UNIVERSITY OF THE WITWATERSRAND
FACULTY OF SCIENCE
SCHOOL OF GEOGRAPHY, ARCHAEOLOGY, AND ENVIRONMENTAL STUDIES

CLIMATE VARIABILITY AND ASSET ADAPTATION OF SMALL-SCALE FARMERS IN ZIMBABWE'S GOKWE SOUTH DISTRICT: A SEARCH FOR A KNOWLEDGE INTEGRATION APPROACH

By

JAISON CHATSIWA

Student Number 1803536

A THESIS submitted to the **FACULTY OF SCIENCE,** at the **UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG**, in fulfilment of the requirements for the degree of **DOCTOR OF PHILOSOPHY** in GEOGRAPHY

SUPERVISOR: PROF MULALA DANNY SIMATELE

Ethics Clearance Number H18/11/05

JOHANNESBURG, SOUTH AFRICA

DECLARATION

I, Jaison Chatsiwa declare that this thesis is my original work. It is submitted for the **DOCTOR OF PHILOSOPHY** at the **University of the Witwatersrand**; Johannesburg and it has not been submitted before at any other University for examination purposes. References used in this document have been fully acknowledged except where I had first-hand experience or participated in the scenario.

This thesis is submitted for the award to the Faculty of Science, School of Geography, Archaeology and Environmental Studies (GAES), at the University of the Witwatersrand, Johannesburg, South Africa.

Signed…  …… (Candidate Signature)

Signed…  …….. (Supervisor Signature)

Date: 10 July 2023

ABSTRACT

Globally, climate change and variability threaten food production and security for an unforeseeable future leaving millions of people vulnerable to hunger and malnutrition-related diseases. Climatic models are projecting that Zimbabwe's climate will be hanging drastically with a high possibility of experiencing extreme weather patterns impacting the livelihoods of small-scale farmers who rely on rain-fed agriculture for their livelihoods. This study aims to investigate the role of asset portfolios in reducing the climate vulnerability of small-scale farmers of Gokwe South in Zimbabwe.

Zimbabwe's agricultural production both crop and livestock production has been negatively impacted due to the dwindling rainfall and increase in temperature and climate-related risks and disasters. The quality and quantity of asset portfolios determine the adaptive strategies and their success against the challenges of climate variability. Despite these effects, small-scale farmers in the Gokwe South district are using their asset portfolios to increase their adaptive capacity and resilience to fight against the challenges of climate variability. Therefore, this thesis revealed a paradigm shift from asset vulnerability to pro-poor asset adaptation. The paradigm shift crafted the 'Theory of Change' which is useful for climate variability adaptation strategies in the Gokwe South district as the small-scale farmers change from asset vulnerability to asset adaptation. The Theory of Change encourages contextual analysis of the area and theme under study. A Theory of Change is a method that explains how a given intervention, or set of interventions, is expected to lead to specific development change, drawing on a causal analysis based on available evidence.

This study used the Participatory Climate Change Adaptation Appraisal (PCCAA) as the primary data collection tool and the Participatory Rural Appraisal (PRA) known as the emancipatory methodology, to collect data in rural areas. A mixed methodological approach involving qualitative and quantitative was applied. We used thematic content analysis to analyse qualitative data collected during the data collection exercise. During the study period, computer-Aided Qualitative Data Software was used to store data in a sorted manner. The parametric variables were coded using the Predictive Analytic Software. This enabled to performance of statistical analysis and obtaining descriptive statistical outcomes

were obtained. The assessment of the effect of the factors on climate adaptation strategies was done through the Likert scale. Indigenous knowledge remained widely used as a source of climate knowledge in the Gokwe South district. The research results showed that indigenous knowledge (IK) is unpredictable, productive assets and adaptive assets are inadequate, technoscience and institutional support are poor support to implement viable adaptation strategies is lacking, and poor distribution and dissemination of climate and weather information to small-scale farmers in the Gokwe South district is poor and asset portfolios and asset mix is poor. The available asset portfolios determine the adaptation strategies used in the Gokwe South district. Results show that climate vulnerability varies spatially and temporally across the Gokwe South district. The studied five constituencies for the Gokwe district have a mean vulnerability index of 3.04 with the highest index being 5 as being well adapted. Sengwa and Mapfungabutsi are highly vulnerable to the vagaries of climate variability in the Gokwe South district. The researchers recommend strong institutional support from the government. The fact that small-scale farmers should integrate their IK and modern science climate knowledge small-scale farmers in the Gokwe South district should adopt proactive or anticipatory adaptation, government climate-smart agricultural policies, and a bottom-up approach to climate variability.

The quality and quantity of asset portfolios are key resources affecting the level of vulnerability to climate variability. The asset mix was seen to be significant in reducing the vulnerability of small-scale farmers in Sengwa and Mapfungabutsi, constituencies worst affected due to poor asset endowment of farmers in the Gokwe South district. The results have shown that the financial asset is the most important asset affecting vulnerability because it can be converted into other assets through buying. Weak institutional intervention renders many small-scale farmers helpless to climate variability, and the government is not fully supporting small-scale farmers to increase their adaptive capacity and resilience.

Keywords*:* Asset adaptation, asset portfolio, climate variability, knowledge integration, indigenous and scientific knowledge, small-scale farmers, vulnerability

DEDICATION

To my belated parents Obert and Raramai Chatsiwa, my wife Juliet, and our children Sharon, Shalom, Shalon, and Shannon for the sacrifice they endured when I embarked on this journey in my quest to complete this research. I greatly appreciate you all for the support you offered when things were going tougher than expected for me to realise my full potential and self-actualization in the field of academics. You were always there for me to complete this thesis. May God bless you abundantly.

ACKNOWLEDGEMENT

Above all, Glory to God the Almighty who guides and strengthens me throughout my entire life. I am deeply indebted to my supervisor, Prof. Mulala Danny Simatele, who in many ways too many to mention went beyond the call of duty and assisted me. The time you invested into my work coupled with the ideas made this journey interesting and intellectually stimulating. You were always stretching me to go beyond my capabilities. Your analysis and advice helped me refine my ideas and you always found time to listen, engage and read many different drafts of my work as well as provide timely feedback. You are a great model for supervision and have taught me how to supervise through what you invested in me. I am also grateful to Prof. Paul Mapfumo, Prof. Daniel Tevera, Prof. Obert Jiri; Dr. Cryton Zazu, Dr. R. Musavengana, and Dr. Pascal Manyakaidze for standing by me and encouraging me, I value your input immensely. Samuel Chatsiwa, I greatly appreciate your financial support. May God bless you.

To the University of Witwatersrand Management, thank you for the excellent opportunity and exposure as well as for providing the best conducive environment to me and my other Ph.D. colleagues.

I also want to thank and appreciate the Government ministries and departments, and all government officials, chiefs, headmen, and councilors my research assistants, Eliazeri Mukanganwi and Lazarus, M. Ngwaya who were assisting me during data collection. I got assistance in administering household questionnaires during fieldwork.

I am sincerely grateful to Overseer S. G. Ganyau, Rev. R. Samambwa, Elders T. Mutsiwa, Chibvongodze, and Deacon Musariri of Azusa Revival Centre in Kwekwe (Apostolic Faith Mission in Zimbabwe) for their moral and spiritual support and encouragement. Above all, I want to thank God who enabled me to sail through all the challenges I faced during my studies.

LIST OF ABBREVIATIONS AND ACRONYMS

ABA	Asset-Based Adaptation
AEZ	Agro-Ecological Zones
AIACC	Assessment of Impacts and Adaptation to Climate
AMA	Agricultural Marketing Authority
ANIDP	Accelerated National Irrigation Development Programme
APA	American Psychological Association
CSAIP	Climate Smart Agricultural Investment Plan
CBDRM	Community-Based Disaster Risk Management
CAQDS	Computer-Aided Qualitative Data Software
CF	Contract Farming
CMB	Cotton Marketing Board
COMESA	Common Market for Eastern and Southern Africa
COTTCO	Cotton Company
DA	District Administrator
DDC	District Development Coordinator
DFID	Department for International Development
DSD	Department of Social Development
EWS	Early Warning Systems
FAO	Food Agricultural Organisation
FGD	Focus Group Discussion
FLRP	Fast Track Land Resettlement Programme
GCF	Green Climate Fund
GDP	Gross Domestic Product
GIS	Geographical Information System
GoZ	Government of Zimbabwe
GHG	Green House Gases
HAP	Household Asset Portfolio
IKS	Indigenous Knowledge Systems
IISD	International Institute for Sustainable Development
IMF	International Monetary Fund
IPCC	International Panel on Climate Change
KAMA	Knowledge Adaptation and Mitigation Approach
LAC	Local Adaptation Strategy

MEB	Multiple Evidence Base
NAP	National Adaptation Plan
NAPF	National Agricultural Policy Framework
NEPAD	New Partnership for Africa Development
NGO	Non-Governmental Organisation
PRA	Participatory Rural Appraisal
PCCAA	Participatory Climate Change Asset Adaptation
SDG	Sustainable Development Goals
SCF	Seasonal Climate Forecast
SSA	Sub-Saharan Africa
SADC	Southern African Development Community
SLA	Sustainable Livelihood Approach
SLF	Sustainable Livelihood Framework
TSP	Transitional Stabilisation Programme
UNDP	United Nations Development Programme
UNFCCC	United Nations Convention on Climate Change
WB	World Bank
ZAIP	Zimbabwe Agricultural Investment Plan
ZIMASSET	Zimbabwe Agenda of Sustainable Economic Transformation
ZIMCODD	Zimbabwe Coalition on Debt and Development
ZIMSTAT	Zimbabwe National Statistics Agency

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

1.1 Background to study

Global economic sectors and livelihoods have been negatively impacted leaving millions vulnerable to climate-related risks and disasters (Bandara & Cai, 2014; Evans *et al*., 2014; International Panel on Climate Change IPCC, 2014). Climate variability is a global challenge to food security, particularly in households in low-income countries depending on rain-fed agriculture. The global economies have been put into disarray, particularly rural households because of climate variability (Shizha *et al.*, 2017; Sultan & Gaetani, 2016). Rain-fed small-scale agriculture is the mainstay of livelihood in communal areas. The heavily affected region in Southern Africa contributes over 90% of primary sector types of employment. Sustainability has been greatly compromised due to the negative effects of climate variability (Slater, 2007).

Agricultural productivity and food security are highly climate-sensitive. There was a serious decline in agricultural output in the last few decades in sub-Saharan Africa (SSA), (Barrios *et al*., 2008; IPCC, 2014). The above view concurs with Calzadilla *et al*., (2013), who noted that 97% of rural communities in SSA rely on rain-fed agriculture for their livelihoods. Many households are expected to suffer more if no viable adaptation strategies are implemented in SSA (Calzadilla *et al*., 2013; IPCC, 2014). In SSA, the agricultural out from the small-scale is expected to decline by a significant percentage by 2050 (Thornton *et al.*, 2008). Various factors expose small-scale farmers to climate change and variability in sub-Saharan Africa (SSA), some of the notable factors are technological advancement, low educational levels, rapid population growth, poor resource base, lack of government support structures and lack of implementation of practical policies (IPCC, 2014; Perez *et al*., 2015). For centuries, rural communities relied on Indigenous Knowledge Systems (IKs) based on various natural phenological manifestations as shall be discussed in Chapter Six, (Eakin, 1999; Nyong *et al*., 2007).

In Zimbabwe, it has been noted that seasons have significantly shifted worsening climate variability as manifested in the decrease in rainfall totals and frequency of dry spells (Unganai, 2009; Mudzonga, 2011). The occurrence of Cyclone Idai devastated some provinces in eastern

Zimbabwe and Mozambique in southern Africa in 2019. However, the implications of climate change and variability vary across regions, farming systems, households, and individuals. Zimbabwe's rainfall is projected to decrease by 10-20% and temperatures to increase by 2-4 degrees Celsius by 2100 compared to the previous decades (Nyong, 2005; Unganai, 2006; Lobell *et al*., 2008). Without adaptation, the vulnerability of rural communities would be worse due to poor asset entitlements. The small-scale farmers in the Gokwe South district confirmed an increase in temperature and a gradual decrease in the amount of rainfall per year as well as high variability in rainfall figures (Gwimbi, 2009). However, smallholder farmers are not passive victims of climate change and variability since they use their asset portfolios to increase their adaptive capacity and resilience against climate change and variability (Li, *at el*., 2013).

Several farming communities employ adaptation strategies in agriculture by diversifying crops, using hybrid varieties, using drought-tolerant crops, early planting, dry planting, zero tillage, and mixed farming as strategies to fight against the challenges of climate variability. Therefore, the current study is based on a pro-poor asset-based adaptation framework (Deressa *et al*., 2008); Macharia *et al*., 2012; Ndaki *et al.,* 2015). The mitigation approach as an alternative to climate change risks and disasters is criticised on the basis that mitigation will require a long process and can be very expensive, particularly for low-income countries, leaving adaptation as the favoured affordable option to climate change challenges (Mudzonga, 2011).

