights will be upheld throughout the data collection process (Bless & Higson-Smith, 2000).

Participation in interviews was entirely voluntary, and informed consent was obtained before administering the tool, ensuring that individuals take part of their own free will. Confidentiality and anonymity was strictly maintained, with the collected data used solely for the stated research purpose. This approach aligns with ethical standards in social research, ensuring respect for participants' rights and the integrity of the study (Neuman, 2014).

### 3.8 Conclusion

To sum up, this study's approach offers a strong foundation for examining how farmers in Binga District are affected by the drought brought on by El Niño. A more comprehensive assessment of the respondents' socioeconomic traits and the sustainability and effectiveness of their adaption strategies is made possible by the mixed-methods methodology. A wide variety of farmer experiences and insights are guaranteed to be included in the study thanks to the meticulous selection of sample strategies and data gathering methodology. This chapter developed the model, and the next chapter went into great detail on the tests that were conducted. The study used primary data that was subjected to Maximum Likelihood Estimation (MLE) in a statistical program. Overall, this chapter's methodological rigor lays the groundwork for the research and conclusions that follow, eventually supporting the study's objective of strengthening smallholder farmers' resilience and ability for adaptation. The next chapter then provided a presentation and interpretation of the findings.

# CHAPTER FOUR
# RESULTS & DISCUSSIONS

## 4.0 Introduction

This chapter summarizes the results of a study on how the drought caused by El Niño affects farmers' lives in Binga District. In order to uncover the socioeconomic traits of the participants, the detrimental effects of drought, and the resilience and adaptation strategies employed by farmers, the data gathered from 252 households via surveys and interviews is reviewed. The study goals are addressed and important insights into the difficulties farmers encounter, their coping strategies, and the variables affecting their actions are highlighted in the topically structured results. Regression (multivariate probit model) findings are also shown in this chapter. The data analysis in this research was done using spatial analysis. This section includes the findings of the diagnostic tests, their presentation, and their interpretation. Excel was used for the descriptive analysis, while Stata 15.0 was employed for the regressions and diagnostic tests. This well-organized lecture seeks to provide a clear grasp of the study findings and how they affect practice and policy. A tabular summary of the findings was provided so that the analysis and significance

## 4.1 Socio-economic Characteristics

This component of the research presents the farmers' demographics and socioeconomic status. Results were shown in tables, graphs, and charts pertaining to socioeconomic factors such as age, gender, household size, education, farm size, and profession.

**Age of Respondents (n=252)**

The graph below shows the age distribution of the interviewed farmers.

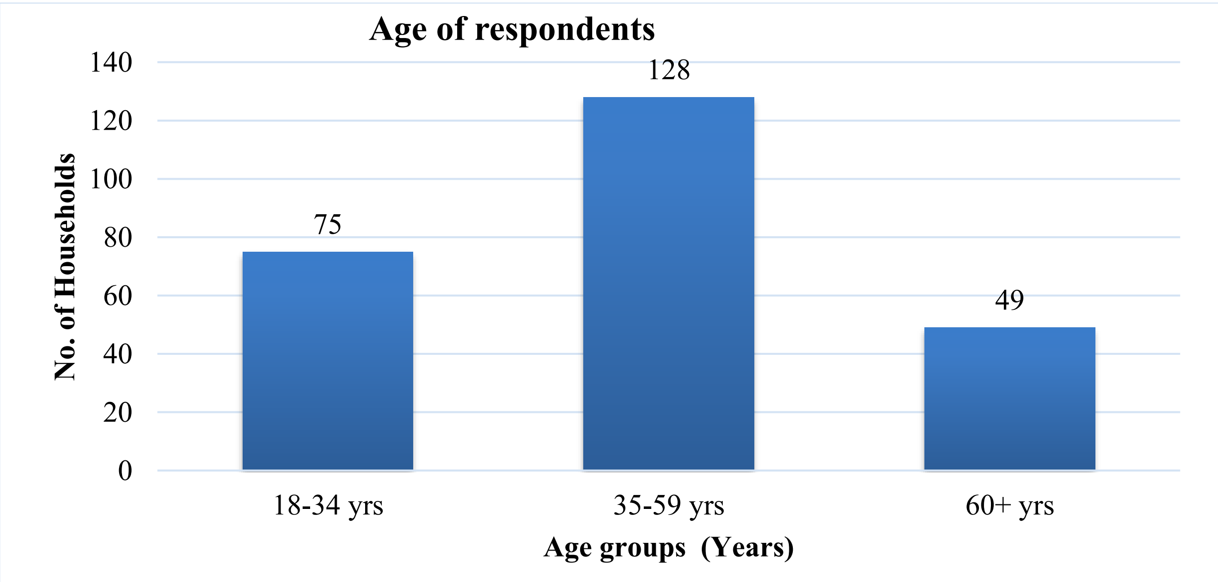


*Figure 4.1: Age of Respondents*

The results show that the majority of respondents (50.8%) are between 35-59 years old. Almost a third (29.8%) of respondents are between 18-34 years old. A significant proportion (19.4%) of respondents are 60 years or older. The average age of the respondents was 43.6 years. These results can help identify the age demographics of the farming community and inform strategies for supporting farmers across different age groups.

**Sex of Respondents (n=252)**

The respondents' gender is shown on the pie chart below for all the sampled wards.

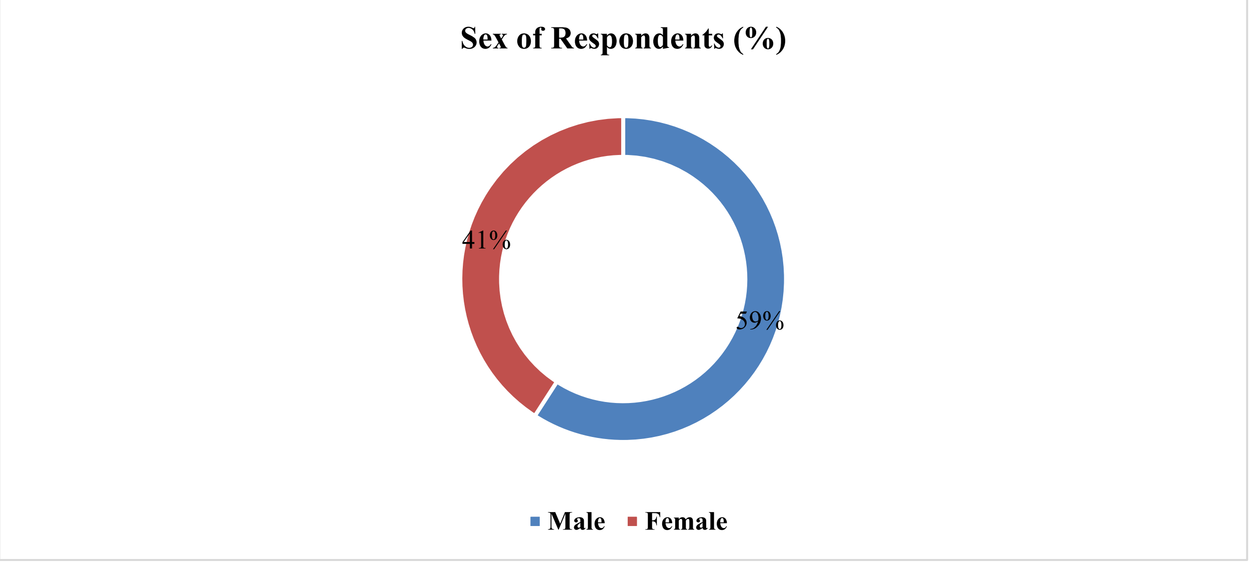


*Figure 4.2: Gender of Respondents*

Males make up the majority (59%) of respondents, indicating a slightly higher representation of male farmers in the sample. Females account for a significant proportion (41%) of respondents, highlighting the important role women play in farming in this community. These results can help identify the sex demographics of the farming community and inform strategies for supporting farmers, taking into account the needs and perspectives of both male and female farmers.

**Household Size Distribution (n=252)**

Household size is one of the independent variables that determine the choices of adaptation and coping strategies employed by farmers in Binga. The distribution of household sizes is shown in the graph below.

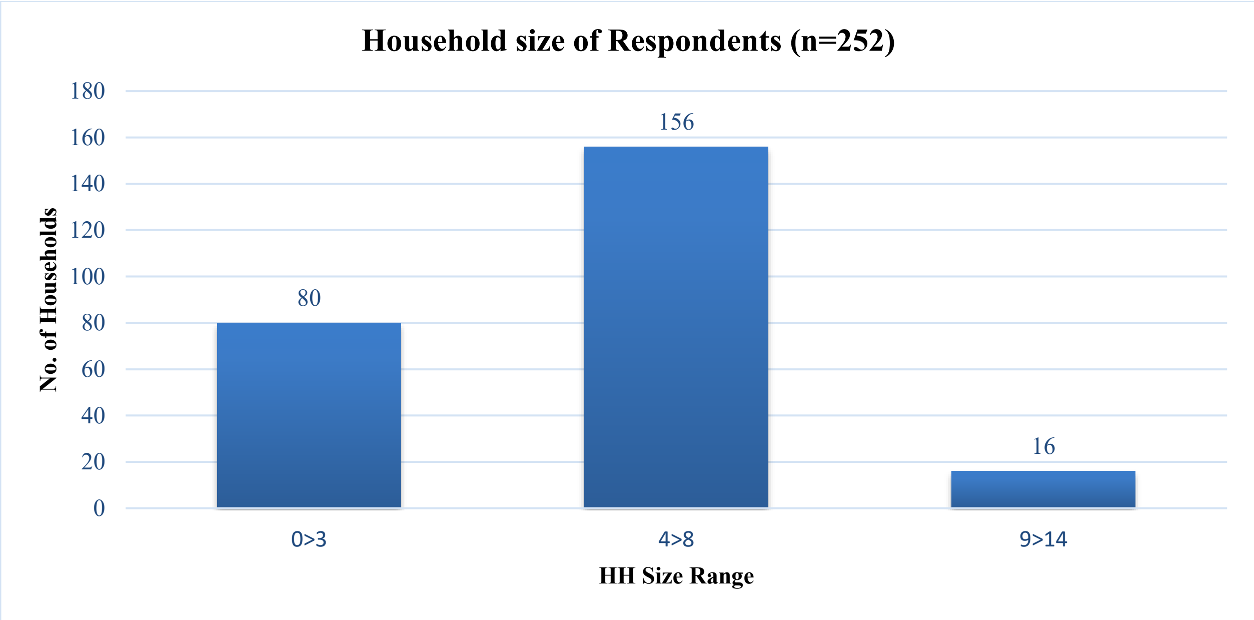


*Figure 4.3: Household Size Distribution*
**Source:** *Research Results, Feb 2025*

The results show that the majority (61.9%) of households have 4-8 members, indicating a moderate household size. A significant proportion (31.7%) of households have 0-3 members, suggesting a smaller household size. A small percentage (6.3%) of households have 9-14 members, indicating a larger household size. The average household size is 4.8 members. This suggests that the average household size is moderate, with approximately 5 members per household. These results can help identify the household size demographics of the farming community and inform strategies for supporting farmers, taking into account the needs and resources of households of varying sizes.

**Education of Household Head (n=252)**

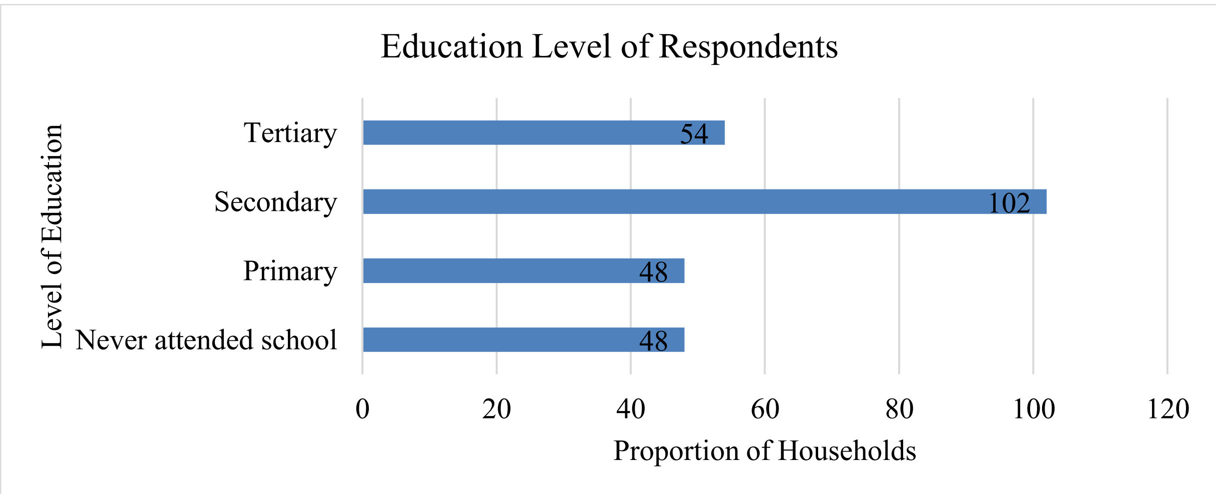


*Figure 4.4: Household Head Level of Education*

The results show that (40.5%) of respondents have a secondary-level education. A significant proportion (21.4%) have a tertiary education. Approximately 1 in 5 (19.0%) respondents have only a primary level education. A similar proportion (19.0%) have never attended school or are illiterate (could not read or write). These results highlight the varying levels of educational attainment among the farming community.