A challenging question arises whether to adopt or mitigate the causes of greenhouse emissions (Preston *et al*., 2009). The reduction in agricultural productivity is attributed to sporadic rainfall and excessively high temperatures causing a devastating effect on both crops and livestock and threatening food security in SSA (Taffesse *et al.*, 2013; Derressa *et al.*, 2010).

Zimbabwe's vulnerability to climate change and variability is catalysed by poor asset entitlement by small-scale farmers (Zvamasiya, *et al.*, 2017). Climate change adaptation is mandatory for small-scale farmers so they can achieve sustainable livelihoods and food security from local to regional scales (Nyahunda *et al*., 2019). Several climate change and variability impacts are manifested in various sectors of the economy, including extractive (primary) industries, manufacturing, and service industries (Dube & Nhamo 2019). Quaternary industries are also indirectly impacted by climate change and variability. The education and tourism sectors are also hard hit by climate change and variability in SSA. Trading activities both domestic and international are affected by climate change and variability. The degree of vulnerability depends

on the quality and quantity of asset portfolios which can affect their adaptive capacity and resilience (Nyahunda *et al.*, 2019). Considering this, in the rural parts of Zimbabwe, the impacts of climate change and variability are already manifested as swamps and earth dams are drying for most of the year, and crop production has seriously decreased, exposing the rural farmers to a precarious position due to food insecurity (Mubaya & Mafongoya, 2017).

The four dimensions of food security (food availability, accessibility, utilisation, and accessibility) will be destabilised by the negative impacts of climate change and variability (Savary, *et al.,* 2022). Climate variability has a ripple effect on human survival and livelihoods because it affects the state of food security in any human society. It also affects their health conditions, and their ability to work and produce food for survival (Fao, 2020).

The availability of asset portfolios or easy access for assets to small-scale farmers alone is not sufficient to make them resilient and fully adaptive to the challenges of climate variability (World Economic Forum, 2021). The proposed approach is that government departments, parastatals, and Non-Governmental Organisations (NGOs) should capacitate small-scale farmers to achieve sustainable livelihoods and food security for rural communities (GoZ, 2020).

1.2 Thematic considerations

Rural communities are incapacitated to adjust to climate change and variability due to poor asset portfolios; therefore, vulnerability is spatial and temporal across SSA. The rate of climate change and variability outpaced the rate of small-scale farmers' adaptation (Ajani *et al.*, 2013). This idea was also shared and supported by Fabiyi and Oloukoi (2013) who noted that indigenous knowledge systems (IKs) are becoming unable to predict and forecast weather events accurately in SSA. The alarming rate of climate change has negatively impacted food security in SSA rendering the IKs inefficient to deal with climate change challenges. Therefore, small-scale farmers must embrace practical strategies to protect themselves against extreme weather conditions. As proposed, such a proactive adaptive strategy will enable sustainable livelihood adaptation (Choi, *et al.*, 2015; Klopper *et al.*, 2006).

The scenario of climate variability and food security is so crucial that failure to adapt to the prevailing climate, the rain-fed farmers will be vulnerable and succumb to such atmospheric

disasters. In the 2018/19 agriculture season, the dry spells left many parts of Central and Southern Africa vulnerable to food shortage and many families went to bed on empty stomachs. Very few families could afford two decent meals per day.

Global efforts by international communities to solve the problems caused by climate variability through mitigation were turned into an undignified fiasco. Very few countries were able to achieve a quarter of their targets of greenhouse gas reduction. The level of carbon dioxide has been on the increase in the past decades; hence farmers' adaptation can be of paramount importance. The Kyoto Protocol objectives of 1997 were not fully implemented by many countries thereby exposing small-scale farmers to climate-related risks. Therefore, adaptation can be a viable option. The objectives of the Paris Agreement in 2015 to reduce global temperatures by 1.5^0C did not materialise due to the failure of adequate funding and some economic motives and generation of electricity which produced many greenhouse gases. However, integrating indigenous knowledge and asset-based adaptation has been proposed at many international fora. Given the above, the current study was interested in investigating the relationship between climate vulnerability and asset portfolios at the farmers' disposal to build small-scale farmers' adaptive capacity. Resilience can only be successful when the victims realise that the effects of climate change need to be anticipated rather than a reactionary adaptation (Kolawole *et al.*, 2014). While Zimbabwe ratified several international and national climate change policies, Mtisi (2010) deplores, the policies are not fully implemented. Zimbabwe developed the Climate Change Response Strategy in 2014 and the education framework coded 5.0 which allowed researchers to find an alternative solution to the challenges of climate variability. However, the Government of Zimbabwe (GoZ) makes sure that the policies of National Climate Policy are fully implemented by all stakeholders from bottom to top.

Small-scale farmers are using their IKs because such knowledge systems are cheap, locally available, and easy to understand with the use of equipment such as scientific knowledge systems. Regardless of the fast-approaching climate change disasters, small-scale farmers are utilising their asset portfolios and traditional methods to achieve the best livelihoods (Tawodzera, 2012). Various studies concur with the view that extreme climate hazards are beyond the ability of the IKs to predict future climate change hazards accurately (Ajani *et al.*, 2013; Fabiyi & Olouki, 2013). The quality and quantity of assets of rural farmers affect their ability to adapt and increase their resilience against challenges of climate variability (Moser, 2011).

Adaptation is preferred over mitigation because adaptation can be applied even at a small scale compared to mitigation which is applicable at a macro scale and does not stop the climate from changing. The ability to adapt depends on various factors either tangible or intangible and the way the asset portfolios are mixed (Maddison, 2006). The impacts of climate variability on communal farmers are becoming part of the main agenda in climate change discourse but nothing much has been done focusing on small-scale farmers in the Gokwe South district.

This study sought to investigate the indigenous adaptation strategies in use, integrate them with scientific knowledge, and determine the influence of adaptation assets on vulnerability to climate change risks amongst small-scale farmers in the Gokwe South district. In addition, this study focused on how small-scale farmers mobilise their assets to increase their adaptive capacity against climate variability in the Gokwe South district. The thrust of the government is to develop, implement and scale-up climate smart agriculture solutions and strengthen the resilience of agricultural value chains and markets (GoZ, 2021).

1.2.1 Research questions

Given the above observations, the following questions guided the research process.

i. What factors influence small-scale farmers' adaptation strategies to climate variability in the Gokwe South district?
ii. In what ways can indigenous knowledge systems be exploited to improve small-scale farmers' adaptive capacity against climate variability challenges?
iii. What assets portfolios are available in the Gokwe South district to improve their adaptive capacity against climate variability?
iv. What adaptive strategies are being taken in the Gokwe South district by small-scale farmers against challenges of climate variability?
v. What are the wider implications of the findings in the Zimbabwean context?
vi. What institutional and policy frameworks exist to implement adaptive policies among small-scale farmers?

1.3 Research aim and objectives

The study aimed to investigate the role of asset portfolios owned by small-scale farmers in Gokwe South in reducing the effects of climate variability and an attempt to produce knowledge integration.

The following were the objectives of the study:

i. To examine the factors that affect the small-scale farmer's choice of adaptation strategies to climate variability in the Gokwe South district.
ii. To critically assess the types of indigenous knowledge and their significance to reduce climate variability impacts in the Gokwe South district.
iii. To identify and critically review the assets portfolios available in the building used to reduce the impacts of climate variability in the Gokwe South district.
iv. To assess the small-scale farmer's perceptions of climate variability's impacts in the Gokwe South district.
v. To assess the knowledge integration between scientific and indigenous systems in solving climate variability risks in the Gokwe South district.
vi. To critically evaluate the institutional and policy frameworks and make recommendations for mall-scale farmers to reduce climate-related vulnerabilities.

1.4 Theoretical considerations and literature review

Climate change affects agricultural activities; hence, poor small-scale farmers remain poorer (Hallegatte *et al*., 2016). Small-scale farmers in Saharan Africa are highly exposed to climate variability due to negative atmospheric conditions like negative water balance, excessive evapotranspiration, stochastic rainfall regimes, and weak adaptive capacities (Muzawazi *et al*., 2017). The quality and quantity of asset portfolios play a crucial role in the adaptation process of small-scale farmers in the face of climate variability (Moser & Satterthwaite, 2008; Moser & Stein 2011; IISD, 2003). Each household's vulnerability depends on social, human, physical, financial, and natural assets, so-called the pentagon of assets (Moser & Stein, 2011; Simatele & Simatele, 2015) are too archaic and the fact that assets are not static but change over time prompted this study. The omission of other assets such as those intangible prompted this study in the quest for climate change adaptation for small-scale farmers. The literature that influenced the study is that

small-scale farmers modify their assets to achieve food security in rural areas. Climate variability greatly influences the matrix of food security such as food accessibility, utilisation, availability, and stability. The variables of the human development index such as health, livelihoods, buying power, and market flow are also affected by climate variabilities. In addition to the impacts on food security, it is also argued that due to climate variability other aspects of the human development index such as human health, livelihoods, asset portfolios diet, and food production are negatively impacted (Simatele, Binns & Simatele, 2012).

The core elements that affect small-scale farmers are the resource endowments and asset mix (Moser & Satterthwaite, 2008; Bebbington, 1999). However, small-scale farmers have been relying on IKs and other traditional techniques to achieve their livelihoods before the colonisation of the African continent (Tawodzera, 2012). However, full detail of climate change adaptation and discourses are comprehensively presented in Chapter Two.

1.5 Methodological considerations

The data used in this study was collected through primary and secondary data sources. Secondary sources of data include publications, maps news bulletins, and magazines, while primary data sources include questionnaires, focus group discussions, and interviews. This study used the Participatory Rural Appraisal (PRA) supported by the participatory climate asset adaptation participatory appraisal (PCCAA) which is the emancipatory methodology applied in rural areas of the Gokwe South district. The PCCAA was used to collect primary data from the rural residents of the Gokwe South district. A mixed methodological approach of qualitative and quantitative research was applied because they produce a hybrid outcome. While quantitative methods allow for responses that could be analysed with a sophisticated statistical approach, they lack in providing an insider's view of the research subjects. In this study, the qualitative approach was used to assess the descriptive and non-numerical variables data (Flick, 2014). In this study, thematic content analysis was used to analyse the data from questionnaires, and Focus Group Discussions (FGD). However, a full account of the step-by-step methods used is presented in Chapter Three.

1.6 Scope of the study

The scope of the study was focused on the assets or resources that the small-scale farmers must adapt to climate variability through enhancing food security in the Gokwe South district.
The study also focused on how small-scale farmers are modifying their asset portfolios to improve their adaptive capacity against the challenges of climate change and variability in the Gokwe South district in Zimbabwe. The climatological conditions of Zimbabwe's agro-ecological regions were also analysed to see how small-scale farmers are impacted by the shifting of the climate conditions. The study also focused on the search for knowledge integration that may exist between indigenous and scientific knowledge in the quest for food security among rain-fed farmers. A comparison of indigenous knowledge systems and the scientific knowledge system was also done to see how these knowledge systems can complement each other. The study also analyses the government policy frameworks to cushion the rural farmers against climate variability in the Gokwe South district. The type of climate governance was also analysed to see how effective climate governance in Zimbabwe is to achieve a climate-resilient- nation. The study was based on five constituencies in the Gokwe South district, and these are Gokwe Centre, Kana, Mapfungautsi, Sesame, and Sengwa. The temporal scope of the study area spans from the 1960s through to the current 2020s. This has been reflected in the agro-ecological shift of the map of Zimbabwe. The small-scale farmers in the Gokwe South district have been experiencing the same climate variability and impacts for three decades and a half. In this study, the researchers' theoretical scope is limited to the assets used by small-scale farmers at their disposal to fight against the impacts of climate variability in the area. The Sustainable Livelihood Framework was also used to analyse the extent to which small-scale farmers modify their asset portfolios to improve their adaptive capacity against the impacts of climate variability. The whole study was limited to climate variability and the hybrid of indigenous and scientific knowledge to create a successful climate variability adaptation.

1.7 Ethical considerations

When carrying out academic research, ethical considerations and measures are important for honest and just reporting, without prejudicing the participants. This study considered several measures like anonymous identification privacy, confidentiality, and that the participant is free to withdraw from participation at any stage of the process (Richards *et al*., 2002). Ethical guidelines

in research emphasise the importance of informed consent and this is obtained through explaining to participants the research purpose, harms or benefits of participating, confidentiality, use of data, and their right to withdraw should they wish to do so (Flicker *et al.*, 2007). Before the commencement of the study, we obtained an Ethics Clearance Form from the Witwatersrand Ethics Committee. All the participants were informed that the participation was voluntary and that there were no profits in taking part in the exercise and the research was mainly for academic purposes. The participants were to acknowledge and give their due consent in the exercise but remain anonymous to maintain confidentiality. Participants also had access to information sheets and were allowed to question the whole exercise for clarification. Those who were not able to write had to give their verbal consent and clarification was given where it was needed.

The APA Ethics Code (2002) was used during the collection of data in the field. The researchers clarified everything before signing the participant information sheet. The issue of confidentiality was emphasised among stakeholders involved in this research. This study involved government departments, non–governmental organisations, and Gokwe South small-scale farmers. Anonymity was guaranteed to all participants. In conducting this study, an informed consent form was drawn up to ensure participants understood the purpose of the study and to ensure both parties agree to the terms of the research. Cultural and gender issues were taken into consideration. All efforts were done to make sure that the research was designed so that even the participants' integrity was kept free from defamation of character, physical injury, emotional damage, pain, and other negativities. Costs of ethical aspects that were considered include negotiating access to sites and guaranteeing the confidentiality of participants (Creswell, 2003). Ethical variations among participants were also taken into consideration, and to safeguard against these factors the researchers followed three guidelines:

(i) Outline the significance of the study

(ii) Inform the participant's free will to take part, and

(iii) Obtain informed consent either verbal or written

Where there was a need, participants were debriefed to clarify any grey areas. Rights of privacy and confidentiality were also taken into consideration throughout the research period. Our Ethical Clearance Project Protocol Certificate number is H 18/11/ 05, see Appendix A.

1.8 Structure of the thesis

This thesis is structured into seven chapters with sub-sections. **Chapter One** presents an outline of the thesis including an Introduction, and gives the background of the research aim, and objectives. The outline of theoretical considerations, literature review and methodological considerations are presented in this chapter. The research approach and ethical considerations were also discussed in this chapter. **Chapter two** is a presentation of an in-depth review of the literature on climate variability on a global, sub-regional, and country level. **Chapter Three** focuses on the Research Methodology for climate variability and asset adaptation framework. This chapter focuses on the characteristics of the study area of the Gokwe South district and then details the methods used to collect data on how small-scale farmers are affected by the availability of assets against the effects of climate variability. **Chapter Four** presents the Empirical Evidence and research findings from the discussions from the focus groups, responses from the questionnaires, and transect walks. The chapter is mainly a presentation of the results of the research questions for the study area. Perceptions of small-scale farmers were also presented in this chapter. The significance of indigenous knowledge to an adaptive strategy was also assessed in this chapter. Various institutional and policy frameworks used in the Gokwe South district were also presented. **Chapter Five** presents a discussion of the findings. It also analyses the empirical evidence and research findings from Chapter Four. **Chapter Six** presents the conclusions and recommendations for study the area. In this chapter, future research studies are also presented. The recommendations were suggested to improve the adaptive capacity of small-scale farmers against the challenges of climate variability. The future research studies also highlighted the possible areas of study in the climate change and variability discourses.

CHAPTER TWO[1]

THEORETICAL CONSIDERATIONS AND LITERATURE REVIEW

2.0 Background to theoretical considerations

Sub-Saharan Africa (SSA) has suffered serious repercussions of climate variability to an extent that poor small-scale rural farmers have challenges engaging in productive agriculture. Agricultural livelihoods have become so precarious that some small-scale farmers are vulnerable to hunger because crop production in SSA is highly dependent on natural rainfall. A shift in climate conditions for rain-fed agriculturalists in SSA will disproportionately expose small-scale farmers to food insecurity, poverty, and misery. This chapter presents a discussion of theoretical considerations and the literature already available on asset adaptations to climate variability. This thesis revealed that the quality and quantity of assets and the asset mix of small-scale farmers affects the vulnerability of households in the Gokwe South district. The research found that there is a need to integrate the two sources of knowledge to complement each other and come up with a hybrid of knowledge that can improve small-scale farmers' adaptive capacity in the Gokwe South district. The results from this research indicated that indigenous knowledge systems are becoming unpredictable, lack productive assets, and modern science, lack institutional help, and lack climate variability information. The research findings indicated that the Gokwe South district was vulnerable with an index of 3.04 on average with the highest value of 5 as highly adapted. The issues of climate change vulnerability, adaptation, and food security have become topical at various national, regional, and international forums.

Keywords: Asset adaptation, climate change adaptation; food security; climate variability; climate vulnerability, Zimbabwe.

[1] This chapter is based on a paper published in the Journal of Asian African Studies: Chatsiwa, J.; Memory Reid; and Mulala, D. Simatele., (2023) Asset Portfolios in Climate Change Adaptation and Food Security. Lessons from Gokwe South district, Zimbabwe: https://doi.org/10.1177/00219096231158340

2.1 Introduction

The focus of this chapter is to provide a review of the existing literature on small-scale farmers' adaptation to climate variability. This geographical study is important because it identifies the gaps in small-scale farmers' adaptation to climate change extremes. This chapter is therefore structured in the order where it begins with the definition of terms and then highlights factors affecting the choice of adaptation strategies at various scales. The negative impact of climate variability is greatly impacting small-scale farmers in low-income countries and their food security is highly compromised and leaving them highly vulnerable (Bene *et al.*, 2014). Climate variability adaptation is one of the main options remaining for small-scale farmers to secure food security in their households. The following subsection dealt with contextualising the literature on small-scale farmers and their adaptation strategies from a global to a local perspective.

Climate variability-related effects have increased globally threatening food security in various countries (Mugambiwa & Tirivangasi, 2017; Mugambiwa, 2018; Tirivangasi, 2018). Climate variability destroyed the economies of rural communities in the SSA and on a global scale. The communal farmers' vulnerability to climate variability is attributed to abject poverty and lack of appropriate technology (Perez *et al*., 2015). The IPCC (2022) revealed that agriculture is the worst economic sector that has been negatively impacted by climate change (Bandara & Cai, 2014).

Climate variability challenges will negatively impact SADC countries in decades to come (Brazier, 2017). Zimbabwe is projected to suffer extreme challenges due to climate variability and many rural farmers are the victims and are highly exposed (GoZ, 2014). In Zimbabwe, the temperature is expected to increase by 3^0C, and annual rainfall is projected to decrease and become very erratic. Climate hazards and risks are projected to increase in a few decades disrupting the livelihoods of the Zimbabwean rural communities and other sectors of the economy (Brazier, 2017).

In Zimbabwe, crop production particularly maize which is a staple crop is expected to decrease (Ndebele & Mubaya, 2015). Zimbabwe used to be the breadbasket of Southern Africa three decades ago but currently is the largest importer of maize. This has also resulted in many people migrating to neighbouring countries as the country is experiencing food insecurity. While the climate is changing, the Zimbabwean government is mainly concerned with the adaptation response and strategies that the rural farmers increase resilience and adaptive capacity. In

Zimbabwe, agriculture accounts for more than 10% of the country's revenue, and 10% of the country's Gross Domestic Product (GDP). Approximately 70% of the people are employed in agriculture (GoZ, 2015).

2.2 Key concepts used in the study

There are several definitions and concepts used in climate change discourse but most of the definitions are highly contested in climate change international forums. Given that these terms are usually contested. This study adopted the working definitions outlined below:

a) **Climate change adaptation**: This is the process by which communal farmers adjust their livelihoods to the changing climate (IPCC, 2014). It involves a change in adaptive activities aimed to reduce the negative effects of climate change (Elmum, Modise & Marr, 2017).
b) **Adaptive Capacity** is the capacity and ability of the food generation system to confirm and adjust to climate change and variability and be able to cope with climate change and variability. Adaptive capacity in the context of climate change discourse has been defined by the IPCC (2007). For such a geographical study, we adopted this definition because it recognises what the victims are doing to adjust to the challenges of climate extremes such as drought and floods.
c) **Climate change**: In this study, climate change has been defined as a significant change in climate variables that are noticeable over a period of 30-40 years (IPCC, 2014).
d) **Climate variability** refers to variation in the numerical average of climate variability in a country to regional and scale mean above or below the single weather event (IPCC, 2014; Luers & Moser, 2006).
e) **Climate change vulnerability** refers to any changes in the climate variables exposing small-scale farmers to climate changes that result in negative agricultural production due to a lack of resources to ensure that crops and livestock are protected against the vagaries of climate change (Fraser, 2007; Simelton, 2009; IPCC, 2007). Vulnerability is assessed by three variables, namely adaptive capacity, exposure, and sensitivity. This thesis adopted the definition by Fraser (2007) because it addresses production systems in agriculture.

f) **Food security** refers to the availability, and accessibility of affordable, safe, and nutritious food that can achieve a balanced diet for members of the community (Food Agricultural Organisation, 2002).

g) **Indigenous knowledge**: knowledge, skills, technologies, and practices acquired from the native group of people accumulated through life experiences and observing natural phenomenological changes (Chanza, 2014).

h) **Assets** are resources or capital, either tangible or intangible used by farmers to achieve food security in their agricultural activities (Ford Foundation, 2004).

i) **Resilience** is the ability of agricultural production systems to resist and withstand the negative effects of climate change and variability resulting in a limited loss of production of both animals and crops (Simelton *et al.,* 2009). This thesis applied the definition by Simelton *et al*., (2009) as the working definition because it makes references to crop production.

2.3 Contextualising the literature on climate and change adaptation: a global context

Global economies have been put into disarray because of climate injustice, leaving most of the continents exposed and vulnerable to climate extremes (Mashizha *et al*., 2017; Sultan & Gaetani 2016). There is an inverse relationship whereby the global population is increasing and food production is declining (Ray *et al*., 2019). If food production is not doubled by 2050, half of the global population will suffer from food insecurity (FAO, 2018). Food insecurity is a global challenge because the population is growing at an exponential rate while food production is growing at an arithmetic rate. The population which remains undernourished, is 842 million individuals, approximately 12% of the world's population (Zhou *et al.,* 2019). The above sentiments were shared by Ali *et al.,* (2014) who observed that the global climate variables are changing and impacting agricultural production.

The impact of climate variability varies globally whereby some regions are expected to experience worse conditions than others (IPCC, 2022). Given the above observations, vulnerability is not a uniform taxonomy and varies spatially and temporally. Climate extremes affect agricultural production and practices on a global scale (Conway & Schipper, 2011; Conway, 2011). Other research findings noted that poor small-scale farmers have relied on IK for producing food for their households (Al Mamun *et al*., 2014; Bola *et al*., 2014; Nkomwa *et al.,* 2014). The IPCC

(2022) noted that global temperature rise will reach or surpass 1.5^{0}C (2.7 degrees F) between 2021 and 2040. The purpose, timing, and scope of various modes of adaptation are outlined in Table 2.2. The functions, performance, and form of each method of adaptation depend on each geographical area and asset availability of each community.

Table 2.1: Characteristics and differentiating climate change adaptation

General Differentiating Concept orAttribute	Examples of Terms Used
Purposefulness	Autonomous ⟷ Planned Spontaneous ⟷ Purposeful Automatic ⟷ Intentional Natural ⟷ Policy Passive ⟷ Active Strategic
Timing	Anticipatory ⟷ Responsive Proactive ⟷ Reactive *Ex ante* ⟷ *Ex post*
Temporal Scope	Short term ⟷ Long term Tactical ⟷ Strategic Instantaneous ⟷ Cumulative Contingency Routine
Spatial Scope	Localized ⟷ Widespread
Function/Effects	Retreat - Accommodate - Protect Prevent - Tolerate - Spread - Change - Restore
Form	Structural - Legal - Institutional - Regulatory - Financial - Technological
Performance	Cost - Effectiveness - Efficiency - Implementability - Equity

Source: Smit *et al*., (1999).

Autonomous adaptation planned adaptation and appropriate technology are the best interventions required to fight against the effects of climate change and variability (Dixon *et al*., 2003). The climate variability footprint has marked an indelible mark on small-scale farmers and therefore the farmers are modifying their assets to adapt to climate variability (IPCC, 2013).

The vulnerability of small-scale farmers can be influenced by the type of adaptations that have been tried in the previous attempts and the contemporary strategies done by the farmers with the assets being the basis of adaptations (Brooks, 2003). There is an inseparable link between climate change adaptation and asset erosion and if the relationship is inverse, the farmer will suffer from asset vulnerability (Moser, 2010). The basis of this study is that asset-based framework determines climate vulnerability, resilience, and ability to adapt. In the same vein, Grothmann & Pat (2005), that adaptation is linked to assets and access to assets. The asset approach has the concept of climate vulnerability and has been suggested to be the most applicable to individual and household adaptation (Birkmann *et al*., 2010). Vulnerability and adaptive capacity are directly

opposite concepts that are affected by similar factors like level of education, government policies and priorities, political landscape, asset portfolios, environmental factors, land tenure systems, and lack of climate information (UNFCCC, 2007).