The data suggests that there is a significant proportion of respondents with secondary and tertiary education, indicating a relatively high level of educational attainment. However, a substantial proportion of respondents have limited or no formal education, which may impact their access to information, technology, and other resources. These findings can inform strategies for supporting farmers, taking into account their educational backgrounds and potential needs for training, capacity building, and extension services.

**Household Head Occupation (n=252)**

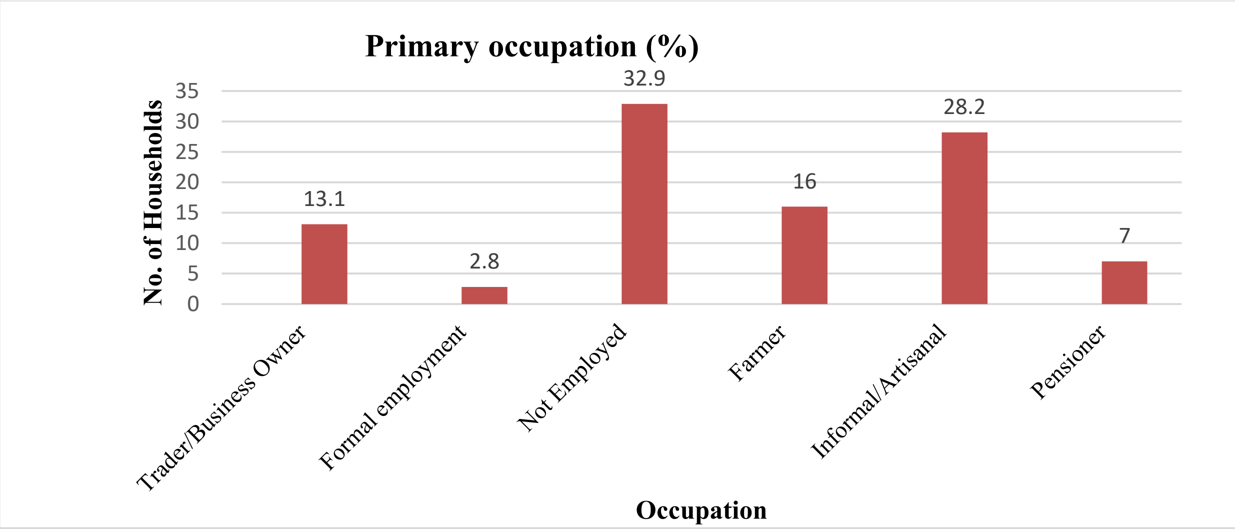


*Figure 4.5: Household Head Occupation*

The majority (32.9%) of respondents are not employed, indicating a high level of unemployment or inactivity. Informal/Artisanal work is the second most common occupation (28.2%), suggesting a significant proportion of respondents engage in informal economic activities. Farmers make up only 16% of respondents, which is lower than expected. Trader/Business owners and Formal employment make up smaller proportions (13.1% and 2.8%, respectively). Pensioners account for 7% of respondents. These findings highlight the diverse occupational backgrounds of the respondents, with a significant proportion engaged in informal economic activities or not employed. The relatively low proportion of farmers may indicate that the survey captured a broader range of occupations beyond farming. These results can inform strategies for supporting respondents, taking into account their occupational backgrounds and potential needs for training, capacity building, and economic empowerment.

**Household Sources of Income**

The bar chart below shows the income sources for farmers in Binga district.

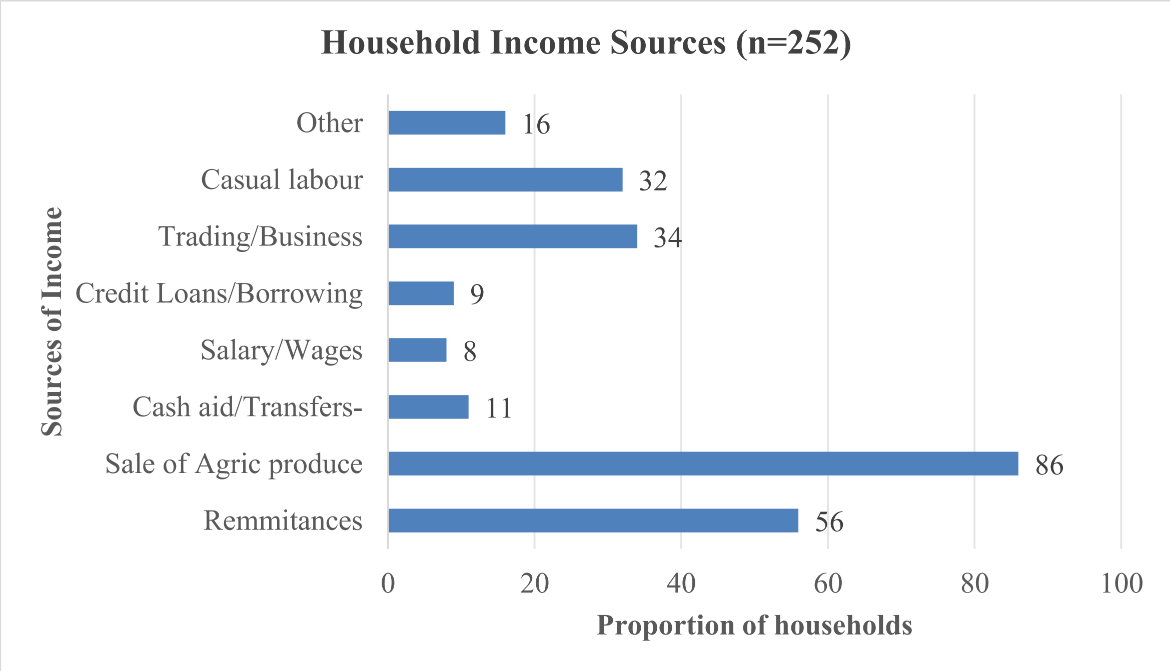


*Figure 4.6: Main Sources of Income*

Most households (86%) rely on sales of agricultural produce sales as their main source of income. Farmers sale excess crops or livestock to earn money for other non-food uses like school fees, medication and purchase of inputs. Remittances are the second source of income at 56%, however some households/farmers rely on trading (34%), casual labour (32%) and other sources (16%). Cash transfers, Credit Loans and Salaries are the least sources of income with 11%, 9% and 8% respectively.

**Livestock Ownership**

Farming in the district includes crop and livestock production at a smaller scale. Livestock production serves as a supplementary livelihood. The pie chart below shows the type of livestock owned by farmers in Binga district.

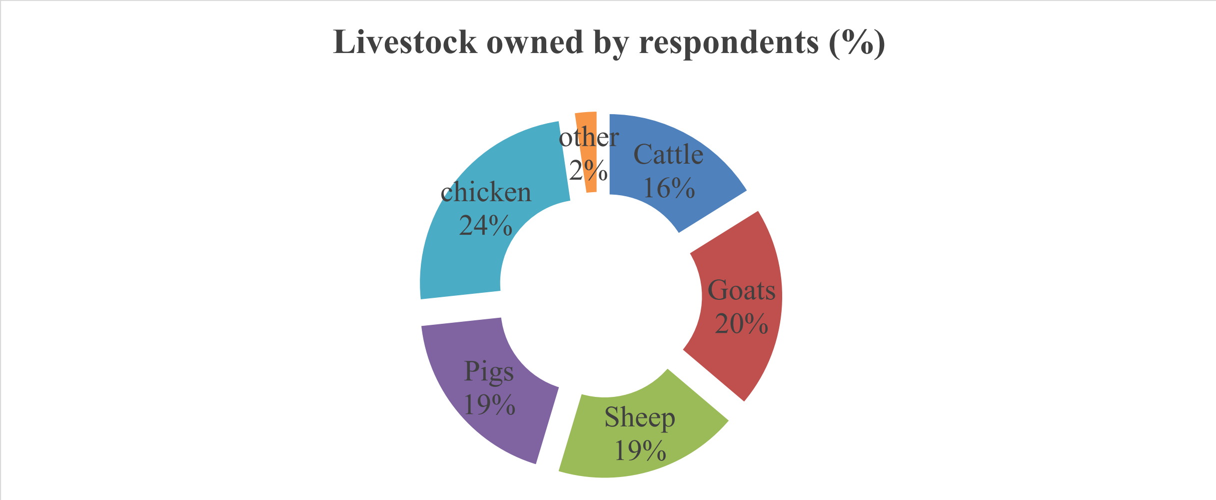


*Figure 4.7: Livestock Ownership by Farmers*
*Source: Own Research*

*Implications on Resilience and Adaptive Capacities*

The diversification of livestock ownership suggests that households are adapting to climate-related stressors by spreading risk across different livestock species. Chicken, goats, pigs, and sheep are relatively drought-resilient livestock species, which can provide a stable source of income and food during droughts. Cattle, being more water-dependent, may be more vulnerable to drought impacts.

**Crop Varieties or Diversification**

Farmers in Binga have been diversifying crop varieties. Most farmers have been planting more than on crop in the seasons under review.

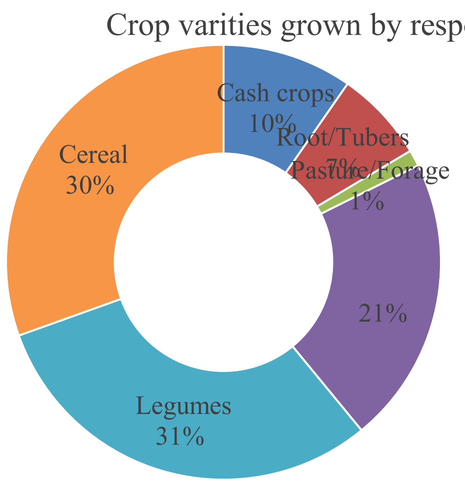


*Figure 4.8: Crop Production*
***Source:*** *Farm household survey results Feb 2025*

*Implications for Resilience and Adaptive Capacities*

The high proportion of legumes and cereals indicates a reliance on drought-prone crops, making households vulnerable to El Niño-induced drought impacts. The presence of root/tubers (21%) suggests some level of diversification, which can enhance resilience. The relatively low proportion of cash crops (10%) may limit households' ability to generate income and purchase drought-tolerant crop varieties.

**Farm Sizes of Households**

The figure below shows the distribution of farm size in hectares

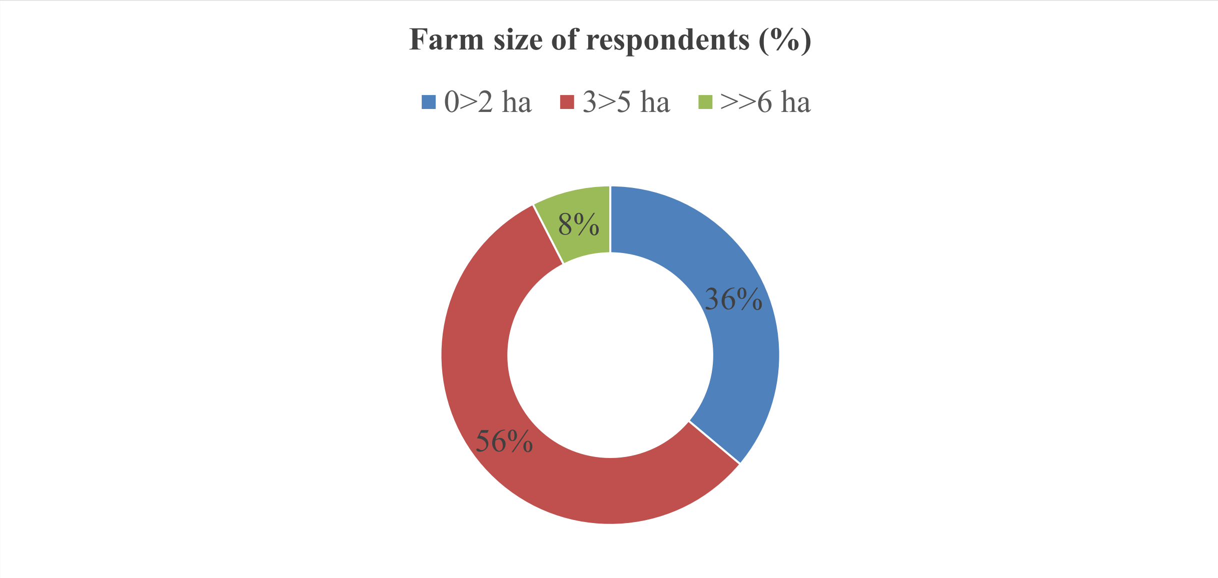


*Figure 4.9: Farm Size Distribution*
**Source:** Own Research

The majority (56%) of households own relatively small to medium-sized farms (3-5 ha), which may limit their ability to diversify crops and livestock, making them more vulnerable to drought impacts. A significant proportion (36%) of households own very small farms (0-2 ha), which may indicate limited resources and capacity to adapt to droughts. A small proportion (8%) of households own larger farms (>6 ha), which may provide more opportunities for diversification and resilience.

**Farming Experience for Households (n=252)**

Households with more farming experience were expected to employ more adaptation strategies than those with fewer years of agriculture. The distribution of land for farmers is represented in the bar graph below.

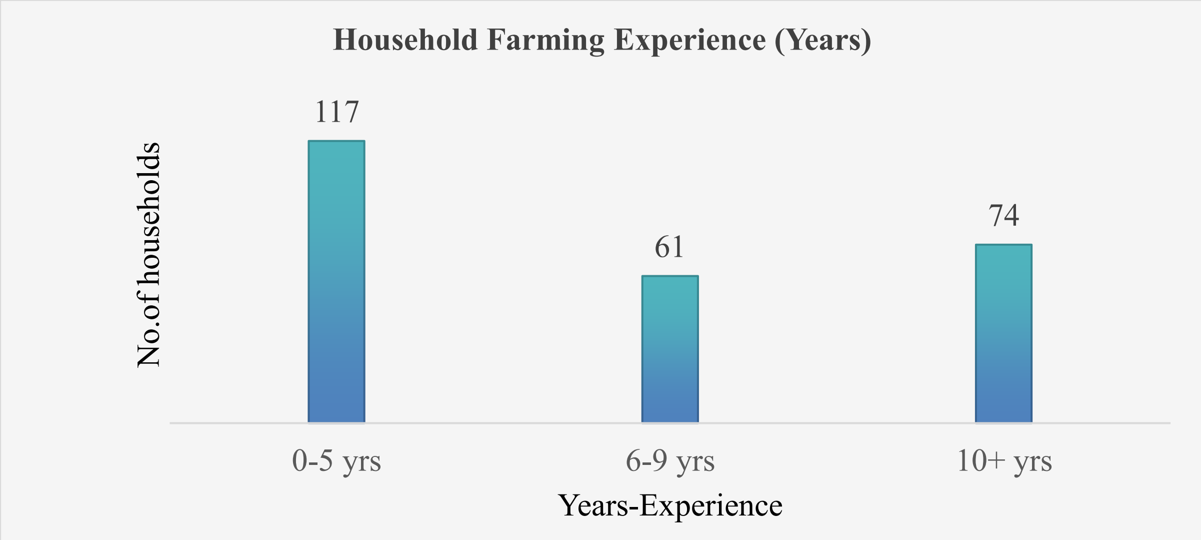


*Figure 4.10: Farming Experience*
*Source: Own Research*

According to the statistics, 47% of farmers have been farming for 0–5 years, 29% have been farming for 6–9 years, and 24% have been farming for 10+ years. This distribution of agricultural expertise is intriguing since it implies that the farming industry is dominated by newcomers.. The high percentage of farmers with 0-5 years of experience indicates that many new farmers are entering the sector. This could be due to various factors, such as government initiatives, non-governmental organisation (NGO) support, or changing economic conditions. Experienced farmers are a significant minority. The 24% of farmers with 10+ years of experience represent a significant minority. These experienced farmers likely possess valuable knowledge and skills, which could be leveraged to support newer farmers. Mid-career farmers are relatively few. The 29% of farmers with 6-9 years of experience seems to be relatively fewer compared to the other two groups. This could indicate that farmers either exit the sector or gain significant experience within the first 5-6 years.

**Access to Credit by respondents**

Preceding chart shows the access to credit by farmers. The study looked at how farmers can access loans from commercial banks, microfinance institutions (MFIs) and any other facilities that offer agricultural loans.

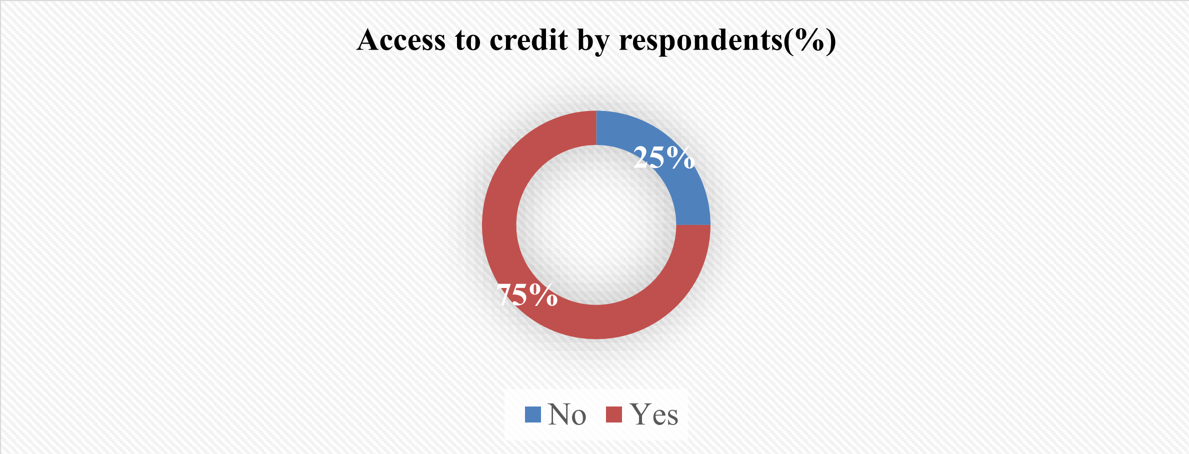


*Figure 4.11: Farmers' Access to Credit*

The majority (75%) of households have access to credit, which can enhance their resilience and adaptive capacities to drought impacts by providing financial resources to:

- Purchase drought-tolerant crop varieties and livestock
- Invest in irrigation infrastructure
- Access climate information and advisory services
- Diversify livelihoods and income sources

However, a significant proportion (25%) of households lack access to credit, making them more vulnerable to drought impacts due to limited financial resources.

**Impact of El'Nino-induced drought on Crops and Livestock**

**Table 5**: *Impact of El'Nino on Maize Production in Binga (Season 2023-24)*

| ***Province*** | **District** | **2024 Production (MT)** | **2023 Production (MT)** | **Difference (MT)** | **Change (%)** |
|---|---|---|---|---|---|
| ***Matabeleland North*** | Binga | 12092 | 33818 | -21726 | -64% |

*Source: AKADEMIYA2063, AAgWa,2024*

**Table 6**: *Proportion of Households Experienced Agri-Related Shocks in Binga*

| District | Prolonged mid-season dry spell % | Cash shortage | Cereal Price changes- a sharp increase % | Livestock price changes- a sharp drop % | Livestock deaths % | Livestock diseases % | Crop pests % |
|---|---|---|---|---|---|---|---|
| Binga | 84.1 | 58.5 | 87.0 | 42.1 | 25.2 | 17.6 | 11.0 |

**Source**: *ZimLAC, 2024- Matabeleland North, Provincial Report*

According to the report in Matabeleland North Province, Binga district recorded highest number of livestock deaths (25.2) due to El'Nino-induced drought during the 2023-2024 period.

### 4.2 Negative impact of El Niño-induced drought on Farmer's Livelihoods

Farmers outlined several effects of El Niño on livelihoods. These effects included an increase in pests and diseases, sudden changes in weather, food shortages for both humans and livestock, poor yields, soil erosion, rising temperatures, animal deaths, fluctuations in rainfall, and fish migration.

**Table 7**: *Observed Effects of El'Nino Induced Drought*

| Value | Frequency | Percentage |
|---|---|---|
| The poor yield of crops | 203 | 70.98 |
| Death of animals | 192 | 67.13 |
| Scarcity of resources (food and water) | 183 | 63.99 |
| Increase in temperatures | 152 | 53.15 |
| Erosion/flooding | 151 | 52.8 |
| Increase in pest and disease infestation | 145 | 50.7 |
| Sudden change in weather condition | 144 | 50.35 |
| Increase in rainfall | 131 | 45.8 |
| Decrease in rainfall | 64 | 22.38 |
| Migration of fish into the deep | 33 | 11.54 |
| Other (Specify) | 5 | 1.75 |

**Source:** *First Research Results, 2025*

The most prevalent effect mentioned by farmers is 70.98% of poor yields due to erratic rainfalls in recent farming seasons. Death of animals was experienced by 67.13% of the farmers' samples. Livestock like cattle were the most affected. The scarcity of food was also high, where 63.99 farmers experienced food shortages. Effects like an increase in temperatures, erosion/flooding, an increase in pest and disease infestation, and sudden changes in weather conditions were reported at more than 50% in the study area. The results are supported by KIIs and FGDs who indicated increased livestock health issues such as deaths and reduced productivity. Farmers also expressed concern over water access and availability as most reliable sources were drying up.

### 4.2.1 Reduction in Crop yields

The data shows a decrease in the yields from 2 seasons compared (2022/23 and 2023/24 farming seasons). The table below shows mean yields from these 2 seasons.

**Table 8**: *Summary of Yields (2023-24 Season)*

| Season | Obs. | Crop yield (tonnes) | Mean yield | Standard dev |
|---|---|---|---|---|
| **2022/23** | 252 | 622 | 1.722222 | 0.9830345 |
| **2023/24** | 252 | 263 | 1.063492 | 0.2443312 |

**Source**: *Research Results, Feb 2025*

The analysis of crop yield data from the 2022/23 and 2023/24 seasons reveals a significant decline in productivity. The mean yield dropped from 1.72 in 2022/23 to 1.06 in 2023/24, indicating a notable reduction in overall output. Additionally, the standard deviation decreased from 0.983 to 0.244, suggesting that while yields in 2023/24 were lower, they were also more consistent across observations. The maximum recorded yield decreased from 4 to 2, indicating a decline in the highest productivity levels, while the minimum remained constant at 1. This decline in yield could be attributed to various factors, including weather variability, soil degradation, pest infestations, changes in agricultural inputs, or economic constraints. The reduced variability in 2023/24 suggests that most farms experienced similar declines, potentially due to El Niño-induced drought. Further statistical analysis, such as a t-test, could determine whether this decline is statistically significant and help identify the key drivers behind this downward trend.

**Table 9**: *T-test Results on Yield Reduction (2023-2024 Season)*

| Group | Obs. | Mean | Std. Err. | Std. Dev. | [95% conf. | Interval] |
|---|---|---|---|---|---|---|
| 1 | 236 | 1.648305 | .0612128 | .9403696 | 1.527709 | 1.768901 |
| 2 | 16 | 2.8125 | .2452677 | .9810708 | 2.289724 | 3.335276 |
| COMBINED | 252 | 1.722222 | .0619254 | .9830345 | 1.600263 | 1.844182 |
| DIFF | | -1.164195 | .2435746 | | -1.643915 | -.6844751 |

diff = mean (1) – mean (2) t = -4.7796
Ho: diff = 0 degrees of freedom = 250

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 1.0000
Source: *Research Results, Feb 2025*

The t-test results confirm a statistically significant decline in crop yields between the two seasons, with the mean yield dropping from 2.812 to 1.648 (p = 0.0000). The confidence interval (-1.644, -0.684) and t-statistic (-4.78) indicate that this decline is not due to random variation but rather a substantial shift in productivity. A key factor contributing to this reduction is the El Niño-induced drought, which resulted in low rainfall and high temperatures, severely affecting crop growth. Insufficient moisture likely led to poor germination, stunted plant development, and lower grain formation, while excessive heat accelerated evapotranspiration, further stressing crops. These climatic conditions (Mid-season dry spell) disproportionately impacted yields, making it crucial for future agricultural planning to incorporate drought-resistant crop varieties and improved irrigation techniques to mitigate such adverse effects.

#### 4.2.2 Negative Impact on Household Food Security

**Table 10**: *Impact of El'Nino on Households Food Security*

| Food Security Pillars | Frequency | Percentage |
|---|---|---|
| Access | 231 | 91.7 |
| Availability | 204 | 81 |
| Consumption/Utilisation | 137 | 54.4 |
| Stability | 242 | 96 |

**Source:** *Research Results, Feb 2025*

The survey results indicate that the El Nino induced drought has significantly affected the four pillars of food security among farm households. The high percentages of respondents reporting impacts on access (91.7%), availability (81%), consumption/utilisation (54.4%), and Stability

(96%) suggest that the drought has had a devastating effect on household food security. During the FGDs and KIIs, respondents expressed concerns about the impact of the El Niño induced drought on their livelihoods and food security. Some common sentiments included:

> *"The drought has been devastating. We have lost our crops, and our livestock are struggling to find food and water." (FGD participant)*
> *The El Niño-induced drought has shown us that we need to diversify our crops and livestock. We can't rely on just one or two sources of income (FGD participants)*
> *"We have had to rely on relief food, but it's not enough. We need support to rebuild our livelihoods". (KII Respondent-Community Leader)*

**4.3 Resilience and Adaptation Strategies employed by respondents**

Farmers in Binga district employ several resilience, copying, and adaptation strategies, which were identified through household interviews, focus group discussions, and key informant interviews during the research.

**4.3.1 Resilience and Adaptation Strategies**

The results showed that several copying, resilience, and adaptation strategies were employed by farming households in the district. The researcher sampled farmers in 6 wards, and the frequency of farmers using the adaptation strategies is shown in the table below.

**Table 11**: *Resilience and Adaptation Strategies used by Farmers*

| **Value** | **Frequency** | **Percentage** |
|---|---|---|
| Farming technologies (Pfumvundza) | 181 | 83.29 |
| Drought tolerant crops | 178 | 62.24 |
| Timing of planting | 171 | 59.79 |
| Income diversification | 163 | 56.99 |
| Crop diversification | 157 | 54.9 |
| Timing of harvesting | 155 | 54.2 |
| Weather forecasting | 108 | 37.76 |
| Other (Food Aid) | 12 | 4.2 |

**Source**: *Research Results. Feb 2025*

The highest number of respondents (83.29%) use climate-smart agriculture technologies, which include conservation farming and agroforestry, as a coping and adaptation strategy to El

Niño-induced drought. Farmers also use drought-tolerant crops (62.24% of farmers confirmed that they plant crop varieties that mature in a short period), as well as the timing of planting (60%), harvesting (54.2%), and diversified income sources (56.99%). Weather forecasting and Other (Food Aid) were all below 40% as the adaptation strategies used by the farmers to El Niño-induced drought.