Food security in low-income countries would be threatened by sporadic rainfall patterns and unstable temperature figures which impact the rain-fed farmers and thus compromise food security in various households (Newton *et al.*, 2010). High temperature-related diseases, death rates mortality and morbidity are projected to rise significantly in the future, if nothing is done to control the emission of greenhouse gases. A temperature rise coupled with erratic rainfall resulted in increased diseases and other pathogens affecting crops and livestock (Newton *et al.*, 2010). Developments in agricultural technology may not improve agricultural production because small-scale farmers rely heavily on seasonal rainfall (Zhai & Zhuang, 2009).

Efforts by various government institutions and small-scale farmers to develop sustainable livelihoods are stifled by climate change and variability (IPCC, 2014). Climate variability may trigger extreme weather events that detrimentally affect small-scale farmers. However, this thesis revealed that even if the climate changes, farmers' vulnerability depends on asset portfolios and other factors.

When small-scale farmers show resilience in their endeavours to adapt, it signifies that they are not passive victims of climate variability. Incorporating the concept of resilience recognizes people as active agents in decision-making rather than passive victims of change. From a global perspective, the following suggestions have been raised by various authors: The first is greater cooperation between high-income countries and middle-income and low-income countries in the field of science, then climate information, and adaption attempts (Wang'ati, 1996; Gupta & Schimoler, 1997). It is therefore important to include all stakeholders in the policy formulation, financing, monitoring, evaluation, and implementation from national to global levels (Ahmed *et al*., 1999).

2.4 Contextualising the literature on climate and change adaptation: a Sub-Saharan context

Sub-Saharan Africa is not spared from the climate extremes characterised by physical and physiological droughts and floods (Muzawazi *et al*., 2017). Several studies noted that there was a decline in annual rainfall figures notably in the SSA (Hulme *et al*., 2001; Nicholson, 2001).

Climate variability impacts are worst evidenced in Africa where drought and floods are devastating the continent's economies leaving several households and individuals vulnerable to food insecurity (Bwalya, 2013; Masipa, 2017). SSA is predicted to suffer more climate variability externalities on a global scale (IPCC, 2012). The effects of climate variability are quite manifested in many countries in the SSA due to increased food insecurity, as noted by Mashizha *et al*., (2017) who stated that there is a 10% decrease in food production. Several proponents supported the view that communal farmers in SSA are exposed to climate variability and change due to limited appropriate technology, poor social safety nets, and abject poverty (Binns, *et al.*, 2012; IPCC, 2014; Perez *et al.*, 2015; Roudier *et al*., 2011). Several research findings agree that Africa's capacity to fight against climate variability depends on various factors like asset availability and institutional support (Grothmann & Patt, 2005; Thornton *et al.*, 2006). Africa's weak adaptive capacity is a result of poor technological development and the fact that its economy is climate-sensitive and agro-based (Mathews 2016; Mathews, Kruger & Wentink, 2018).

There are two approaches to reducing the effects of climate variability; adaptation and mitigation but the fact that mitigation has been tried in various countries with little or no success, many think that adaptation is the only viable option to the challenges of climate variability (IPCC, 2013). Many countries failed to meet the agreed targets for limiting greenhouse gas emissions hence adaptation is unavoidable. In various parts of SSA, rural communities have successfully adjusted to and coped with the effects of climate variability for years (Li *at el*., 2013). The effects of climate variability on small-scale farmers have been discussed for the past decades in the climate discourses of SSA (Antwi-Agyei *et al*., 2014); Conway and Schipper, 2011). However, the erosion of asset portfolios among small-scale farmers results in them being more vulnerable to climate variability. Poverty in SSA is a social evil because it prevents small-scale farmers from realising their full potential in a war against the challenges of climate variability (IPCC, 2013).

Africa is suffering from an 'adaptation deficit' a concept which refers to a lack of sustainable livelihood complemented by the development of projects aligned to adaptation (Osbahr *et. al*., 2007). Africa has been observed to suffer from this adaptation syndrome and this was also shared by some authors (Tschakert & Drietcht, 2010). In Ghana, the Africa Climate Change Resilience Alliance (2011), developed the local adaptive capacity (LAC) after extensive consultation with various stakeholders and policymakers to solve climate-related problems for small-scale farmers. Small-scale farmers in SSA are encouraged to embrace the future challenges emanating from climate disasters because, if not addressed, the problem will persist for decades to come,

(Shepherd *et al.*, 2013). Given the above argument, this thesis proposed an integrated approach that would assist small-scale farmers to increase their adaptive capacity against climate variability. Africa should be prepared for harsh climate conditions in the decades to follow. Crop production is projected to decrease by 50% and crop revenue by 90% by 2025, a decline of approximately 90% in crop revenue by 2100 because of the impacts of climate change and variability in the African continent (Boko *et al.*, 2007).

Millions of hectares of arable areas in Sub-Saharan Africa will be unproductive resulting in many international migrations to various continents, particularly Europe (Arnell, 2009). The price of inputs will increase, making in most small-scale farmers unable to buy them, resulting in many countries suffering from food insecurity (FAO, 2008). Agricultural productivity in SSA is rain-fed, and therefore it is dependent on climate variables, and this has been observed in many countries. The climate extreme events of SSA are projected to worsen leaving many households suffering from food insecurity and other health-related issues (Niang, 2014; Lobell *et al.*, 2011).

Rainfall is projected decline by 10% in Southern Africa by 2050 (Zinyowera *et al.*, 1998:39). Slight climate variability can cause a huge impact on agricultural productivity, both in livestock and crop production (IPCC, 2014; Nelson *et al.*, 2014). Economies in SSA have a degree of built-in climate resilience. Africa is projected to become more exposed to climate disasters because of slow technological advancement and the fact that its economy is based on agriculture (Ndaki, 2014; Mathews, Kruger & Wentink, 2018). Several research studies have noted with concern and proposed the idea of knowledge integration between IKS and SCF to create a holistic approach to climate change adaptation because small-scale farmers still rely on indigenous knowledge, (Mahoo, 2015; Ziervogel & Opere, 2010; Ebhuoma & Simatele, 2017; Kalawole *et al.*, 2016). Climate change and variability are also projected to compromise sustainable food security in Africa. Crop production could decline by as much as 90 percent by 2100, with small-scale farmers most affected (IPCC, 2007).

Viable and sustainable adaptation strategies in Southern Africa and other regions in Africa are usually stifled by a lack of governmental support and unequal distribution of assets (Magadza, 2000). O'Riordan & Jordan (1999) opined that government departments play a significant role in the adaptation process of small-scale farmers in the face of climate variability because they act as enablers of the adaptation policies. Most high and middle-income countries have a better adaptive capacity compared to income countries (Smith & Lenhart, 1996). The lack of institutional support

in agriculture has been regarded as a deterrent to climate variability adaptation. In a similar situation, Kelly and Adger (2000) noted that lack of governmental support and a weak asset base exposed the Vietnam rural communities to challenges of climate variability.

2.5 Contextualising the literature on climate change adaptation: a Zimbabwean context

The effects of climate variability on small-scale farmers have left many households more vulnerable to food shortages (Rurinda *et al*., 2015). The livelihoods of small-scale farmers are severely compromised by the effects of climate change and variability. The rate at which the climate is changing, and the slow pace of small-scale farmers' adaptation will result in a decrease in staple crop production from 75% to 55% by 2080, (GoZ, 2014). Knowledge about regional vulnerability to climate change is not equivalent to the efforts toward climate change adaptation. There is evidence in Zimbabwe's rural communal areas that point to climate change adaptation in rural communities (Gukurume, 2013; Ndebele-Murisa & Mubaya; 2015; Nyahunda & Tirivangasi, 2019). The idea of climate variability and asset adaptation has been proposed and is regarded as a prerequisite adaptation to climate change impacts and is becoming a pillar to achieving food security in Zimbabwe and other countries in SSA (Nyahunda *et al*., 2019). Most small-scale farmers in Zimbabwe depend on natural assets (Dube & Phiri, 2013; Gukurume, 2012; Ndebele Mubaya, 2015). Small-scale farmers are vulnerable to climate-related disasters which are linked to their socio-economic conditions and resonate with their resilience and coping abilities (Ofoegbu *et al*., 2015).

Zimbabwe's rainfall totals are expected to decrease by 5%, 8%, and 10% on average in the 2020s, 2050s and 2070s respectively, and temperature is projected to increase (Murombo *et al*., 2019). Some of the adaptation strategies proposed are targeting crop and animal production, and these include conservation agriculture, water supplementary through irrigation, and drought-resistant animals and crops (Mugambiwa, 2018). Fig. 2.1 shows projected average temperatures for Zimbabwe and that of the globe. The increase in temperature in Zimbabwe and other African countries has negative impacts on agricultural production as shall be shown under empirical evidence in Chapter 4.

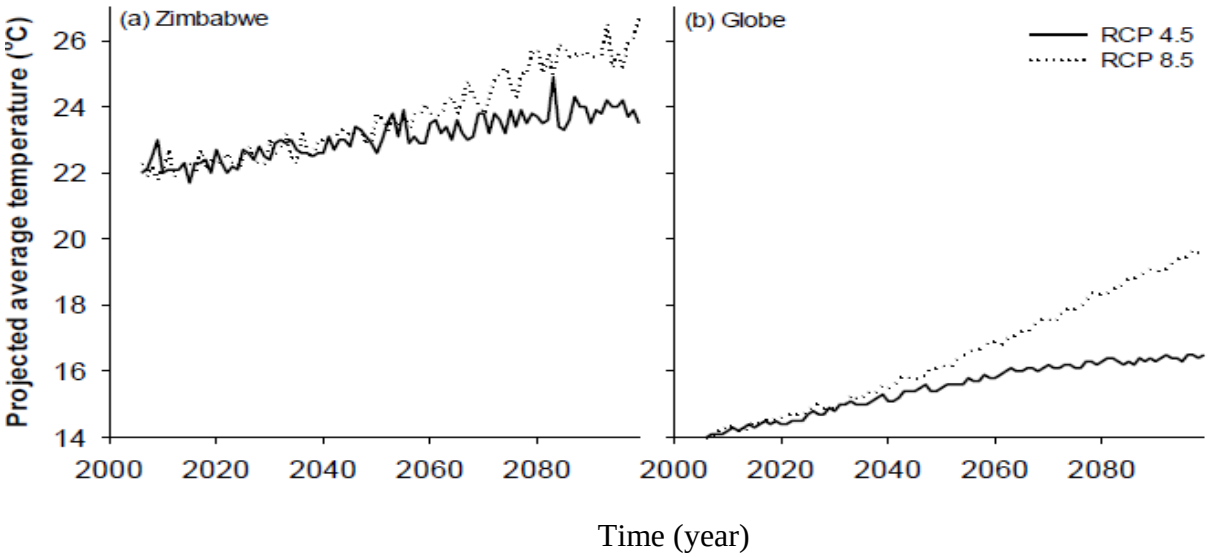


Figure 2.1: Projected temperature increase in (a) Zimbabwe (b) the Globe

***Source*:** GoZ (2014).

The temperatures of Zimbabwe are projected to increase tremendously more than the global average estimates as shown in Figure 2.1. The climate models developed indicate that Zimbabwe will face general rainfall unreliability, accompanied by high variability and 2^0C an increase in temperature (Bohle *et al.*, 1994). The above observation has been supported by other proponents who noted that rainfall in Zimbabwe is characterised by regional variability as reflected by changing the onset of rains, an increase in the frequency and intensity of heavy rainfall events, and fluctuations in temperature and rainfall regimes (Unganai, 2009). The small-scale farmers who rely on rain-fed agriculture are highly vulnerable to climate variability, with the degree of vulnerability depending on the bundle of assets the farmer must adapt successfully.

2.5.1 Shifting of Zimbabwe's natural farming regions

The natural farming regions of Zimbabwe are classified according to edaphic, biodiversity, and climatological variables. The agroecological regions which were mapped in the 1960s have shifted and as a result, the agricultural activities have shifted in response to the prevailing rainfall and temperature figures. The change in the rainfall and temperature figures resulted in a new classification of the regions. Zimbabwe is divided climatologically into 5 natural regions with different agricultural practices for each agroecological zone (AEZ) which have changed due to the devastating impacts of climate variability. Natural regions 1; 11 and 111 are the most suitable for crop production because they usually receive above-average rainfall and average temperatures

for crop production. Natural regions 1V are characterised by dry conditions and high temperatures and are suitable for livestock production and not crop production. The regions are characterised by drought-prone conditions. Regions IV and V become drier than previously experienced, and Gokwe South is in those regions (Paddy, 2020). Due to climate change, the sizes of regions 1V and V have significantly expanded by 5.6% and 22.6% respectively (Paddy, 2020). Gokwe South district lies in the semi-arid region. Climate change has ripple effects in various economic sectors including food security and employment structures. Okonya *et al.*,(2013); IPCC, (2007) also noted that rain-fed agriculture is climate-sensitive.