The survey results and sentiments from Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) suggest that the El Niño-induced drought has had a severe impact on farm households. However, they also demonstrated some level of resilience by adapting to the changing circumstances.

During the KIIs and FGDs, respondents shared their experiences and perspectives on these strategies:

> *"Conservation farming has helped us reduce soil erosion and improve soil fertility. It's been a game-changer for us." (KII respondent)*
>
> *"Agroforestry has provided us with an additional source of income. We now have fruit trees and other crops that we can sell." (FGD participant)*
>
> *"Drought-tolerant crops have been a lifesaver. We've planted crops like sorghum and cowpeas that can withstand the drought." (KII respondent)*
>
> *"Timing of planting is crucial. We've learned to plant our crops at the right time to minimize the impact of drought." (FGD participant)*
>
> *"Diversified income sources have helped us cope with the drought. We now have multiple sources of income, including livestock and off-farm activities." (KII respondent)*
>
> *"We don't have access to reliable weather forecasting information. It's hard to plan our farming activities without knowing what the weather will be like." (FGD participant)*
>
> *"Food aid is not a sustainable solution. We need support to produce our food and improve our livelihoods." (KII respondent)*

#### 4.3.2 Determinants of Adaptation Strategies

The study also examined the factors that influence the resilience and adaptability tactics used by Binga farmers. To determine the factors influencing the adaptation tactics farmers used, the data were processed using STATA 15.0 (see Appendix 2). The factors influencing certain adaptation and resilience tactics were investigated using the multivariate probit model. Below are the model's specifications;

$$mvprobit\ (IncmDiv$$
$$= AgeHH\ Gender\ HHSize\ Educ\ Occup\ FarmExp\ AccssCrdt\ AccssCCInfo\ Training)\ (Forecast$$
$$= AgeHH\ Gender\ HHSize\ Educ\ Occup\ FarmExp\ AccssCrdt\ AccssCCInfo\ Training)\ (PlantTim$$
$$= AgeHH\ Gender\ HHSize\ Educ\ Occup\ FarmExp\ AccssCrdt\ AccssCCInfo\ Training)\ (HarvTim$$
$$= AgeHH\ Gender\ HHSize\ Educ\ Occup\ FarmExp\ AccssCrdt\ AccssCCInfo\ Training)(CropDiv$$
$$= AgeHH\ Gender\ HHSize\ Educ\ Occup\ FarmExp\ AccssCrdt\ AccssCCInfo\ Training)(PDTC$$
$$= AgeHH\ Gender\ HHSize\ Educ\ Occup\ FarmExp\ AccssCrdt\ AccssCCInfo\ Training)(FarmTech$$
$$= AgeHH\ Gender\ HHSize\ Educ\ Occup\ FarmExp\ AccssCrdt\ AccssCCInfo\ Training)(Other$$
$$= AgeHH\ Gender\ HHSize\ Educ\ Occup\ FarmExp\ AccssCrdt\ AccssCCInfo\ Training)$$

The results from the above equation (see appendix 2) are interpreted in the subsequent paragraphs for each of the adaptation strategies.

**4.3.3 Diagnostic Tests**

**Model Fit**

According to the LR test's null hypothesis ($H_0$), both the complete model (m1—with all predictors) and the reduced model (m2-simpler model) matched the data. The entire model (m1) fits the data much better than the limited model (m2), according to the alternative hypothesis ($H_1$). lrtest m1 m2

| | |
|---|---|
| Likelihood-ratio test | LR chi2(**48**) = **53.92** |
| (Assumption: m2 nested in m1) | Prob > chi2 = **0.2582** |

Since p = 0.2582, more significant than 0.05, we fail to reject the null hypothesis and conclude that there is no substantial evidence that the whole model fits the data significantly better than the restricted model.

**4.3.4 Results from Multivariate Probit Regression**

**Income Diversification (IncmDiv)**

Education (coefficient of 0.4758 and p-value of 0.006) and access to credit (AccssCrdt) both strongly positively influence the chance of income diversification, with a coefficient of 1.2706 and a p-value of 0.000. Similarly, there is a substantial positive impact of access to climate change information (AccssInfor) (coef = 0.8084414, p-value = 0.0120), indicating that families with greater knowledge are more likely to diversify their sources of income. There is a negative correlation between farm size and income diversification (coefficient of -0.1744 and p-value of 0.036), meaning that as farmland ownership rises, revenue diversification falls. However, education (Educ), occupation (Occup), and farm experience (FarmExp) are not statistically significant, indicating that these factors do not strongly influence income diversification.

**Forecasting (Forecast)**

Households with an educational background were more likely to use forecasting as an adaptation strategy, which was statistically significant (p = 0.000) with a coefficient of 0.3943. Those who engage in livestock farming (Livestock) are more likely to use forecasting methods, with a coefficient of 0.4769 and a p-value of 0.025, suggesting a highly significant positive effect. Additionally, training is the most significant factor (coef = 0.4222, p = 0.001), indicating that capacity-building programs have a significant impact on forecasting adoption. Other factors, such as household size and farm size, do not significantly impact forecasting decisions.

**Planting Timing (PlantTim)**

Access to climate change information (AccssInfo) plays a crucial role in adjusting planting times, with a significant positive coefficient of 0.8359 and a p-value of 0.004. Similarly, access to credit (AccssCdrdt) has a strong influence (coef = 0.6725, p = 0.012), highlighting its importance in decision-making. Other independent variables, including household size (HHSize) and farm size (FarmSize), do not show statistical significance, indicating that these factors have limited effects on adjusting planting schedules.

**Harvesting Timing (HarvTim)**

Households engaged in livestock farming (Livestock) are also more likely to adjust their harvesting periods (coef = 0.4144, p = 0.044). Households who received training have knowledge on harvesting techniques and timing. Training had a significant influence on harvesting time, with a coefficient of 0.7759 and a p-value of 0.000. Access to climate change information (AccssCCInfor) and access to credit (AccssCrdt) have no association with adjustments in harvesting time.

**Crop Diversification (CropDiv)**

Farm size (FarmSize) significantly increases the likelihood of crop diversification (coef = 0.4128, p = 0.001), indicating that farmers with larger arable land are more inclined to diversify their crops. Households who received agricultural-related training also tend to diversify their crops (coef = 0.8123, p = 0.001), showing that skill development encourages diversification.

**Planting Drought Tolerant Crops (PDTC)**

Training has a significant positive effect (coef = 1.0461, $p < 0.001$). Gender (Gender) shows marginal significance (coef = 0.274, $p = 0.048$), suggesting that male-headed households might be slightly more likely to implement pest and disease control measures.

**Farm Technology Adoption (FarmTech)**

Farm size (FarmSize) has a positive and significant effect on the adoption of farm technologies (coef = 0.1458, $p = 0.014$), indicating that larger farms are more likely to integrate modern agricultural techniques. Training (Training) remains a strong predictor (coef = 0.6548, $p = 0.002$), reinforcing the importance of skill-building in technology adoption.

**Other Adaptation Strategies (Other)**

Surprisingly, climate change information (AccssCCInfor) has a negative and significant association with the adoption of other adaptation strategies (coef = -1.012, $p = 0.001$), suggesting that households with access to information may focus on specific strategies rather than diversifying broadly. Training (Training) does not show a significant effect ($p > 0.05$) in this category, implying that other factors may drive the choice of additional adaptation measures.

Overall, the findings from KIIs and FGDs suggest that farmers are employing a range of adaptation strategies to cope with El Niño-induced drought. However, there is a need for additional support, including access to reliable weather forecasting information and other forms of assistance, to enhance their resilience to climate-related shocks

### 4.4 Coping Strategies used by respondents to cope with El Niño-Induced Drought

Farmers in Binga District adopted various strategies to cope with the El Niño-induced drought. These strategies included livestock management, food security measures, financial management, adoption of new farming practices, and reliance on government or NGO support. The following tables present key findings on these coping mechanisms, accompanied by explanatory notes that highlight their significance and relevance to resilience and adaptation strategies.

#### 4.4.1 Livestock Management Strategies

**Table 12**: *Livestock Management Strategies Employed by Farmers*

| **Strategy** | **Frequency** | **Percentage** |
|---|---|---|
| Livestock feed supplement | 50 | 19.8 |
| Moving livestock to better grazing lands | 204 | 81 |
| Destocking | 96 | 38.1 |
| Other | 36 | 14.3 |

**Source**: *Research Results. Feb 2025*

The researcher sampled farmers in 6 wards and the frequency of farmers using the adaptation strategies is shown in the table below. The most common livestock management strategy was moving livestock to better grazing lands (81%), indicating the severe impact of drought on pasture availability. Destocking (38.1%) was another key approach, allowing farmers to sell off part of their livestock to reduce pressure on scarce resources. Livestock feed supplementation (19.8%) was used by fewer households, likely due to financial constraints. These strategies align with the broader adaptation mechanisms discussed in the study, such as diversification and resource management.

During the FGDs and KIIs, respondents shared their experiences and challenges with these strategies:

> *"We had to move our livestock to a neighbouring village in search of better grazing land and water. It was a difficult decision, but we had no choice." (FGD participant)*
>
> *"Destocking was a hard decision, but it helped them reduce the pressure on their remaining livestock. We sold some of our weaker animals to reduce the burden." (KII respondent- Agritex Officer)*
>
> *"We tried to supplement our livestock feed, but it was too expensive. We had to rely on the little pasture we had left." (FGD participant)*
>
> *"The drought has taught us to be more proactive in managing our livestock. We're now exploring alternative feed sources and improving our grazing management practices." (KII respondent)*

These sentiments highlight the difficulties faced by households in managing their livestock during the drought, as well as their resourcefulness and resilience in adapting to the challenging circumstances. The strategies employed by households align with the broader adaptation mechanisms discussed in the study, such as diversification and resource management

#### 4.4.2 Access to Nutritious Foods and Diversity Strategies

**Table 13**: *Strategies for Food and Nutrition Security by Households*

| **Strategy** | **Frequency** | | **Percentage** |
|---|---|---|---|
| Diversifying foods | 252 | | 100 |
| Raise small livestock | 252 | | 100 |
| Gardening/Growing vegetables | 80 | | 31.7 |
| Food preserving | 95 | | 37.7 |
| Other (fishing, fruits, etc.) | 14 | | 5.6 |

**Source**: *Research Results, Feb, 2025*

To ensure access to nutritious food, all surveyed households (100%) diversified their food sources and raised small livestock. Gardening (31.7%) and food preservation (37.7%) were additional measures adopted to ensure household nutrition security. Fishing and fruit gathering were used by a small portion (5.6%) of households. These strategies align with resilience-building approaches discussed in the study, helping farmers mitigate food shortages during climate related shocks.

During the FGDs and KIIs, respondents shared their experiences and perspectives on these strategies:

> *"We used to rely on maize, but with the drought, we had to diversify to other crops like cassava and sweet potatoes. It's been a game-changer." (FGD participant).*
> *"Raising small livestock like chickens and goats has helped us access protein-rich food. It's also a source of income." (KII respondent)*

> *"Gardening has been a lifesaver. We grow our own vegetables , which has improved our nutrition and reduced our reliance on markets." (FGD participant). "Food preservation has helped us store food for longer periods. We can now enjoy our harvests even during the dry season." (KII respondent). "Fishing and fruit gathering are not our*

*main sources of food, but they help supplement our diets during times of scarcity." (FGD participant)*

These sentiments highlight the importance of diversification, small livestock production, gardening, food preservation, and other strategies in enhancing food security and resilience among farm households. By adopting these approaches, households can better manage climate-related shocks and enhance their overall well-being.

### 4.4.3 Coping Strategies during El Niño Drought

Results from the research showed that farmers in Binga are growing drought-resistant crops, utilizing small irrigation systems, and using livestock feed supplements to diversify their livelihoods, as well as relocating livestock to better grazing lands and coping with the effects of El Niño through remittances and migration. The table below shows the frequency of farmers utilising these strategies.

**Table 14**: *Copying Strategies Employed by Household During El 'Nino Period*

| Coping Strategy | Frequency | Percentage |
|---|---|---|
| Grow drought-resistant crops | 252 | 100 |
| Irrigation | 122 | 48.4 |
| Livestock feed supplement | 94 | 37 |
| Livelihood diversification | 160 | 63.5 |
| Moving livestock to better grazing | 179 | 71 |
| Remittances | 116 | 46 |
| Migration and labour mobility | 159 | 63.1 |
| Other | 45 | 17.9 |

**Source**: *Research Results, Feb 2025.*

The most widespread adaptation strategy was growing drought-resistant crops (100%), ensuring some level of agricultural productivity. Livelihood diversification (63.5%) and migration (63.1%) were also key survival mechanisms. Small-scale irrigation (48.4%) was practised by some farmers under operational irrigation schemes like Siabuwa/Nabusenga Irrigation scheme in Ward 2, but financial and infrastructural constraints likely limited its widespread adoption. These findings highlight the importance of promoting climate-smart agriculture and alternative income sources.

During the FGDs and KIIs, respondents shared their experiences and perspectives on these coping strategies:

*"We had to switch to drought-resistant crops like sorghum and cowpeas. It was a good decision, as they withstood the drought better than maize." (FGD participant)*

*"Diversifying our livelihoods has helped us survive. We now do small-scale trading, and some of us have even started small businesses." (KII respondent). "Migration was a last resort for us. Some of our family members had to move to urban areas in search of work, but it's not a sustainable solution." (FGD participant)*

*"Irrigation has been a game-changer for us. We can now grow crops even during the dry season, but we need more support to expand our irrigation schemes." (KII respondent)*

These comments validate the quantitative findings and highlight the importance of promoting climate-smart agriculture, alternative income sources, and livelihood diversification to enhance resilience among farm households. Additionally, they emphasize the need for supportive policies and programs to address financial and infrastructural constraints

### 4.4.4 Adoption of New Farming Practices

The study further looked at adoption of new farming technologies/climate-smart agriculture (CSA) by farmers in the Binga district. The results show that most farmers use CSA.

**Table 15**: *Adoption of New Farming Practices*

| Farming Practice | Frequency | Percentage |
|---|---|---|
| Climate Smart Agriculture (CSA) | 215 | 85.3 |
| Precision farming | 0 | 0 |
| Crop insurance | 0 | 0 |
| Conservation Agriculture-CA (Pfumbvudza) | 225 | 89.3 |

**Source**: *Research Results, Feb 2025*

The adoption of Conservation Agriculture-CA (Pfumbvudza) (89.3%) and Climate-Smart Agriculture (85.3%) was high. However, precision farming and crop insurance had zero adoption, indicating low awareness or financial barriers. This reinforces the need for improved agricultural extension services and access to financial tools that enhance resilience. During the

FGDs and KIIs, respondents shared their experiences and perspectives on these agricultural practices:

> *"We've been practising Pfumbvudza for a few seasons now, and it's been a game-changer. Our soils are healthier, and we're using less water." (FGD participant)*
> *"Climate-smart agriculture has helped us adapt to the changing weather patterns. We're now using drought-tolerant crops and conservation tillage." (KII respondent)*
> *"I've heard of precision farming, but I don't know much about it. We need training and support to adopt new technologies." (FGD participant)*
> *"Crop insurance is a good idea, but it's too expensive for us. We can't afford the premiums." (KII respondent). "We need more extension services and training on new agricultural practices. We're willing to learn, but we need support." (FGD participant)*

These comments validate the quantitative findings and highlight the need for improved agricultural extension services to increase awareness and adoption of new technologies and practices. Access to financial tools, such as affordable credit and insurance, can as well enhance resilience among farm households. Capacity building and support can also help farmers adopt Climate-Smart Agriculture and Conservation Agriculture practices. Addressing these needs, farm households can enhance their resilience to climate-related shocks and improve their overall well-being.

### 4.4.5 Financial Management Strategies

**Table 16***: Financial Management Strategies During El 'Nino Drought Period*

| Strategy | Frequency | Percentage |
|---|---|---|
| Income diversification | 180 | 71.4 |
| Saving | 169 | 67.1 |
| Pre-El Niño Financial Planning/Emergency Fund | 33 | 13.1 |
| Review or adjust household budget | 201 | 80 |
| Prioritize and cut back on non-essential expenses | 252 | 100 |
| Negotiate with creditors | 117 | 46.4 |
| Others | 53 | 21 |

**Source**: *Research Results Feb, 2025*

Income diversification (71.4%) and savings (67.1%) were key strategies to cope with financial challenges. Budget adjustments (80%) and cutting back on non-essential expenses (100%) were widely used to sustain livelihoods. However, only 13.1% of households had pre-El Niño financial planning, highlighting gaps in long-term financial preparedness. During the FGDs and KIIs, respondents shared their experiences and perspectives on managing their finances during El Niño:

> "*We had to diversify our income sources to make ends meet. Some of us started small businesses, while others took on casual labour." (FGD participant)*
>
> *"Savings were crucial during El Niño. We had to dip into our savings to buy food and other essentials." (KII respondent). "We had to adjust our budget to prioritize essential expenses. We cut back on non-essential expenses like entertainment and travel." (FGD participant)*
>
> *"It was tough, but we had to make sacrifices. We reduced our food expenses by eating less expensive meals and reducing food waste." (KII respondent)*
>
> *"We didn't have a financial plan in place before El Niño, but we learned the hard way. Now we're trying to save more and plan for the future." (FGD participan*t)

These comments highlight the resourcefulness and resilience of households in managing their finances during El Niño. However, they also underscore the need for improved financial planning and preparedness to mitigate the impact of future shocks and access to financial services, such as savings and credit, to support income diversification and financial resilience. Training and support is also crucial to enhance financial literacy and budgeting skills among households. Henceforth, by addressing these needs, households can better manage their finances and build resilience to future climate-related shocks

**Support Received from Government/NGOs**

**Table 17**: *Support Services Received from Government/NGOs*

| Forms of Support | Frequency | Percentage |
|---|---|---|
| Climate change adaptation training | 178 | 70.6 |
| Livestock support | 88 | 35 |
| Food Aid | 39 | 15.5 |
| Cash Transfers | 20 | 8 |
| Farming Inputs | 205 | 81.3 |
| Agricultural Training/Extension | 155 | 61.5 |

**Source**: *Research Results, Feb 2025*

Surveyed farmers (100%) received some form of support. The most common assistance included farming inputs (81.3%) and climate adaptation training (70.6%). Cash transfers (8%) and food aid (15.5%) were limited, emphasizing the need for stronger social protection mechanisms to enhance resilience. During the FGDs and KIIs, respondents shared their experiences and perspectives on the support they received:

> *"The farming inputs we received were a big help. We got seeds, fertilizers, and tools that helped us plant and harvest our crops." (FGD participant).*
> *"The climate adaptation training (workshops) by NGOs and Agritex was very useful. We learned how to use conservation agriculture techniques and how to select drought-tolerant crops." (KII respondent- Lead farmer)*
> *"We appreciated the cash transfers, but they were not enough. We needed more support to buy food and other essentials." (FGD participant)*
> *"Food aid was helpful, but it was not sustainable. We need support to produce our own food and improve our livelihoods." (KII respondent). "We need more support to enhance our resilience. We need access to credit, insurance, and other financial services to help us cope with climate-related shocks." (FGD participant)*

These remarks confirm the quantitative results and emphasize how crucial it is to boost farmers' resilience and production by offering agricultural inputs and training on climate adaptation. It's also critical to strengthen social safety nets like food assistance and cash transfers to help homes who are at risk. Expanding access to financial services, such insurance and loans, to help farmers maintain their livelihoods and resilience. Farmers may enhance their general well-being and more effectively handle climate-related shocks by attending to these demands.

## 4.5 Constraints on the adoption of Climate-resilient Adaptation strategies by respondents

The research looked at constraints farmers face in adopting different resilience, copying and adaptation strategies to El'Nino-induced drought. The table below summarises the findings on the constraints.

**Table 18**: *Constraints to Adaptation and Coping Strategies*

| Constraint | Frequency | Percentage |
|---|---|---|
| High cost of farm labour | 143 | 56.7 |
| Lack of finance | 187 | 74.2 |
| Poor government attention | 163 | 64.7 |
| Scarcity of farm input | 162 | 64.3 |
| High cost of improved varieties | 158 | 62.7 |
| Limited household income | 165 | 65.5 |
| High cost of farm inputs | 105 | 41.7 |
| Poor storage facilities | 49 | 19.4 |
| Lack of access to improved crop varieties | 68 | 27 |
| Lack of climate change information | 73 | 29 |

**Source:** *Research Results, February 2025*

Farmers faced significant barriers to adaptation, with lack of finance (74.2%), poor government support (64.7%), and scarcity of farm inputs (64.3%) being major challenges. The high cost of improved crop varieties (62.7%) further restricted adaptation efforts. These findings reinforce the need for enhanced financial access, better extension services, and stronger policy interventions to support smallholder farmers.

The findings as supported by KIIs and FGDs demonstrate that farmers in Binga District employ a mix of short-term coping strategies (such as selling livestock and adjusting household budgets) and long-term adaptation measures (such as conservation agriculture and drought-resistant crops). However, financial barriers, limited government support, and lack of access to climate-smart technologies remain critical challenges. Strengthening agricultural policies, improving financial inclusion, and enhancing climate education can significantly improve farmers' resilience to El Niño-induced droughts.

During the FGDs and KIIs, respondents shared their experiences and perspectives on the challenges they face in farming. The sentiments expressed by respondents validated the quantitative findings, highlighting the significance of these challenges in affecting their livelihoods.

> *"Access to finance is a major problem for us. We can't afford to buy inputs or hire labour without credit." (FGD participant)*
>
> *"The government doesn't provide enough support to farmers. We need subsidies, credit, and other forms of assistance and we feel neglected by the government. They don't listen to our concerns or provide adequate support." (FGD participant)*
>
> *"We need access to affordable and high-quality inputs to improve our productivity." (KII respondent). "Improved crop varieties are expensive, and we can't afford them." (FGD participant). "We need to diversify our income sources to improve our livelihoods." (KII respondent). "We don't have access to improved crop varieties, and our yields are low." (FGD participant). "We don't have enough information about climate change and how to adapt to it." (FGD participant). "We need more information and training on climate-smart agriculture practices." (KII respondent*)

KIIs and FGDs also suggested the following policy and practical recommendations that can enhance the resilience and adaptive capacities of farmers to El Niño-induced drought in Zimbabwe.

### 4.6 Discussions

The study highlights key similarities derived between literature reviewed and the results or findings regarding the impact of El Nino-induced drought on farmers' livelihoods in Binga District. Both results from empirical evidence or previous studies and this study emphasize the that El Nino events lead to reduced rainfall and prolonged dry spells, significantly affecting agricultural productivity. The findings demonstrating a "significant decline in agricultural productivity," with a mean yield drop from 1.2 in the 2022–2023 farming season to 1.06 in the 2023–2024 farming season, support the literature's observation that "El Nino events lead to reduced rainfall and prolonged dry spells," affecting vulnerable regions (Mason et al., 2016) (Research results, Feb 2025). Droughts have far-reaching effects on farmers' livelihoods, including decreased crop yields and livestock deaths, according to the research, which also emphasises the extensive effects of drought on food security (Mubaya et al., 2014). Results showing that "91.7% of households reported impacts on availability and access to food"

(Research results, Feb 2025) support this, revealing acute food insecurity brought on by the El Nino drought.

Additionally, the study's conclusions and empirical data address the coping mechanisms and adaptive strategies used by farmers. According to the literature, "farmers employ various resilience, adaptation, and coping strategies," such as "crop diversification and income diversification" (Nhamo et al., 2019). This is consistent with the findings that "56.99% adopted income diversification" and "62.24% of farmers reported using drought tolerant crops" (Research results, Feb 2025). Socioeconomic factors, such as access to credit and education are identified as significant influences on adaptation strategies, reflecting the literature's assertion that ‘’ socioeconomic vulnerability plays a significant role’’ in farmers ‘ability to adapt to climate change (Mastrorillo et al., 2016).

Finally, the research emphasises the importance of "strong institutional frameworks" to develop adaptive skills, reiterating the necessity for strong institutional frameworks and government support (Chikodzi et al., 2014). Although "81.3% of farmers received farming inputs," the findings show that there is still a need for "better government support" (Research results, Feb 2025). Together, these observations demonstrate the serious difficulties farmers have and the need for focused interventions to increase resilience to the effects of climate change.

### 4.7 Conclusion

In summary, the results of this study highlight the major difficulties that farmers in Binga District are facing as a result of the drought brought on by El Niño. Reduced crop yields and rising food insecurity are two of the main issues raised by the data, which shows a sharp drop in agricultural production. Farmers show resilience in the face of adversity by using a range of adaptation techniques, such as the use of crops resistant to drought and creative agricultural methods. However, socioeconomic limitations including restricted financial availability and a lack of government and non-governmental organization backing can make these tactics less successful. Future policies and interventions targeted at strengthening smallholder farmers' resilience in the face of climatic variability must be informed by the knowledge gathered from this chapter

# CHAPTER FIVE
# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 5.0 Introduction

The study on the effects of drought caused by El Niño on the livelihoods of farmers in Zimbabwe's Binga District is summarized in this chapter. It provides a summary of the study's main findings, makes inferences from the data, and makes useful suggestions for improving smallholder farmers' resilience and ability for adaptation. In order to guarantee food security and enhance the standard of living for marginalized people, it is imperative that climate change and its impacts on agriculture be addressed. This chapter attempts to provide practical recommendations for policymakers, practitioners, and stakeholders engaged in agricultural development and climate adaptation projects by considering the goals and findings of the study.

## 5.1 Summary of the Study

This research evaluated how farmers' lives in Binga District were affected by the drought brought on by El Niño. The primary objective was to assess the effectiveness and long-term sustainability of their coping mechanisms, resilience, and adaptation strategies in improving their food security and adaptability in the years 2023–2024. Forecasting, crop and income diversification, changing planting and harvesting schedules, and using farming technologies are some of the coping and adaptation strategies that farmers use. Surveys and interviews were used to gather data from 252 homes using a mixed-methods approach. The findings revealed that El Niño significantly affected agricultural productivity, leading to reduced crop yields and livestock deaths, which exacerbated food insecurity among households. Farmers employ various coping and adaptation strategies, including forecasting, adjusting planting and harvesting times, crop and income diversification, and the use of farming technologies.

An analysis was conducted on the respondents' primary socioeconomic attributes, including age, gender, and household size, education, and credit availability. According to the findings, most farmers were having a very difficult time because of climatic unpredictability. Diversification of income, conservation agriculture, and the adoption of drought-resistant crops were among the many adaption measures that were found. Despite these initiatives, major obstacles to successful adaptation were a lack of funding, inadequate government assistance, and restricted information availability.