A comparison of the maps in Figures 2.2 and Figure 2.3 shows a shift in the agro-ecological regions of Zimbabwe. Small-scale farmers in agroecological 1V and V are suffering serious impacts of climate change and variability (Mugandani *et al.*, 2012). Zimbabwe's agroecological zones have either increased or decreased but more towards the drier conditions due to climate change and variability (Paddy, 2022). Much of the Gokwe South district has been affected by this ecological shift resulting in most of the small-scale being exposed to hunger and malnutrition. Figure 2.2 and Figure 2.3 Zimbabwe's agroecological regions, show a shift in the agroecological regions between 1960 and 2020.

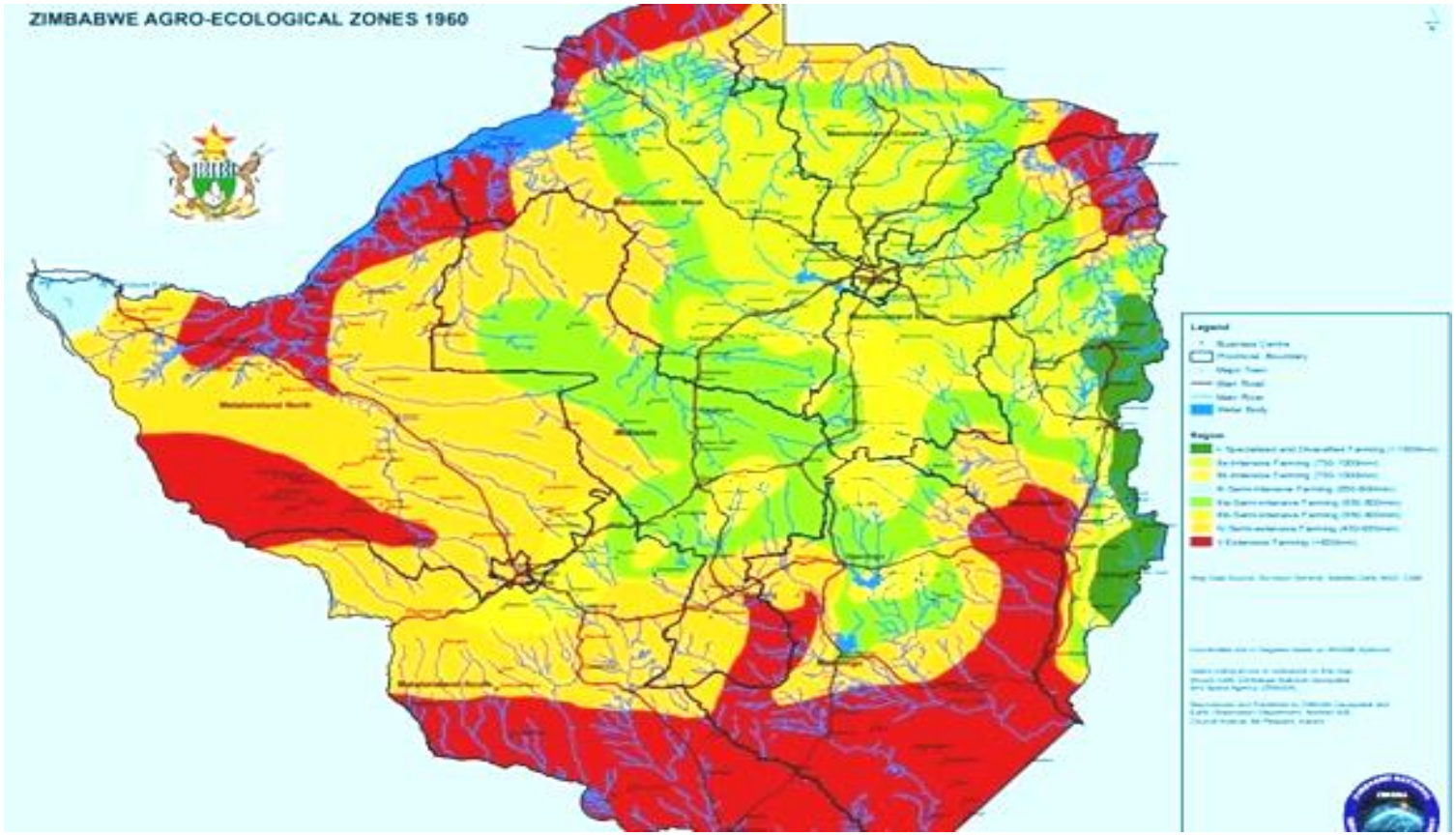


Figure 2.2: Zimbabwe's agro-ecological regions in 1960

Source: Paddy (2020).

Climate variability has impacted the agroecological activities of small-scale farmers but the rate at which small-scale farmers can adapt or increase their resilience is far less than the rate at which climate is changing. The agroecological regions of Zimbabwe have greatly shifted with some regions increasing in dryness and rainfall becoming so erratic to an extent that communal farmers are not able to realise their full agro-potential and most parts of Zimbabwe are facing food insecurity (Paddy, 2020).

It is therefore critical at this point to review the policies and strategies that have been established over the past years to respond to the climate change challenges facing the country. This would facilitate a constructive and efficient national strategy for civil society organizations, the private sector, the government, and communities to develop joint work programs in response to climate variability. The overall goal of the National Agricultural Policy Framework (NAPF) is to create a stable enabling environment and flow of investment that sustainably enhances the capacity of the agricultural sector to anchor national economic growth to upper middle-income status by 2030. A key principle of NAPF is that the policy is participatory and aligned to agro-ecological potential and the devolution agenda.

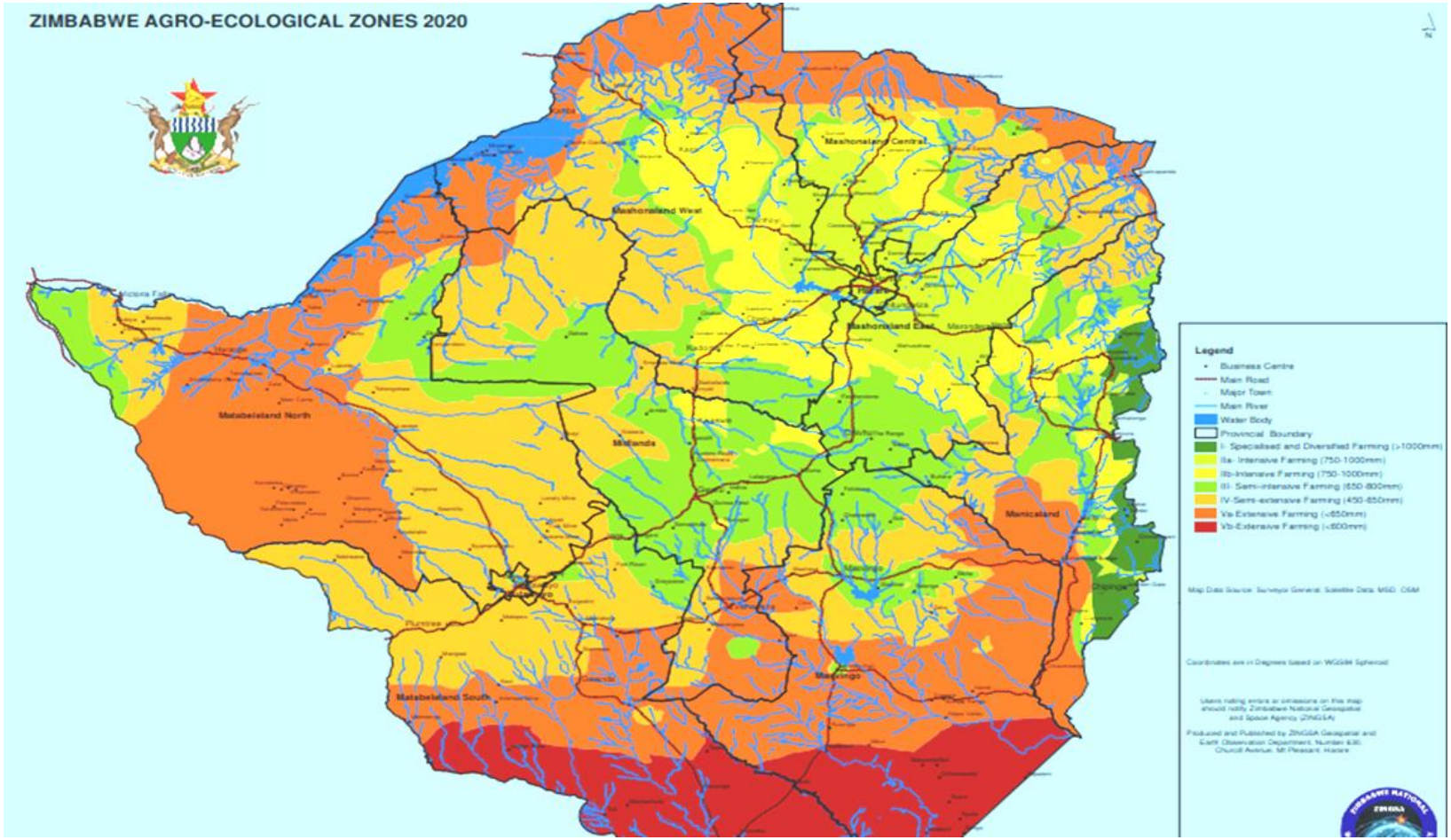


Figure 2.3: Zimbabwe's current agro-ecological regions, current map 2020

Source: Paddy (2020).

More than 60% of Zimbabwe's population depends on communal agriculture which is sensitive to climate variables (Shumba *et al*., 2012). Previous research findings noted that more than 90% of Southern Africa depends on rain-fed agriculture, which is climate-sensitive (Unganai & Murwira, 2010). Therefore, Zimbabwe, like most African countries, is promoting "adaptation" as the major strategy to manage climate change (GoZ, 2014). Considering the above exposition, this study tries to identify sustainable climate variability adaptation strategies in the Gokwe South district. The impacts of climate variability are quite visible in various parts of the country, for instance, drying wetlands, cracked soils and dwindling waters such as springs and aquifers (Unganai & Murwira, 2010; IPCC, 2014; GoZ, 2015).

The 2015-2016 agricultural season had a poor agricultural harvest resulting in 67% of Zimbabwe's population starving because of climate change (ZIMSTAT, 2013) mainly small-scale farmers relying on rural areas. Small-scale farmers continue to suffer climate variability impacts due to unpredicted and unplanned impacts of climate variability (Dodman & Mitlin, 2015). The way small-scale farmers respond to climate change challenges depends on when and how, climate variability information is disseminated to the victims of climate change (Gukurume, 2014). It is against the above background, that policymakers and institutional support should be tailor-madeto the victims of climate change and variability (Chikozho, 2010).

A pattern of an increase in temperature, high dry spell frequency, and rainfall shortages characterises the Zimbabwean climate variables (Brown, *et al.*, 2012; Mugandani, *et al.*, 2013). Farmers are also adjusting to rainfall patterns and rainfall variability by engaging new strategies in farming practices (Kristjanson *et al*., 2012; Stringer *et al*., 2009). Livestock production has not been spared by climate variability. Temperature rises, led to new animal pests and diseases (Tadross *et al*., 2009).

Due to the alarming rate of climate variability, Zimbabwe is expected to have a drier climate by 2075 (GoZ). Cereal production has already been affected in some parts of Zimbabwe due to climate variability (Zinyengere *et al.*, 2013). In low-lying areas like the Gokwe South district, maize production will not be viable. Since the growing season is expected to be reduced, it is paramount for small-scale farmers to adjust accordingly and grow short-term varieties and drought-resistant animals. The availability and quality of assets at the farmer's disposal affect the degree of vulnerability (IPCC, 2013). Therefore, vulnerability is not homogenously distributed, but it varies according to communities and regions. Some of the suggested viable and bottom-up

adaptation measures include the use of irrigation, multiple cropping, drought-tolerant cultivars, mixed farming, and dry planting *(pfubvunza*), (Gwimbi, 2009).

2.5.2 Models of vulnerability

The matrix of vulnerability is determined by the interaction of three major variables such as adaptive capacity, sensitivity, and exposure which all affect and are affected by the pentagon of assets (Care, 2010). A successful adaptation to climate variability considers the social, economic, and political landscape of the communal area (Vincent *et al.*, 2013). The ability to adjust and adapt to climate variability varies spatially and temporally because vulnerability is context-specific (IPCC, 2001; Smith & Wandel, 2006). Community, household, or individual vulnerability is affected by tangible and intangible assets that are at the farmer's disposal (Devereux, 2010). In the vulnerability matrix, exposure consists of climate variables such as temperature and rainfall (Devereux, 2010). This study supported the view by Engle (2011), (see Figure 2.4) reveals that the larger the adaptive capacity the less the vulnerability. The elasticity of adaptive capacity affects the vulnerability of communal farmers. Figure 2.4 shows how a farming community's vulnerability is affected by its adaptive capacity.