A multivariate probit model was used in the research to determine the variables affecting the selection of adaption tactics. Farmers' decisions on adaptation tactics were statistically impacted by factors such as information, farm size, education, livestock management, agricultural training, and loan availability. Numerous variables impact adaptation techniques, and these variations fluctuate across farmers according on their economic circumstances. Educated farmers are using adaptation strategies like income diversification because they can get employed and earn money to cushion them from effects of climate change. Education motivates farmers to initiate income-generating projects, enabling them to earn more income and better cushion themselves against drought. Farm size and pieces of training influence crop diversification as farmers can plant more varieties when having a more significant piece of land. The study emphasizes the need for targeted interventions to enhance resilience and adaptive capacity in the face of ongoing climate challenges

## 5.2 Conclusion

According to the study's findings, farmers in Binga District are particularly affected by the drought brought on by El Niño, which has resulted in significant drops in agricultural output and a rise in food insecurity. Smallholder farmers are especially at risk because of their limited resources and ability to adjust. They mostly rely on rain-fed crops. In order to create resilience, the research emphasizes how crucial it is to comprehend local coping methods and adaptive techniques.

We evaluated the variables that affect Binga smallholder farmers' adaptation plans to the consequences of climate change in this research. Using a sample size of 252 smallholder farmer household heads from six wards in the district, we discovered that the most common adaptation strategies used by smallholder farmers to deal with the effects of climate change were date changes, income diversification, and planting different crop varieties, followed by drought-resistant crop varieties. A significant percentage of smallholder farmers may be shielded from the damaging impacts of droughts and floods if they had better access to meteorological information. Several variables that impact the adoption of distinct adaptation methods by household heads of smallholder farmers to the impacts of climate change were also identified by the research.

Additionally, it was shown that while farmers are using a variety of tactics to lessen the effects of the drought, socioeconomic constraints, limited financing availability, and a lack of agricultural extension assistance limit the efficacy of these tactics. The results underscore the need of holistic strategies that include indigenous expertise, augment financial accessibility, and strengthen governmental response to the obstacles encountered by farmers.

### 5.3 Policy Recommendations

The researcher recommends the following:

- *Develop and implement climate*-resilient agricultural policies that mainstream climate change into national agricultural policies, prioritizing climate-resilient agriculture and sustainable land management.
- *Strengthen Early Warning Systems (EWS)* by enhancing the capacity of the Meteorological Services Department to provide accurate and timely weather forecasts, and ensure that this information reaches farmers in a timely and usable manner.
- *Promote Climate-smart agriculture* by encouraging the adoption of climate-resilient crop and animal varieties, conservation agriculture, and integrated soil fertility management practices.
- *Support social protection programs* by implementing programs that provide financial support to vulnerable farmers, such as cash transfers, crop insurance, and livestock insurance.
- *Foster partnerships and collaborations* between government, private sector, NGOs, and farmers' organizations to leverage resources, expertise, and funding.

#### 5.3.1 Practical Recommendations

***Early Warning Systems***

- Establish a national early warning system by developing a system that integrates weather forecasts, soil moisture monitoring, and crop monitoring to provide timely warnings to farmers.
- Use mobile technology by leveraging mobile phones to disseminate early warnings and weather forecasts to farmers.
- Conduct regular weather updates to provide regular weather updates through various media channels, including radio, TV, and social media.

***Climate-Smart Agriculture***

- Promote conservation agriculture through Extension by encouraging farmers to adopt conservation agriculture practices, such as reduced tillage, crop rotations, and cover crops.
- Support using drought-tolerant crops that promote using drought-tolerant crop varieties, such as maize, sorghum, and cowpeas.
- Encourage farmers to adopt integrated soil fertility management practices, including the use of organic and inorganic fertilizers.

***Social Protection Programs***

- Implement cash transfer programs or financial support to vulnerable farmers
- Support crop and livestock insurance by encouraging farmers to purchase crop and livestock insurance to mitigate the risks associated with drought.
- Establish emergency funds to provide financial support to farmers in times of drought.

***Capacity Building and Extension Services***

- Provide training on climate-smart agriculture services to smallholder farmers on climate-smart agriculture practices.
- Support farmer field schools to provide hands-on training and demonstration of climate-smart agriculture practices.
- Enhance extension services by strengthening extension services to provide regular support and guidance to farmers on climate-smart agriculture practices.

***Implementation and Monitoring by Min of Agriculture, Lands Fisheries and Rural Development***

- Establish a national coordination mechanism to oversee the implementation of these recommendations in rural areas.
- Develop a monitoring and evaluation framework to track progress and identify areas for improvement.
- Provide regular progress reports to stakeholders, including farmers, policymakers, and donors.

Key informant, Mr. Ndlovu, the District Agritex Extension Officer (DAEO) for Binga district, believes that implementing these policies and practical recommendations can improve farmers' resilience to El Niño-induced droughts, improve their livelihoods, and contribute to the country's food security.

### 5.4 Areas of further research

The dissertation "Assessing the Impact of El Niño-Induced Drought on Farmers' Livelihoods in Binga District" identifies several key areas for further research in order to better inform and support farmers. Longitudinal studies of adaptation strategies would be helpful to monitor changes over multiple seasons and gain insight into the long-term effectiveness of these strategies under various climatic conditions. Second, research might examine how farmer resilience is impacted by present climate change policies and activities, particularly the long-term effects of governmental and non-governmental organisations' actions on adaption capacities. Lastly, integrating indigenous knowledge into modern agricultural practices deserves further study since it may increase resilience and help farmers manage climate unpredictability and extreme weather events. These research topics could significantly improve the adaptability of farmers in Binga District and other similar places.

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## Appendices

### *Appendix 1: Correlation Matrix*

```
. corr AgeHH Gender HHSize Educ Occup Lvstck FarmExp FarmSize AccssCrdt AccssInfor AgricTrain
(obs=252)
```

| | AgeHH | Gender | HHSize | Educ | Occup | Lvstck | FarmExp | FarmSize | AccssC~t | AccssI~r | AgricT~n |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AgeHH | 1.0000 | | | | | | | | | | |
| Gender | 0.2723 | 1.0000 | | | | | | | | | |
| HHSize | 0.4711 | 0.0621 | 1.0000 | | | | | | | | |
| Educ | -0.2931 | -0.0537 | -0.1890 | 1.0000 | | | | | | | |
| Occup | -0.1495 | -0.0326 | -0.1393 | 0.4935 | 1.0000 | | | | | | |
| Lvstck | 0.1425 | 0.0414 | 0.1338 | -0.1429 | -0.1711 | 1.0000 | | | | | |
| FarmExp | 0.8230 | 0.2360 | 0.3976 | -0.2318 | -0.1190 | 0.0973 | 1.0000 | | | | |
| FarmSize | 0.2841 | 0.0366 | 0.3220 | -0.0161 | -0.0581 | 0.3678 | 0.2315 | 1.0000 | | | |
| AccssCrdt | -0.0900 | 0.0056 | -0.0361 | 0.5668 | 0.3313 | 0.1183 | -0.0962 | 0.1461 | 1.0000 | | |
| AccssInfor | -0.1921 | -0.0123 | -0.0446 | 0.5137 | 0.2453 | 0.0047 | -0.1615 | 0.0319 | 0.4537 | 1.0000 | |
| AgricTrain | -0.0493 | -0.0179 | -0.0750 | 0.3491 | 0.1878 | 0.0071 | -0.0139 | 0.0918 | 0.3175 | 0.4016 | 1.0000 |

## *Appendix 2: Multivariate Probit Regression Results*

```
. mvprobit (IncmDiv = AgeHH Gender HHSize Educ Occup Lvstck FarmExp FarmSize AccssCrdt AccssInfor AgricTrain)  (Forecast = AgeHH
> Gender HHSize Educ Occup Lvstck FarmExp FarmSize AccssCrdt AccssInfor AgricTrain)(PlantTim = AgeHH Gender HHSize Educ Occup Lvs
> tck FarmExp FarmSize AccssCrdt AccssInfor AgricTrain)  (HarvTim = AgeHH Gender HHSize Educ Occup Lvstck FarmExp FarmSize AccssC
> rdt AccssInfor AgricTrain)(CropDiv = AgeHH Gender HHSize Educ Occup Lvstck FarmExp FarmSize AccssCrdt AccssInfor AgricTrain)(PD
> TC = AgeHH Gender HHSize Educ Occup Lvstck FarmExp FarmSize AccssCrdt AccssInfor AgricTrain)(FarmTech = AgeHH Gender HHSize Edu
> c Occup Lvstck FarmExp FarmSize AccssCrdt AccssInfor AgricTrain)(Other = AgeHH Gender HHSize Educ Occup Lvstck FarmExp FarmSize
>  AccssCrdt AccssInfor AgricTrain)

Iteration 0:   log likelihood = -1005.9903
Warning: cannot do Cholesky factorization of rho matrix
Iteration 1:   log likelihood = -995.77057
Iteration 2:   log likelihood = -988.64912
Iteration 3:   log likelihood = -985.55772
Iteration 4:   log likelihood = -985.16286
Warning: cannot do Cholesky factorization of rho matrix
Warning: cannot do Cholesky factorization of rho matrix
Warning: cannot do Cholesky factorization of rho matrix
Warning: cannot do Cholesky factorization of rho matrix
Warning: cannot do Cholesky factorization of rho matrix
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Warning: cannot do Cholesky factorization of rho matrix
Warning: cannot do Cholesky factorization of rho matrix
Warning: cannot do Cholesky factorization of rho matrix
Iteration 5:   log likelihood = -985.15632
Iteration 6:   log likelihood = -985.15632

Multivariate probit (MSL, # draws = 5)          Number of obs     =        252
                                                Wald chi2(88)     =     321.82
Log likelihood = -985.15632                     Prob > chi2       =     0.0000
```

| | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| IncmDiv | | | | | | |
| AgeHH | -.0046198 | .0152983 | -0.30 | 0.763 | -.0346038 | .0253643 |
| Gender | -.0627863 | .268431 | -0.23 | 0.815 | -.5889013 | .4633287 |
| HHSize | -.0270378 | .0716194 | -0.38 | 0.706 | -.1674093 | .1133337 |
| Educ | .4758406 | .1734264 | 2.74 | 0.006 | .1359311 | .81575 |
| Occup | .0797194 | .0991859 | 0.80 | 0.422 | -.1146814 | .2741202 |
| Lvstck | .5803075 | .3100746 | 1.87 | 0.061 | -.0274276 | 1.188043 |
| FarmExp | .0287749 | .026221 | 1.10 | 0.272 | -.0226174 | .0801671 |
| FarmSize | -.1744009 | .0830383 | -2.10 | 0.036 | -.337153 | -.0116488 |
| AccssCrdt | 1.270645 | .2887525 | 4.40 | 0.000 | .7047002 | 1.836589 |
| AccssInfor | .8084414 | .3233928 | 2.50 | 0.012 | .1746032 | 1.44228 |
| AgricTrain | .3111718 | .286505 | 1.09 | 0.277 | -.2503677 | .8727114 |
| _cons | -1.355728 | .6272443 | -2.16 | 0.031 | -2.585104 | -.1263514 |
| Forecast | | | | | | |
| AgeHH | .0049191 | .0113458 | 0.43 | 0.665 | -.0173183 | .0271566 |
| Gender | -.1344867 | .1903153 | -0.71 | 0.480 | -.5074978 | .2385244 |
| HHSize | -.0420857 | .0531223 | -0.79 | 0.428 | -.1462035 | .062032 |
| Educ | .3943369 | .1265685 | 3.12 | 0.002 | .1462672 | .6424066 |
| Occup | .0117136 | .0717898 | 0.16 | 0.870 | -.1289918 | .1524191 |
| Lvstck | .4769422 | .213415 | 2.23 | 0.025 | .0586564 | .8952279 |
| FarmExp | -.0051421 | .0178929 | -0.29 | 0.774 | -.0402116 | .0299274 |
| FarmSize | .0249692 | .0589105 | 0.42 | 0.672 | -.0904932 | .1404317 |
| AccssCrdt | -.0376092 | .2550092 | -0.15 | 0.883 | -.537418 | .4621995 |
| AccssInfor | .3581554 | .2828455 | 1.27 | 0.205 | -.1962116 | .9125225 |
| AgricTrain | .4222656 | .2158844 | 1.96 | 0.050 | -.0008601 | .8453914 |
| _cons | -.9983261 | .4832199 | -2.07 | 0.039 | -1.94542 | -.0512325 |
| PlantTim | | | | | | |
| AgeHH | .0039041 | .0118062 | 0.33 | 0.741 | -.0192356 | .0270439 |
| Gender | -.2629945 | .212166 | -1.24 | 0.215 | -.6788322 | .1528431 |
| HHSize | -.01557 | .0560841 | -0.28 | 0.781 | -.1254928 | .0943529 |
| Educ | .1704695 | .137419 | 1.24 | 0.215 | -.0988668 | .4398058 |
| Occup | -.0754759 | .0805844 | -0.94 | 0.349 | -.2334184 | .0824665 |
| Lvstck | -.0522547 | .2425941 | -0.22 | 0.829 | -.5277305 | .4232211 |
| FarmExp | .0055066 | .0194682 | 0.28 | 0.777 | -.0326503 | .0436636 |
| FarmSize | .0523208 | .0683599 | 0.77 | 0.444 | -.0816622 | .1863038 |
| AccssCrdt | .6725368 | .2665778 | 2.52 | 0.012 | .1500538 | 1.19502 |
| AccssInfor | .838966 | .2894321 | 2.90 | 0.004 | .2716894 | 1.406243 |
| AgricTrain | .3960986 | .2338372 | 1.69 | 0.090 | -.0622139 | .8544111 |
| _cons | -.8697231 | .5125629 | -1.70 | 0.090 | -1.874328 | .1348818 |

| | | | | | | |
|---|---|---|---|---|---|---|
| HarvTim | | | | | | |
| AgeHH | .0135962 | .0109438 | 1.24 | 0.214 | -.0078533 | .0350457 |
| Gender | -.0293087 | .1782836 | -0.16 | 0.869 | -.3787382 | .3201208 |
| HHSize | -.0939933 | .0519556 | -1.81 | 0.070 | -.1958244 | .0078379 |
| Educ | .0887317 | .1198754 | 0.74 | 0.459 | -.1462199 | .3236832 |
| Occup | .039615 | .0683784 | 0.58 | 0.562 | -.0944041 | .1736341 |
| Lvstck | .4144144 | .2055611 | 2.02 | 0.044 | .0115221 | .8173066 |
| FarmExp | -.0161756 | .0166151 | -0.97 | 0.330 | -.0487406 | .0163894 |
| FarmSize | -.0197763 | .0523857 | -0.38 | 0.706 | -.1224504 | .0828978 |
| AccssCrdt | .024845 | .2593434 | 0.10 | 0.924 | -.4834587 | .5331486 |
| AccssInfor | .3882581 | .2811427 | 1.38 | 0.167 | -.1627716 | .9392878 |
| AgricTrain | .7759163 | .2094178 | 3.71 | 0.000 | .365465 | 1.186368 |
| _cons | -1.101511 | .4783792 | -2.30 | 0.021 | -2.039117 | -.1639047 |
| CropDiv | | | | | | |
| AgeHH | -.0080773 | .0125868 | -0.64 | 0.521 | -.032747 | .0165924 |
| Gender | .0239252 | .2094399 | 0.11 | 0.909 | -.3865695 | .43442 |
| HHSize | -.001917 | .0601893 | -0.03 | 0.975 | -.1198858 | .1160518 |
| Educ | -.1036622 | .1358725 | -0.76 | 0.446 | -.3699674 | .1626429 |
| Occup | .033463 | .0841804 | 0.40 | 0.691 | -.1315276 | .1984536 |
| Lvstck | .0518201 | .2310902 | 0.22 | 0.823 | -.4011083 | .5047485 |
| FarmExp | .012165 | .0205869 | 0.59 | 0.555 | -.0281847 | .0525146 |
| FarmSize | .4128634 | .0875134 | 4.72 | 0.000 | .2413403 | .5843866 |
| AccssCrdt | -.0007284 | .2857942 | -0.00 | 0.998 | -.5608748 | .5594179 |
| AccssInfor | .4311311 | .3135255 | 1.38 | 0.169 | -.1833675 | 1.04563 |
| AgricTrain | .8123831 | .2386536 | 3.40 | 0.001 | .3446306 | 1.280135 |
| _cons | -1.190675 | .5119602 | -2.33 | 0.020 | -2.194099 | -.1872516 |
| PDTC | | | | | | |
| AgeHH | .0010415 | .0104687 | 0.10 | 0.921 | -.0194767 | .0215597 |
| Gender | .2005754 | .1792288 | 1.12 | 0.263 | -.1507066 | .5518575 |
| HHSize | .0264352 | .0512957 | 0.52 | 0.606 | -.0741026 | .1269729 |
| Educ | -.2033045 | .12346 | -1.65 | 0.100 | -.4452817 | .0386728 |
| Occup | .0789012 | .0695558 | 1.13 | 0.257 | -.0574258 | .2152281 |
| Lvstck | -.042536 | .2094239 | -0.20 | 0.839 | -.4529992 | .3679272 |
| FarmExp | -.024388 | .0160243 | -1.52 | 0.128 | -.0557951 | .0070191 |
| FarmSize | -.0128557 | .0545924 | -0.24 | 0.814 | -.1198549 | .0941435 |
| AccssCrdt | .031359 | .2607144 | 0.12 | 0.904 | -.4796319 | .5423499 |
| AccssInfor | .1464009 | .2865053 | 0.51 | 0.609 | -.4151391 | .7079409 |
| AgricTrain | 1.046189 | .2173261 | 4.81 | 0.000 | .6202377 | 1.47214 |
| _cons | -.3828827 | .4649749 | -0.82 | 0.410 | -1.294217 | .5284513 |
| FarmTech | | | | | | |
| AgeHH | -.0077894 | .011306 | -0.69 | 0.491 | -.0299487 | .01437 |
| Gender | .056994 | .1863435 | 0.31 | 0.760 | -.3082324 | .4222205 |
| HHSize | -.0443018 | .0537408 | -0.82 | 0.410 | -.1496318 | .0610281 |
| Educ | .0169904 | .1241486 | 0.14 | 0.891 | -.2263364 | .2603171 |
| Occup | .0390812 | .0721456 | 0.54 | 0.588 | -.1023216 | .180484 |
| Lvstck | .2773996 | .2078136 | 1.33 | 0.182 | -.1299075 | .6847067 |
| FarmExp | .0162995 | .0176586 | 0.92 | 0.356 | -.0183107 | .0509096 |
| FarmSize | .1458968 | .0595874 | 2.45 | 0.014 | .0291076 | .262686 |
| AccssCrdt | .0454288 | .260342 | 0.17 | 0.861 | -.464832 | .5556897 |
| AccssInfor | .5969559 | .2811225 | 2.12 | 0.034 | .0459659 | 1.147946 |
| AgricTrain | .6548944 | .2143303 | 3.06 | 0.002 | .2348146 | 1.074974 |
| _cons | -1.050758 | .485032 | -2.17 | 0.030 | -2.001403 | -.1001125 |
| Other | | | | | | |
| AgeHH | .0039142 | .0105549 | 0.37 | 0.711 | -.016773 | .0246015 |
| Gender | .0796673 | .1732965 | 0.46 | 0.646 | -.2599876 | .4193222 |
| HHSize | -.0241 | .0498485 | -0.48 | 0.629 | -.1218012 | .0736012 |
| Educ | .0394608 | .1192954 | 0.33 | 0.741 | -.1943538 | .2732754 |
| Occup | .05432 | .0683592 | 0.79 | 0.427 | -.0796615 | .1883015 |
| Lvstck | .0180035 | .2006275 | 0.09 | 0.928 | -.3752192 | .4112262 |
| FarmExp | .0137498 | .0163206 | 0.84 | 0.400 | -.018238 | .0457375 |
| FarmSize | -.0141355 | .0524272 | -0.27 | 0.787 | -.1168908 | .0886199 |
| AccssCrdt | -.0977263 | .2576523 | -0.38 | 0.704 | -.6027155 | .4072628 |
| AccssInfor | -1.012853 | .2917054 | -3.47 | 0.001 | -1.584585 | -.4411207 |
| AgricTrain | -.0740438 | .2118966 | -0.35 | 0.727 | -.4893536 | .3412659 |
| _cons | .554724 | .4608766 | 1.20 | 0.229 | -.3485775 | 1.458026 |

| | | | | | | |
|---|---|---|---|---|---|---|
| /atrho21 | -.0372274 | .1351973 | -0.28 | 0.783 | -.3022093 | .2277545 |
| /atrho31 | -.0305574 | .1461334 | -0.21 | 0.834 | -.3169736 | .2558588 |
| /atrho41 | -.0889487 | .1362706 | -0.65 | 0.514 | -.3560341 | .1781368 |
| /atrho51 | -.0312259 | .1611173 | -0.19 | 0.846 | -.34701 | .2845582 |
| /atrho61 | .1869707 | .1396438 | 1.34 | 0.181 | -.086726 | .4606675 |
| /atrho71 | .031421 | .1317202 | 0.24 | 0.811 | -.2267458 | .2895879 |
| /atrho81 | .0553947 | .1290639 | 0.43 | 0.668 | -.1975658 | .3083552 |
| /atrho32 | .1741401 | .1333537 | 1.31 | 0.192 | -.0872284 | .4355086 |
| /atrho42 | .1786085 | .1116794 | 1.60 | 0.110 | -.0402792 | .3974962 |
| /atrho52 | .1567464 | .1308745 | 1.20 | 0.231 | -.0997628 | .4132557 |
| /atrho62 | .1092398 | .1098514 | 0.99 | 0.320 | -.1060649 | .3245446 |
| /atrho72 | .0535063 | .1214554 | 0.44 | 0.660 | -.1845419 | .2915545 |
| /atrho82 | -.0305317 | .1095473 | -0.28 | 0.780 | -.2452404 | .184177 |
| /atrho43 | -.0228692 | .1165476 | -0.20 | 0.844 | -.2512982 | .2055599 |
| /atrho53 | .2752119 | .1443161 | 1.91 | 0.057 | -.0076425 | .5580663 |
| /atrho63 | .309352 | .1235977 | 2.50 | 0.012 | .067105 | .5515991 |
| /atrho73 | .1082973 | .115548 | 0.94 | 0.349 | -.1181726 | .3347672 |
| /atrho83 | -.0499855 | .1104275 | -0.45 | 0.651 | -.2664194 | .1664484 |
| /atrho54 | -.2165533 | .1470613 | -1.47 | 0.141 | -.5047882 | .0716815 |
| /atrho64 | .2502379 | .1093587 | 2.29 | 0.022 | .0358989 | .4645769 |
| /atrho74 | .1939371 | .1074617 | 1.80 | 0.071 | -.0166841 | .4045582 |
| /atrho84 | -.0194043 | .1030784 | -0.19 | 0.851 | -.2214342 | .1826255 |
| /atrho65 | .2997494 | .1345293 | 2.23 | 0.026 | .0360767 | .563422 |
| /atrho75 | .1494535 | .1202728 | 1.24 | 0.214 | -.0862768 | .3851839 |
| /atrho85 | -.0963822 | .1219264 | -0.79 | 0.429 | -.3353535 | .1425892 |
| /atrho76 | .1367511 | .1134066 | 1.21 | 0.228 | -.0855217 | .3590239 |
| /atrho86 | -.1185648 | .1052872 | -1.13 | 0.260 | -.3249239 | .0877943 |
| /atrho87 | -.0162233 | .1037265 | -0.16 | 0.876 | -.2195235 | .187077 |
| rho21 | -.0372102 | .1350101 | -0.28 | 0.783 | -.2933331 | .2238965 |
| rho31 | -.0305479 | .145997 | -0.21 | 0.834 | -.3067679 | .250418 |
| rho41 | -.0887148 | .1351981 | -0.66 | 0.512 | -.341716 | .1762761 |
| rho51 | -.0312157 | .1609603 | -0.19 | 0.846 | -.3337212 | .2771185 |
| rho61 | .1848221 | .1348736 | 1.37 | 0.171 | -.0865092 | .4306281 |
| rho71 | .0314107 | .1315902 | 0.24 | 0.811 | -.2229382 | .2817554 |
| rho81 | .0553381 | .1286686 | 0.43 | 0.667 | -.1950349 | .29894 |
| rho32 | .172401 | .1293902 | 1.33 | 0.183 | -.0870078 | .4099147 |
| rho42 | .1767332 | .1081912 | 1.63 | 0.102 | -.0402574 | .3778046 |
| rho52 | .1554752 | .1277109 | 1.22 | 0.223 | -.0994332 | .3912335 |
| rho62 | .1088074 | .1085509 | 1.00 | 0.316 | -.105669 | .3136104 |
| rho72 | .0534553 | .1211084 | 0.44 | 0.659 | -.1824752 | .283565 |
| rho82 | -.0305222 | .1094452 | -0.28 | 0.780 | -.2404394 | .1821223 |
| rho43 | -.0228652 | .1164866 | -0.20 | 0.844 | -.2461386 | .2027127 |
| rho53 | .2684678 | .1339145 | 2.00 | 0.045 | -.0076424 | .5065413 |
| rho63 | .2998475 | .1124852 | 2.67 | 0.008 | .0670045 | .5017177 |
| rho73 | .1078759 | .1142033 | 0.94 | 0.345 | -.1176256 | .3227978 |
| rho83 | -.0499439 | .110152 | -0.45 | 0.650 | -.26029 | .1649281 |
| rho54 | -.2132305 | .1403748 | -1.52 | 0.129 | -.4658745 | .071559 |
| rho64 | .2451423 | .1027868 | 2.38 | 0.017 | .0358835 | .4338072 |
| rho74 | .1915417 | .1035192 | 1.85 | 0.064 | -.0166825 | .3838424 |
| rho84 | -.0194019 | .1030395 | -0.19 | 0.851 | -.2178846 | .1806219 |
| rho65 | .2910832 | .1231307 | 2.36 | 0.018 | .0360611 | .510512 |
| rho75 | .1483506 | .1176258 | 1.26 | 0.207 | -.0860634 | .3672009 |
| rho85 | -.0960848 | .1208007 | -0.80 | 0.426 | -.3233229 | .1416306 |
| rho76 | .135905 | .1113119 | 1.22 | 0.222 | -.0853138 | .344354 |
| rho86 | -.1180124 | .1038209 | -1.14 | 0.256 | -.3139524 | .0875694 |
| rho87 | -.0162219 | .1036992 | -0.16 | 0.876 | -.2160639 | .1849247 |

```
Likelihood ratio test of  rho21 = rho31 = rho41 = rho51 = rho61 = rho71 = rho81 = rho32 = rho42 = rho52 = rho62 = rho72 = rho82 =
>  rho43 = rho53 = rho63 = rho73 = rho83 = rho54 = rho64 = rho74 = rho84 = rho65 = rho75 = rho85 = rho76 = rho86 = rho87 = 0:
                chi2(28) =  41.6679    Prob > chi2 = 0.0466
```

*Appendix 3: T-test Results*

. summarize Cropyeild202223

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Cropy~202223 | 252 | 1.722222 | .9830345 | 1 | 4 |

.