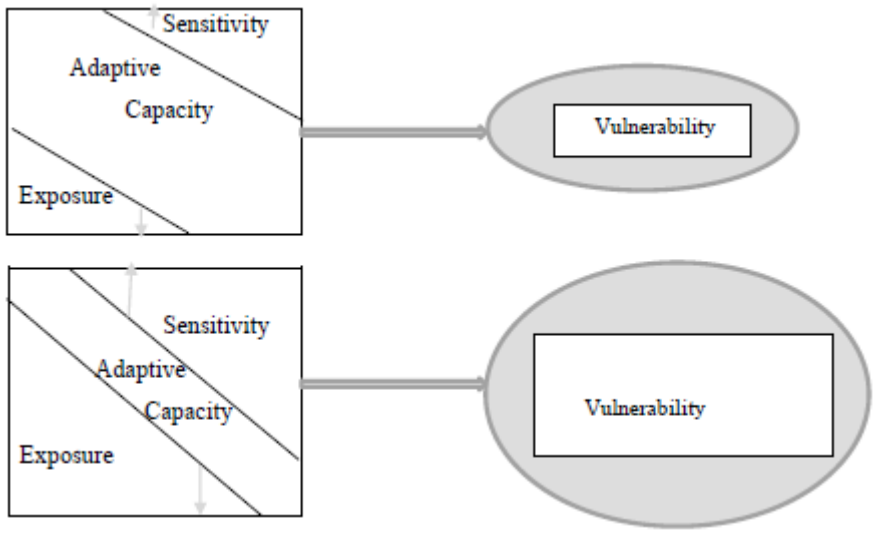


Figure 2.4: How a farming community's vulnerability is affected by the adaptive capacity

***Source*:** Engle (2011).

Figure 2.4 illustrates how a farming community's vulnerability is affected by the adaptive capacity, exposure, and sensitivity of any household. Vulnerability is directly affected by adaptive

capacity and sensitivity. While other research findings noted that assets are crucial to climate variability adaptation, Engle (2011) acknowledges that the institutional management and governance styles also contribute to the degree and nature of vulnerability of small-scale farmers to climate change. The political and social landscape of any country can affect the level of adaptation of the indigenous communities. Adaptive capacity consists of adjustments in attitudes, assets, and appropriate technologies (Adger *et al.*, 2007). As such, it varies within communities and households, based on gender, age, social position and economic status.

The relationship among the vulnerability variables can be expressed in the following equations: where vulnerability (V) is expressed as a function of exposure (E), sensitivity (S), and adaptive capacity (AC), (Pearson *et al.*, 2008):

$$V = f(E, S, AC) \qquad \text{Equation 1}$$

Pearson et al., (2008) also mathematically defined vulnerability as:

$$V = f(AC-(E+S) \qquad \text{Equation 2}$$

The interaction between adaptive capacity and vulnerability for small-scale farmers shows that there is an inverse relation. The framework employed in this study expands the general form of the previous approach by guiding vulnerability assessments in a greater diversity of settings. From the above equations, this study acknowledges that variables used to calculate vulnerability underscore the role of asset portfolios and other factors affecting small-scale farmers' vulnerability.

Isoard *et al.*, (2008) developed a model of climate change and variability with emphasis on options that humans can do to reduce the impacts of climate change and variability, and these are mitigation and adaptation. Figure 2.5 shows a conceptual model for climate change impacts, vulnerability, and adaptation.

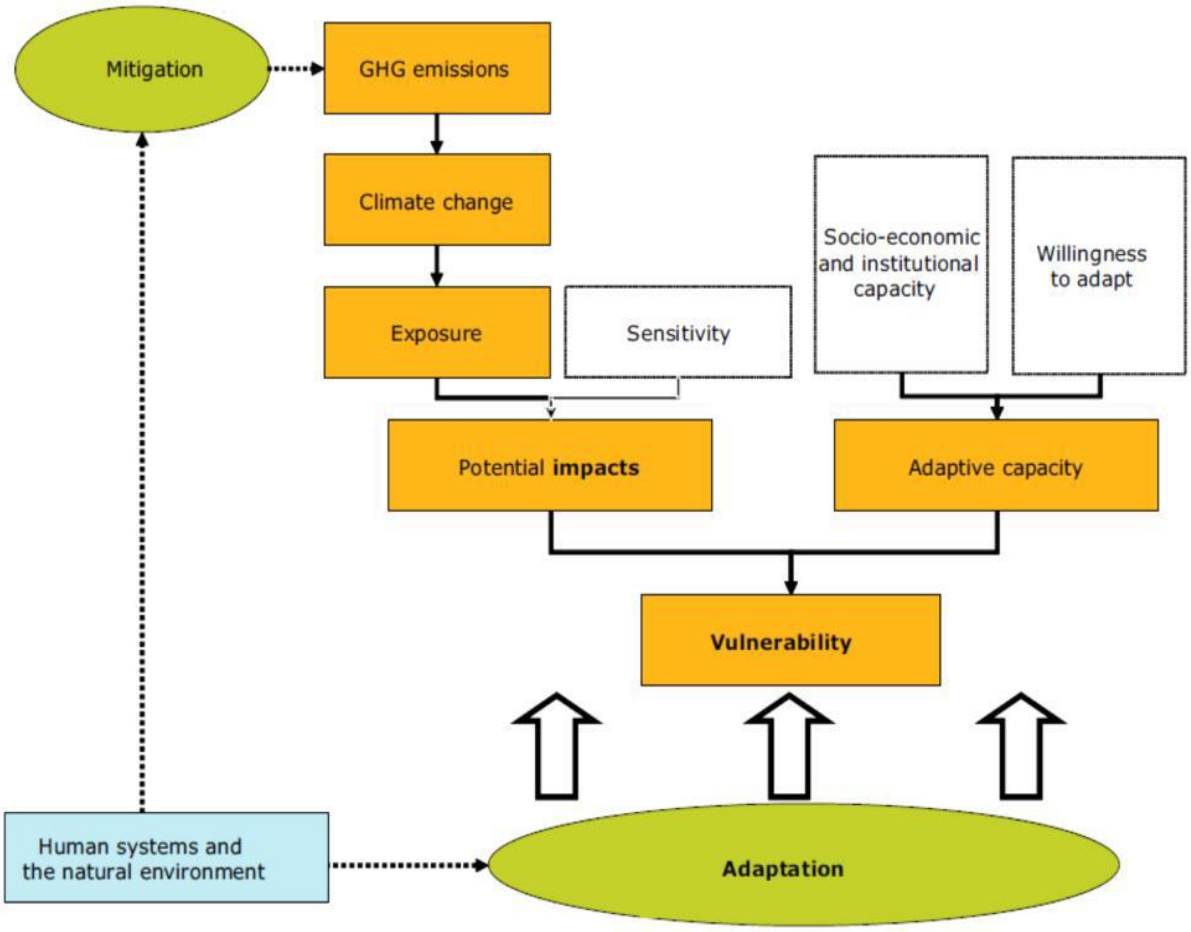


Figure 2.5: Conceptual model for climate change vulnerability versus mitigation and adaptation

***Source*:** Isoard *et al*., (2008).

The model (see Figure 2.5) illustrates that human beings have options at their disposal against climate-related disasters. Mitigation and adaptation are the two options and for small-scale farmers, adaptation is the more applicable. The socio-economic and institutional ability and the willingness to adapt to climate variability affect communal farmers to adapt to climate variability. Proactive or planned adaptation responses are usually put in place in anticipation of climate-related disasters. The Zimbabwean government had many policies including agricultural, economic, and climate to help small-scale farmers in increasing their resilience and adaptive capacity as shown in Chapter 6. Figure 2.6 shows a model of human reactions toward climate change.

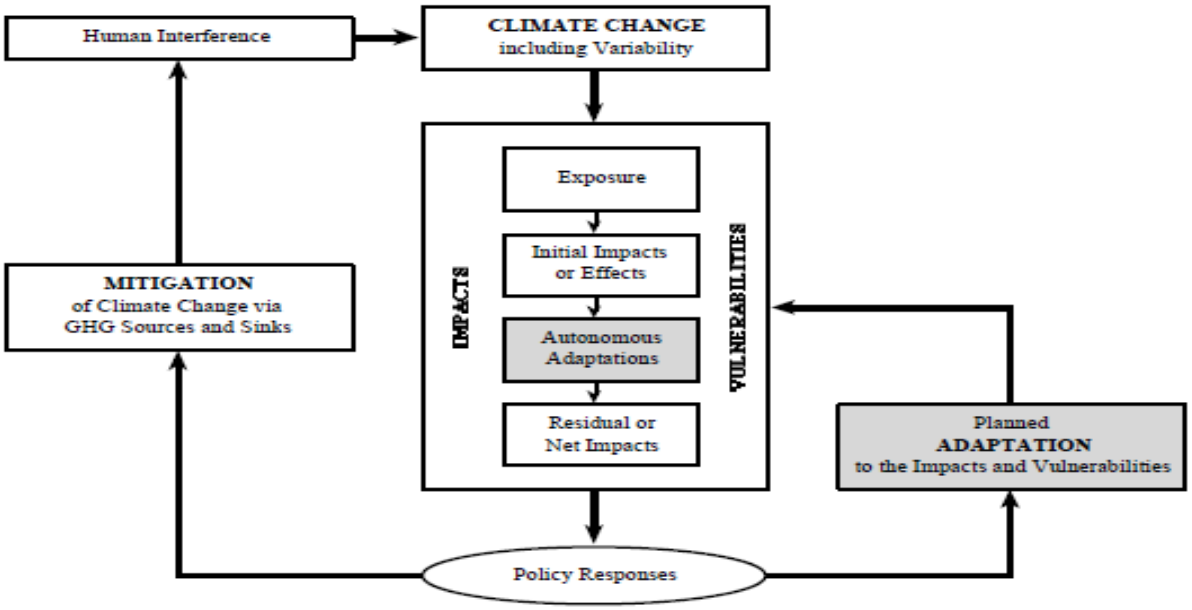


Figure 2.6: Human response to climate change impacts and vulnerabilities

Source: Smit *et al*., (1999).

The policy responses mentioned in Figure 2.6 are taken to mean the government policies including, the National Climate Change Policy discussed in Section 6.2.1. Vulnerability frameworks are classified into three as shown in Figure 2.7. Exposure describes the extent to which individuals and households are open to natural disasters. Exposure focuses on the size of the disaster, how often they occur, and the time taken when the hazard is occurring. Some of the climate change hazards are creeping hazards in the fact that they occur slowly, for instance, drought, while others are rapid onset hazards like floods and heatwaves which occur without any warning. The second variable affecting vulnerability is sensitivity, which focuses on humans and the physical environment. The human and physical environment contributes to how the system can respond to climate-related hazards. Resilience considers what future action can be taken to reduce the impact of climate change and variability. Examples are actions like coping and adaptation strategies like government policies and autonomous adaptation done by small-scale farmers. It also considers coping and adaptation measures implemented to reduce farmers' vulnerability to hazards. Turner's Vulnerability Framework Figure 2.7 has been criticised because it does not provide full detail but just an outline of the variables and flows of the system.

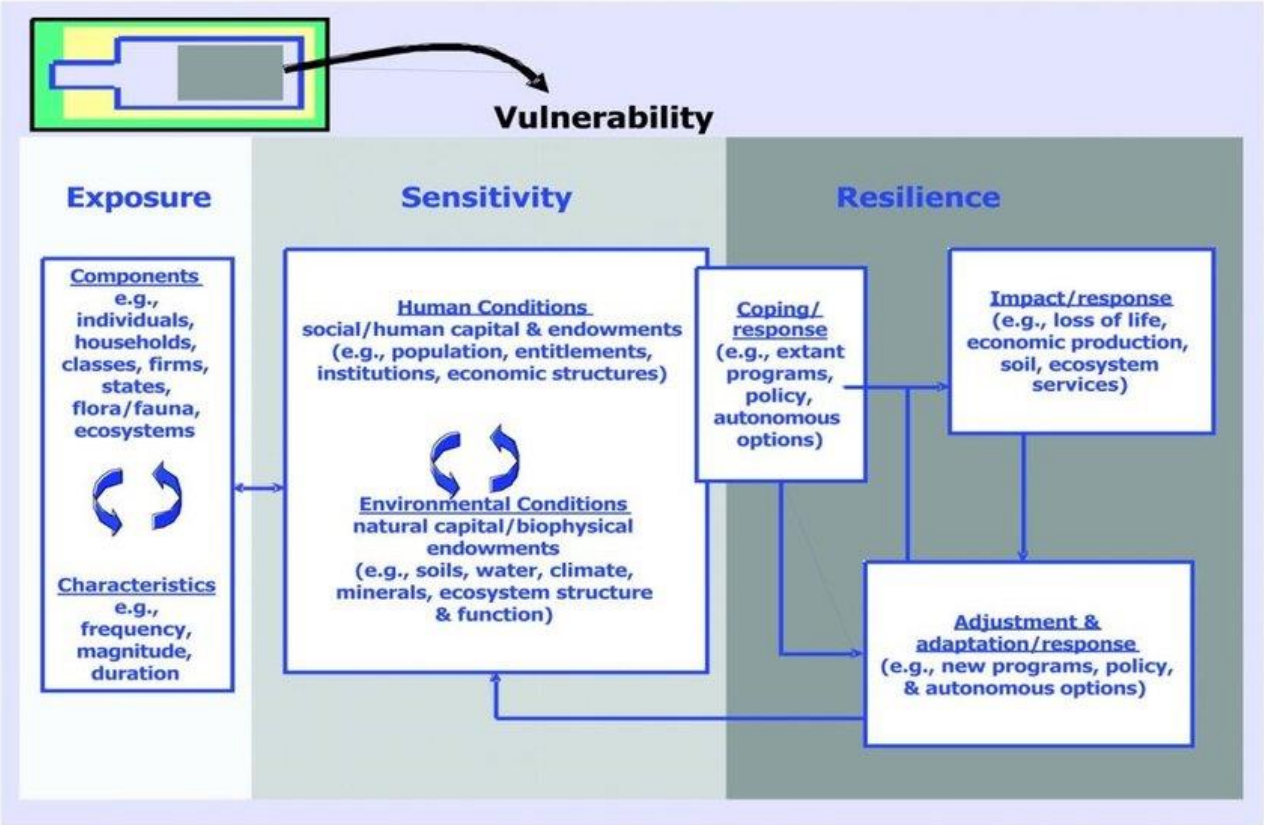


Figure 2.7: Turner's vulnerability framework.

***Source*:** Turner *et al.*, (2003).

Turner's vulnerability model (Figure 2.7) is a framework of vulnerability based on human dimensions of a region based on social characteristics such as vulnerable children and the elderly, household density, sex, marital status, age, and educational status. In rural social stratification, the lowest social strata, with weak social connections or assets are vulnerable to climate change and variability (Moser, 2007). Households and individuals who receive money and other donations from friends and relatives abroad can reduce their vulnerability because they can increase their adaptive capacity more than those without such links (Hahn *et al.*, 2009). This is a topic in which Western scientists can combine with small-scale farmers to provide integration of science and social capital and come up with a hybrid of knowledge that can assist adaptation in the Gokwe South district.

Environmental vulnerability (Table 4.2) shows that the level of dependence on natural assets varies spatially. Several studies testify that there are various factors affecting environmental vulnerability including climate, edaphic, flora, and geomorphological factors (Deressa, Hassan, & Ringler, 2008; Fussel, 2009). Edaphic conditions of the area contribute a lot towards the

vulnerability of small-scale farmers, these include conditions like the fertility of the soil a crop production. Most small-scale farmers in resettled former commercial farms can only fully realise their full agricultural potential when they have adequate assets and proper environmental management and land tenure systems (JMIT, 2008). Anticipatory adaptive strategies are always mandatory for success because farmers can prepare for the unforeseeable effects of climate change (Moser, 2011). Most small-scale crops are sensitive to climate variability, and ecosystems will shift over space in response to climate variability.

Adaptation can be done in two ways. Firstly, where early warning systems can be engaged and anticipatory adaptation planning effectively done by supporting actions that reduce existing vulnerability. Second is mainstreaming climate variability into the current agricultural activities can also bring better results to communal farmers. Such an approach is applicable in cases where there are asset failures to enable adaptive capacity.

The use of IKs as the basis for predicting climate change has been criticised by several scholars (IPCC, 2014; Kalanda-Joshua *et al*., 2011; Shepherd *et al*., 2013). This study proposes the integration approach to improve small-scale adaptation strategies. There is a realisation that planned adaptation is the only viable strategy for small-scale farmers to continue producing food for their families (Fankhauser *et al*., 1999). However, the idea of asset adaptation and technological integration was viewed by many researchers as an alternative to problems resulting from climate change (Hansen *et al.*, 2011; Phillips *et al.*, 2001).

Autonomous and planned adaptation is taken to mean private, individual, or household adaptation and public adaptation. Autonomous adaptation can be demonstrated when a farmer changes crop or type of animal reared to suit the prevailing climate conditions. The government can implement planned adaptation strategies by producing and distributing agricultural inputs.

Measures of successful adaptation in climate variability regions depend on reaction and anticipatory planning. Anticipatory adaptation planning is proactive, and the farmer has time to prepare for climate variability problems. Anticipatory also called proactive adaptation takes place before the impacts of climate change whereas reactive adaptation is done after the effects of the climate change are observed. Anticipatory adaptation for any region depends on a deep knowledge of climate variability for it to be successful. One notable distinction between autonomous adaptation and planned adaptation is that planned adaptations can be either reactive

or anticipatory. While adaptation is being implemented, the main challenges are insufficient financial assets and institutional research (Ayers & Huq, 2009). Adaptation can be presented as a problem that is resolved by the people affected governed by their environment, political landscape, institutional power, people's beliefs, and perception of the world (O'brien & Selboe 2015).

The asset vulnerability approach is a conceptual framework that explains the nature of communal peoples' livelihoods. The pentagon of assets affects the livelihoods of small-scale farmers. While asset vulnerability addresses policy issues to do with poor small-scale farmers, vulnerability varies geographically and in different time scales (Ashley & Carney, 1999; Westerhoff & Smit, 2009). The asset-based approach (ABA) was used to analyse the vulnerability of each household. While the asset vulnerability approach is flexible and used for some years, and it yielded positive results, climate variability problems continued to impact the farmers.

The Department for International Development (DFID) is one of the approaches used in livelihood assessment in the context of climate adaptation (Carney *et al.*, 1999). The DFID developed the Sustainable Livelihood Framework (SLF) to eradicate poverty in low-income countries using the asset portfolios at their disposal as indicated in Figure 2.8. In this study, the SLA is used to assess how small-scale farmers' agricultural systems and livelihoods are affected by various resources also known as capitals. Capital assets are important in the application of the SLF to small-scale farmers because they can be converted into other assets easily (Fakin & Bojorquez-Tapia, 2008). The livelihood strategies depend on asset status, institutional capacity, and policies. Figure 2.8 shows the Sustainable Livelihood Framework.

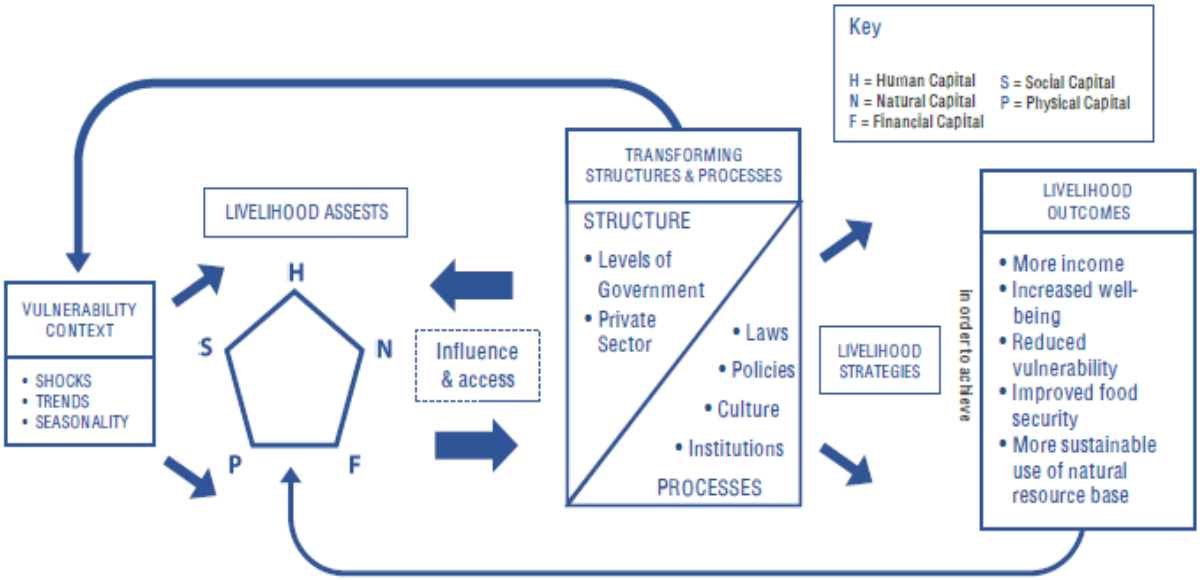


Figure 2.8: Sustainable livelihoods framework (SLF).

Source: DFID (1999).

The DFID Sustainable Livelihoods Framework (SLF), (see Figure 2.8), conceptualises how people can operate in each environment due to climate change and variability and how the small-scale farmers draw and modify their assets to improve their adaptive capacity and livelihoods against challenges of climate change. The SLF has many strengths and weaknesses.

Some of the strengths of the SLF are that it is participatory and people-centred in its approach. In this case, the approach is applicable because it is farmer-centred thereby shaping their development aims and objectives (Du Toit, 2005; van Dijk, 2011). The SLF was also used as a checklist of developments in their area based on what the small-scale farmers have and their potential to achieve sustainable climate change adaptation outcomes. The SLF is dynamic and can be used at various scales from local to national level. Another notable advantage of the SLF is that it is holistic in nature because it includes all stakeholders from the climate variability victims themselves. The SLF is capable of building on the strength that the small-scale farmers have already and increasing their adaptive capacity and improving their adaptation strategies. According to Kollmair *et al*., (2002), the SLF is sustainable in nature because it is resilient to future atmospheric stresses and shocks, in addition, it may not need external support from other institutions.

Besides the credibility given to SLA, some scholars noted that the SLA has been discredited for its failure to recognise the distributional issues (Swift *et al.*, 2001). The SLA's thrust is to unpack the opportunities available to small-scale farmers so that they can achieve climate change adaptation and improve their resilience, however, it fails to promote issues of equity (Yaro, 2004), which are paramount to climate variability adaptation strategies.

The SLA has been criticised for not recognising the role played by intangible assets or resources which are very important for small-scale farmers to be able to adapt to climate change and variability. The political assets and civic assets were not included in the SLA (Scoones, 2009; Toner; 2003; Baumann, 2000). In view of the observation, the SLF underscores the significance of politics in the quest for climate variability adaptation (Baumann & Sinha, 2009). Given the above observation, this study proposes the inclusion of political and civic assets to improve the adaptive capacity of Gokwe small-scale farmers. Another criticism levelled against the SLA is its rigidity to the livelihoods which are so dynamic in nature (Scoones, 2009). While the SLA claims to link micro to macro scales, it is believed to be an ambition to be achieved but currently, it has not yet been achieved (Scoones, 2009). One criticism levelled against SLF is its failure to solve global problems and that most rain-fed agriculturalists are still suffering the impacts of climate variability (Scoones, 2009).

With the identified shortcomings, this study adopted knowledge integration as an alternative to the problems faced by small-scale farmers in the Gokwe South district. Mapping of vulnerability at the constituency level and the household was also done to improve the SLF. The Asset Weighting System was also used to assess the contribution of each asset to the adaptive capacity of each constituency. In addition, the PCCAA utilises the bottom-up approach in which the small-scale farmers are actively involved in climate change adaptation (Moser, 2011). Table 2.3 shows the types of assets and questions asked during the survey.

Table 2.2: Summary of categories of assets, types of assets, relevant sources, and questions asked

Assets	Indicators	Relevant sources	Questions asked during data collection	Challenges and solutions during data collection
Financial	Credit facilities Remittances received Ownership of livestock	Ford and Berrang-Ford (2011), IPPR North (2011); Moss et al., (2010), and May et al., (2009).	Do you have access to credit facilities? Are you receiving any remittances from elsewhere? Do you own any livestock? If any, name the categories.	The participants understood the issue of credit facilities and they responded positively to the questions. This was a simple question with no challenges.
Physical	Irrigation facilities Possession of radio and Television	IPPR North (2011), May et al., (2009); Moser and Dani (2008), Cutter and Finch (2008), Dahlgren and Whitehead (2007).	Are you using any irrigation facility? Do you have any radio, TV, or mobile phone?	This was a simple question that the participants found it simple to answer. Some said they had the gadgets but the challenge of electricity or batteries or malfunctioning of the gadgets was highlighted.