. summarize Cropyield202324

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Cropy~202324 | 252 | 1.063492 | .2443312 | 1 | 2 |

## *Appendix 4: T-test Comparing Yields for 2022/23 and 2023/24 Seasons*

```
. ttest Cropyeild202223, by( Cropyield202324)
```

Two-sample t test with equal variances

| Group | Obs | Mean | Std. Err. | Std. Dev. | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| 1 | 236 | 1.648305 | .0612128 | .9403696 | 1.527709 | 1.768901 |
| 2 | 16 | 2.8125 | .2452677 | .9810708 | 2.289724 | 3.335276 |
| combined | 252 | 1.722222 | .0619254 | .9830345 | 1.600263 | 1.844182 |
| diff | | -1.164195 | .2435746 | | -1.643915 | -.6844751 |

```
    diff = mean(1) - mean(2)                                      t =  -4.7796
Ho: diff = 0                                     degrees of freedom =      250

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000

.
```

*Appendix 5: Model Specification using Likelihood Ratio Test*

```
. lrtest m1 m2

Likelihood-ratio test                          LR chi2(48) =     53.92
(Assumption: m2 nested in m1)                  Prob > chi2 =    0.2582
```

*Appendix 6: Model Fit Diagnostic Results*

```
. estat ic
```

Akaike's information criterion and Bayesian information criterion

| Model | Obs | ll(null) | ll(model) | df | AIC | BIC |
|---|---|---|---|---|---|---|
| m2 | 252 | . | -1012.118 | 76 | 2176.236 | 2444.473 |

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

**Survey for Farmers/Households**

**Bindura University of Science and Education**

<u>Maximum Duration:</u> ***-20 minutes***

<u>Target Respondents:</u> ***Households/Farmers***

Master of Science in Food Security and Sustainable Agricultural Policy Research on **El Nino-Induced Drought and Farmers' livelihoods in Binga District of Matabeleland North Province in Zimbabwe (2023/24): An Assessment of Resilience, Adaptation and Coping strategies**

**Households/Farmers Individual Survey Tool**

## CONSENT

***Greetings***

*Thank you for the meeting; my name is* ***Oscar Nyathi*** *I am a student at Bindura University of Science and Education(BUSE) in the* ***Faculty of Agriculture and Environmental Science*** *under the* ***Department of Agricultural Economics, Education and Extension***

*I am carrying out academic research on* ***El Nino-Induced Drought and Farmers' livelihoods in Binga District of Matabeleland North Province in Zimbabwe (2023/24): An Assessment of Resilience, Adaptation and Coping strategies***

I assure that the information I obtain from you will remain confidential and that it will only be utilised for academic purposes. As a result, I am asking that you take no more than 20 minutes to answer all of the questions. If you have any questions or concerns about this study, you can reach me by phone at +263 77 2575103/+236 71 296 890 or by email at nyathio@gmail.com. I'm grateful.

NB: Where responses are coded, please complete using codes.

Can I begin the interview with your consent? Yes/No……
Proceed with the interview if the answer is yes; if not, select a different agricultural home at random.

The Enumerator's name ______________ _________________________

Interview Date………………………….

## GENERAL CHARACTERISTICS/DEMOGRAPHICS

District _______________ Ward ______________

Province: ____________

Locality

a) Peri-Urban
b) Rural

### A. Household and Household Head General Information

| No | Question | Possible responses | Coding |
|---|---|---|---|
| A1 | Age of the Household Head (Number of year) | | |
| | Gender of the Household Head | ○ 1= Male<br>○ 0= Female | |
| A2 | Household Size (NB: Captures only total number of family labour/Those that can provide labour) | | |
| A3 | Level of Education of the Household head | 0=Never attended school<br>1=Primary<br>2=Secondary<br>3=Tertiary | |

## SPECIFIC SURVEY QUESTIONS

### B. Farming and Livelihood characteristics of the Household

| | | | |
|---|---|---|---|
| B1 | **Household Head's Primary Occupation** | 1=Trading/Business owner<br>2=Farmer<br>3=Informal/Artisanal<br>4=Formal Employment<br>5=Not employed<br>6=Pensioner | |

| | | | |
|---|---|---|---|
| | | | |
| BI | Do you grow crops? | I=Yes<br>0=No (if No skip to B4) | |
| BI | If yes in **BI** what are the major types crops do you grow (Number of each class of crops) | | |
| | ▪ Cereal (maize, rice, wheat, sorghum, millet) | ○ | Tick applicable |
| | ▪ Legumes (cow peas, beans) | ○ | |
| | ▪ Cash crops (cotton, tobacco, tea, sunflower etc) | ○ | |
| | ▪ Root and Tubers (potatoes, cassava etc) | ○ | |
| | ▪ Pasture and Forage (Lucene, ryegrass | ○ | |
| B2 | Do you keep livestock? | I=Yes<br>0=No (if No skip to B4) | |
| B2 | If yes in **B2** what are the major livestock kept by the farmer (Number of each class of livestock) | | |
| | Cattle | | |
| | Goats | | |
| | Sheep/Pigs | | |
| | **Total** | | |
| B3 | Experience in Agriculture (in years) | | |
| B4 | Farm Size (in Hectares) | | |
| B5 | Access to Credit | I=Yes<br>0=No | |

| | | | |
|---|---|---|---|
| | | | |
| B6 | What was your total harvest from crop/cereal produces in the past 2 seasons? (Convert to tonnage | 2022-23 Season<br>○ 0 – 1t<br>○ 2 – 5t<br>○ 6 - 9<br>○ 10t and above<br><br>2023-24 Season<br>○ 0 – 1t<br>○ 2 – 5t<br>○ 6 – 9t<br>○ 10t and above | |
| B7 | What was your total income from agricultural produces in the past 2 seasons? (Amounts in USD. Convert to USD with exchange rate of the moment for other currencies) | 2022-23 Season<br>○ USD0 - USD20<br>○ USD21 - USD50<br>○ USD51 - USD100<br>○ USD101 - USD200<br>○ USD201 and above<br><br>2023-24 Season<br>○ USD0 - USD20<br>○ USD21 - USD50<br>○ USD51 - USD100<br>○ USD101 - USD200<br>○ USD201 and above | |

| | | | |
|---|---|---|---|
| | What is your main sources of income( Select 3 only) | 1=Trading/Business<br>2=Salary/wages<br>3=Casual labour<br>4=Sale of Agric produce<br>5=Remittances<br>6=Cash aid or Transfers<br>7=Credit Loans/Borrowing | |

## C. Climate Change Education and Knowledge

| | | | |
|---|---|---|---|
| C1 | Access to Climate Change Information | 1=Yes<br>0=No | |
| C2 | If the response is **yes**, which of these mode do you receive information on climate change and it effects | ○ 1= Radio<br>○ 2=Own understanding<br>○ 3= Television<br>○ 4= SMS<br>○ 5= Meeting with Extension Officers<br>○ 6= NGOs Programmes<br>○ 7=Community meetings<br>○ 8=Researchers<br>○ 9=Other (*Specify*) | |
| C3 | Did you receive any Agricultural related training in the last 4 years from 2020-2024 | ○ 1= Yes<br>○ 2= No | |
| C4 | If **Yes** to above, was Climate Change part of the training? | ○ 1= Yes<br>○ 2= No | |
| C5 | What was covered under CC? (Select multiple responses) | ▪ Weather forecasting<br>▪ Timing of planting<br>▪ Timing of harvesting<br>▪ Crop diversification<br>▪ Drought tolerant crops<br>▪ Farming technologies (Pfumvundza) | |

| | | |
|---|---|---|
| C6 | Which CC adaptation strategies are commonly practices in your community? | ▪ Weather forecasting<br>▪ Timing of planting<br>▪ Timing of harvesting<br>▪ Crop diversification<br>▪ Drought tolerant crops<br>▪ Farming technologies (Pfumvundza) |
| C7 | Which adaptation strategies have you used in the last 3 years (2022-2024)? | ▪ Weather forecasting<br>▪ Timing of planting<br>▪ Timing of harvesting<br>▪ Crop diversification<br>▪ Drought tolerant crops<br>▪ Farming technologies (Pfumvundza)<br>▪ Social External Assistance<br>▪ Entrepreneurship<br>▪ Agroforestry<br>▪ Gathering<br>▪ Other (specify |

**D. General Climate Perceptions and El Nino Induced-Drought Impacts (Food security, Nutrition, Social and Cultural)**

| | | | |
|---|---|---|---|
| **D1** | Have you experienced any impacts from El Nino in the past 2023/24 farming season? | 1=Yes<br>0=No | |
| **D1** | If yes in **C1** describe the impact (Drought, Floods, Crop failure) | 1=Severe<br>2-=Intermediate<br>3=None | |
| | How have El Nino related events affected your farming activities? | ▪ Erosion/flooding<br>▪ Increase in rainfall<br>▪ Scarcity of resources (food and water)<br>▪ Increase in temperature<br>▪ Increase in pest and disease infestation<br>▪ Poor yield of crops<br>▪ Sudden change in weather condition<br>▪ Death of animals<br>▪ Decrease in rainfall<br>▪ Migration of fish into deep waters | |

| | | | |
|---|---|---|---|
| D2 | Have you experienced any changes in temperature or rainfall patterns during the 2023/24 farming season? | 1=Yes<br>0=No | |
| D2 | If **yes in C2,** what changes have you observed? | ▪ High Temperatures<br>▪ Mid-season dry spells<br>▪ Low rainfall<br>▪ Cold spells | |
| D3 | How has El Niño affected your household's food security?( *Probe on ,Access, Availability and Consumption)* | ○ Severe<br>○ Intermediate<br>○ None | |
| D4 | Have you experienced any changes in your household's dietary diversity or nutrient intake? | 1=Yes<br>0=No | |
| D5 | 3. How do you ensure your household's access to nutritious food during El Niño-related events? | ○ Diversification of food sources<br>○ Raise small livestock<br>○ Fish farming<br>○ Food preserving and storage<br>○ Gardening<br>○ Others (specify) | |
| D6 | Have you experienced any livestock losses or productivity declines due to El Niño? | 1=Yes<br>0=No | |
| D6 | How did you manage your livestock during El Niño-related events (e.g., drought, floods)? | ○ Livestock feed supplement<br>○ Moving livestock to better grazing lands<br>○ Destocking<br>○ Other ( specify) | |

## E. Coping and Adaptation Strategies and Climate Change Support services (Internal and External)

| | | |
|---|---|---|
| E1 | What strategies have you used to cope with El Niño-related impacts (e.g., *drought-tolerant crops, irrigation, livestock feed supplements)?* | ○ Grow drought resistant crops<br>○ Irrigation<br>○ Livestock feed supplement<br>○ Livelihood diversification<br>○ Moving livestock to better grazing lands<br>○ Remittances<br>○ Migration and labor mobility<br>○ Other ( specify**)** |
| E2 | Have you adopted any new farming practices or technologies in response to El Niño? | 1=Yes<br>0=No |
| E3 | 3. How have you managed your finances to cope with El Niño-related losses or expenses? | ○ Income diversification<br>○ Saving<br>○ Pre-El Nino Financial Planning/Emergency fund<br>○ Review or adjust the household budget<br>○ Prioritize and Cut back on non-essential expenses<br>○ Negotiate with creditors<br>○ Develop contingency plan<br>○ Others ( specify) |
| E4 | 4. Have you received any support or assistance from government agencies, NGOs, or other organizations? | 1=Yes<br>0=No |
| E4 | If YES what support services did you receive or do you receive from the social organisation (NGOs) related to CC | Climate change adaptation trainings<br>Livestock Support<br>Food Aid<br>Cash Transfers<br>Farming Inputs<br>Agricultural Trainings |

*E5 How available are these services in relation to Climate Change Adaptation*

| **Support service** | **Very available** | **Somewhat Available** | **Not Available** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Weather forecast services | | | |
| Drought tolerant inputs | | | |
| Food Aid | | | |
| Market for Livestock | | | |
| Climate Smart Agriculture trainings | | | |
| Climate Change Adaptation trainings | | | |
| Other (specify) | | | |

## F. Constraints to Climate Change Adaptation

| | | |
|---|---|---|
| F1 | What are the constraints that affect farmers' adaptive capacities to Climate Change (*Select all possible answers*) | ▪ High cost of farm labour<br>▪ Lack of finance to purchase or use some of the adaptation methods<br>▪ Poor government attention to the climate change problem<br>▪ Scarcity of farm input<br>▪ High cost of improved varieties<br>▪ High cost of improved varieties<br>▪ Limited income of households<br>▪ High cost of farm inputs<br>▪ Poor storage facilities<br>▪ Lack of access to improve crop varieties<br>▪ Lack of information on climate change<br>▪ Limited technology on climate change<br>▪ No/limited subsidies on farm inputs<br>▪ Irregularity of extension workers<br>▪ Lack of information on weather forecast<br>▪ Low awareness of climate change adaptation methods<br>▪ Limited knowledge on water management method<br>▪ Limited knowledge on adaptive measures<br>▪ Other (*Specify*) |
| F2 | Is there anything else you would like to share about your experiences with El Niño? | *Write……...* |

| | | |
|---|---|---|
| F3 | Do you have any suggestions for how governments, NGOs, or other organizations can better support farmers like you in coping with El Niño-related impacts and build a resilient and sustainable livelihood | *Write .....* |

***End of individual interview***

**THANK THE RESPONDENT FOR THE INTERVIEW**