Natural	Farm holding size Land tenure	IPCC, (2012), IPPR North (2011), Riva *et al*., (2010); May *et al*., (2012), Moser and Dani (2008).	What is the size of your farm? How do you own the land? Do you rent any farm?	Challenges associated with land tenure were solved as the interviewers explained the nature of landholding available including the A1 and A2 farm allocation with the 100-year lease agreement in Zimbabwe. Some small-scale farmers indicated that they are not willing to fully implement the climate adaptation strategies because of the lease agreement. In Zimbabwe, some small-scale farmers violently occupied the farms and therefore were not sure of the future of their agrarian systems.
Human	Educational status Health condition	IPCC (2012), IPPR North (2011), May *et al*., (2009), Moser and Dani (2008), Wisner. (2006), DFID, (1999), Rakodi, (1999),	What is your educational level? Is there anyone who fell sick in your family this year?	This was a simple question and most of the participants were able to answer, This was a straightforward question.

Social	No. of social groups you belong to	IPRR North, (2011), Moser and Dani (2008) OECD (2006) Barton, and Grant (2006)	Are you registered with any social groups? Name the social organisation you are registered with.	A social group was clarified to the participants. Most of the participants were able to answer the questions.
	Access to extension advice		Are you getting agricultural extension information? If so, how many times a year?	This was a simple question and most of the participants were able to answer without problems.
	Access to climate information		Are you receiving any climate information? If so by what means?	Participants needed clarification on what climate information constitutes.

Source: (Kollimair & Gamber, 2002).

Assets can be combined and transferred to other livelihoods to enhance a better life for small-scale farmers (Kollimair & Gamber, 2002). The PCCAA utilises participatory research (PR) principles and practices which incorporate an asset-based vulnerability framework (Moser and Satterwaite, 2008). The asset adaptation framework has two sides, asset-based vulnerability and asset adaptation (Moser, 2011). The asset-based vulnerability focuses on the asset availability to improve the adaptative capacity of small-scale farmers against the problems resulting from climate change and variability (Moser & Satterwaite, 2008; Prowse, 2008). The asset-based vulnerability consists of two aspects, one is called the asset analytical framework which describes the relationship between assets portfolios available and vulnerability. If the asset portfolios are outweigh vulnerability, it means the small-scale farmers have achieved sustainable climate variability adaptation. Second is the asset adaptation operational framework which aims to improve the measures of resilience and reduce vulnerability. The second framework is the asset adaptation operational framework focuses on strict measures employed by small-scale farmers to

improve their resilience and reduce vulnerability (Moser & Stein, 2010). Several research findings support the idea that asset portfolios play a crucial role in reducing climate variability challenges (Moser & Satterwaite 2008; Moser & Stein, 2011; Simatele & Simatele, 2015).

2.5.3 Epistemological assumptions for studying IK and climate change

Epistemology refers to the study of natural knowledge and its justification (Schwandt, 2007). This study adopted the participatory methodological approach involving the small-scale farmers affected by climate variability. In the realm of epistemology, this research values the input from the grassroots participants, capturing the validity of the IKs, thus adopting a bottom-up approach. The epistemological position assumed by the researcher allowed the interaction between the researchers and the participants to be communal farmers who are vulnerable to climate change. Table 2.4 shows the characteristics of knowledge domains.

Table 2.3: Characteristics of knowledge domains

Knowledge Domain	Characteristics
Technology specific: Modern/ Western science	Explicit, considered globally applicable, rational, analytical objective, and codifiable, can be transferred through WIFI; its information is communication technology-based.
Application Specific: Knowledge implicated in the application domain	Based on experienced and lived knowledge by communal residents before the advent of scientific knowledge
Rural based	Obtained from the indigenous communities through collection of their experiences and raw experiments. It is based on the local environment and culture.
Practical based: the case of resource managers' knowledge	Based on organised regulations, guidelines, and financial values based on public organisations and/or international statutes.

Source: Puri (2007).

The concept of indigenous knowledge has been selected on the premise that rural communities are endowed with IKS which are unique and yet relevant to members of the society (Table 2.4).

Indigenous knowledge may also be defined as knowledge acquired and accumulated by the indigenous people through their life experiences in their environment (Gadgil *et al.*, 1993). This study recognizes the definition of the importance of local education from the people's experiences and through the interpretation of the environment to improve their adaptive capacity and resilience (Briggs & Service, 2005). Climate scientists are beginning to recognise indigenous observations of climate change and variability (Kalanda-Joshua *et al*., 2011). Indigenous knowledge will influence decision-making and affect the policy frameworks from the local to the country and finally, global, local IKs will enhance decision-making at local levels as well as influence (Adger *et al*., 2009). Some small-scale farmers are doubting the reliability of indigenous knowledge to give accurate results on climate variability. Majority are now relying on modern technology bearing the fact that climate continues to change. Contemporary studies are considering the merging of indigenous knowledge and scientific science knowledge to give small-scale farmers adaptation strategies and resilience. The possibility to improve small-scale farmers' resilience on IK was shared by several scholars and increasing resilience and adaptive capacity in climate discourses is shared by other scholars and is expected to bring positive results (Robinson & Hebert, 2001). The integration of knowledge is believed to be an element of PRA which is sustainable and not expensive. Indigenous knowledge has been used by rural communities, but it is facing some challenges of reliability due to changes in climate variables.

The Declaration on the Rights of Indigenous People Nations United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) stated that:

> "Small-scale farmers have their right to be the custodians of cultural heritage, expressions, traditional knowledge, cultural expressions, as well as the manifestations of their sciences, technologies, including human and genetic resources, seeds, medicines, knowledge of the properties of fauna and flora" (UNDRIP, 2008).

Communication in vernacular language was better understood than in foreign languages (Padgham *et al*., 2013). The indigenous people have been relying on local knowledge and experiences through observation of animal behaviour, trees, wind, plants birds, and insects to predict the forthcoming season (Mhita, 2006). Brown (2003) also supports the value of the fusion between modern or Western knowledge with traditional knowledge to bring innovations in the food production system. Chang'a *et al*., (2010) underscore the value of IK in the prediction of weather phenomena through insects, birds, wind, and butterflies. Muguni (2016) also supported

the view that integrating scientific knowledge and indigenous knowledge should be implemented in farming technology.

Several research findings have the opinion that lack of climate information is a major barrier to successful climate change adaptation in low-income countries (Deressa *et al.*,2008; Mukheibur & Ziervogel, 2007). Ziervogel & Calder (2003), and Archer *et al*., (2007), noted that in Southern Africa, the weather forecast is not suitable for small-scale farmers but the commercial farmers who can interpret the synoptic weather signs and understand the language in which the information is conveyed and conducted.

2.5.4 Role of indigenous knowledge in climate change adaptation

Accessibility and application of knowledge are the fundamental entry point to achieving sustainable adaptation in low-income countries. Traditional knowledge is not expensive and readily available in rural communities; it is extensively used to safeguard against climate-related disasters. The two types of indigenous knowledge discussed in public debates are tacit indigenous knowledge and explicit indigenous knowledge (Tavana, 2002). Explicit knowledge is characterised by rules, policies, facts, and relationships that can be codified (Wyatt, 2001). This view has been supported by Smith (2001) who described explicit knowledge as academic knowledge expressed in modern signs and language with symbols and signs and can be electronically transmitted or transferred. The most worrying thing is that explicit knowledge is fast disappearing and communication from one generation to another is losing value and quality because of poor channels of communication (Mehta, Alter, Semali & Maretzki, 2013; Tikai & Kama, 2010). Indigenous knowledge is usually in form of a tacit category hence difficult to pass on to the next generation. The nature of tacit knowledge is that it is difficult to extract from the heads of individuals. Tacit knowledge is not recorded in any document or storage device (Smith, 2001). Tacit indigenous knowledge is based on human experience and perceptions. Regardless of the difference between the types of indigenous knowledge, integration of the modern and indigenous knowledge produces a hybrid type of knowledge that can contribute to reducing impacts of climate variability. Both tacit and explicit knowledge proved useful in the quest for knowledge integration about climate change and variability in the Gokwe South district.

Due to the difference in technological advancement not every country can solve the problems of climate change and variability The incorporation of indigenous knowledge in climate change

debates comes from rural communal farmers (Boko *et al.,* 2007; Nyong *et al.,* 2007), but they cause limited climate variability in their quest for survival (IUCN, 2008). Many developing countries are suffering the most, yet they contributed the least to the current global crisis (Huq *et al*., 2003).

Indigenous knowledge took a centre stage in international debates as an option for the management of disasters caused by a change in climate variables since the 1990s (Hiwasaki *et al*., 2014). The Indigenous communities relied on IK before the introduction of the western knowledge to fight extreme climate events (Gaillard & Mercer, 2012). Several rural communities are now relying on modern science at the expense of indigenous knowledge.

While Appiah-Opoku (2005), stated that many governments and non-governmental organisations have brought various sophisticated technologies to assist in the adaptation process, the technologies proved unsustainable and were abandoned because projects failed to exploit natural assets at their disposal and the projects depended on ideas, technology, and goals from outside the country. The projects were based on Western concepts which were different from their social, economic, and political environment.

The major challenge was a failure to recognize the validity of the local resources and knowledge systems in the communities. The use of IK to improve the sustainability of projects was proposed in climate discourse some years ago (Warren, 1995; Silitoe *et al*., 2002; Gegeo, 2000). Regardless of the usefulness of indigenous knowledge, very little has been written regarding the utilisation of the IKs domain to address problems of climate change (Turner & Clifton, 2009). Some village elders die before they pass on their knowledge to the younger generation (Jiri, 2015).

2.5.5 The asset portfolios as the determinants of the adaptive capacity

The adaptive capacity and resilience of an individual or household depend on the asset portfolio at their disposal (Moser & Satterthwaite, 2008). The approaches commonly applied by small-scale farmers are the top-down approach which involves interventions by external stakeholders at the regional to country level. Another approach is the bottom-up approach where rural farmers use their strategies to fight against the challenges of climate variability (Simatele, 2009). However,

asset portfolios are not static but dynamic in nature, they change over time, for example, the death of a bread winner in a family (Moser & Satterthwaite, 2008).

The framework used in this study to analyse the effect of assets in Gokwe South shows a paradigm shift from asset vulnerability to asset adaptation. Farmers use anything at their disposal to improve adaptive capacity and resilience against variability Simatele (2010) argued that small-scale farmers are spinning their available assets to achieve food security in their various locations. The asset adaptation approach to climate change challenges is preferred because several small-scale farmers are in a cycle of poverty characterised by a lack of assets, a poor asset mix and natural disasters (Moser & Stein, 2011). Assets are simply resources or entitlements used by small-scale to obtain a sustainable livelihood; therefore, they give communal farmers the ability to improve their resilience to climate variabilities (Bebbington, 1999).

Asset adaptation assumes that small-scale farmers utilise their resources to improve their adaptive capacity against challenges of climate-related disasters (Asian Coalition of Housing Rights, 2005; Moser; 2011). The application of the asset vulnerability framework as a methodological tool in this study enabled the assessment of factors that affect the influence of assets on communal farmers to produce their best in agriculture (Moser & Satterwaite, 2008; Moser & Stein, 2011; Simatele & Simatele, 2015). This idea has been shared by Ebhuoma & Simatele (2017) and Schmidhuber & Tubielo (2007). who premised that the government should prioritise channelling resources and capacitate poor small-scale farmers against the challenges of climate variability. The agricultural land uses and the type of land tenure and the rights attached to it affect the agricultural practices and output as observed in Zimbabwe during the land reform of 2000 (Butt *et al*., 2006). Different types of assets asset the small-scale farmers 'vulnerability at individual regional and country levels (Ellis, 2000).

Social assets are relationships developed among relatives and friends or club members in a community which creates mutual benefits among members (Ellis, 2000; Krishna, 2003). Characteristics of societal assets include networking, affiliations to clubs, exchange or sharing of assets, and connectedness to improve their adaptive capacity. Small-scale farmers can get remittance from members who are abroad. Social affiliations usually provide labour support to small-scale farmers, particularly the during the time of weeding and harvesting of crops. Therefore, if a farmer is socially alienated, he may not get the support to adjust and adapt to climate variability.

Financial assets refer to money from any money lender, bank, donations, or other investments such as money from rent. Financial assets can be changed into any other assets. Access to credit facilities influences adaptive capacity because it affects the quality and quantity that the farmers will use during the planting season (Butt *et al.*, 2006; Fosu-Mensah, *et al.*, 2012). The financial asset is highly flexible because it can be used to buy other assets used in the adaptability of small-scale farmers. Financial assets can even include micro-insurance and other sources of finance that any farmer gets to increase the adaptive capacity (IPCC, 2001).

Physical assets may include things like vehicles, connectivity in the network, land, houses, communication devices and water. The machinery used in the production process and the methods that enable society to pursue livelihoods are equally important. The more these physical assets the farmer has, the more the adaptive capacity. Use of mobile phones improved communication, particularly in market research and receiving climate-related formation which enables them in planning their farming activities. Figure 2.9 shows a summary of asset portfolio small-scale adaptation and livelihoods.

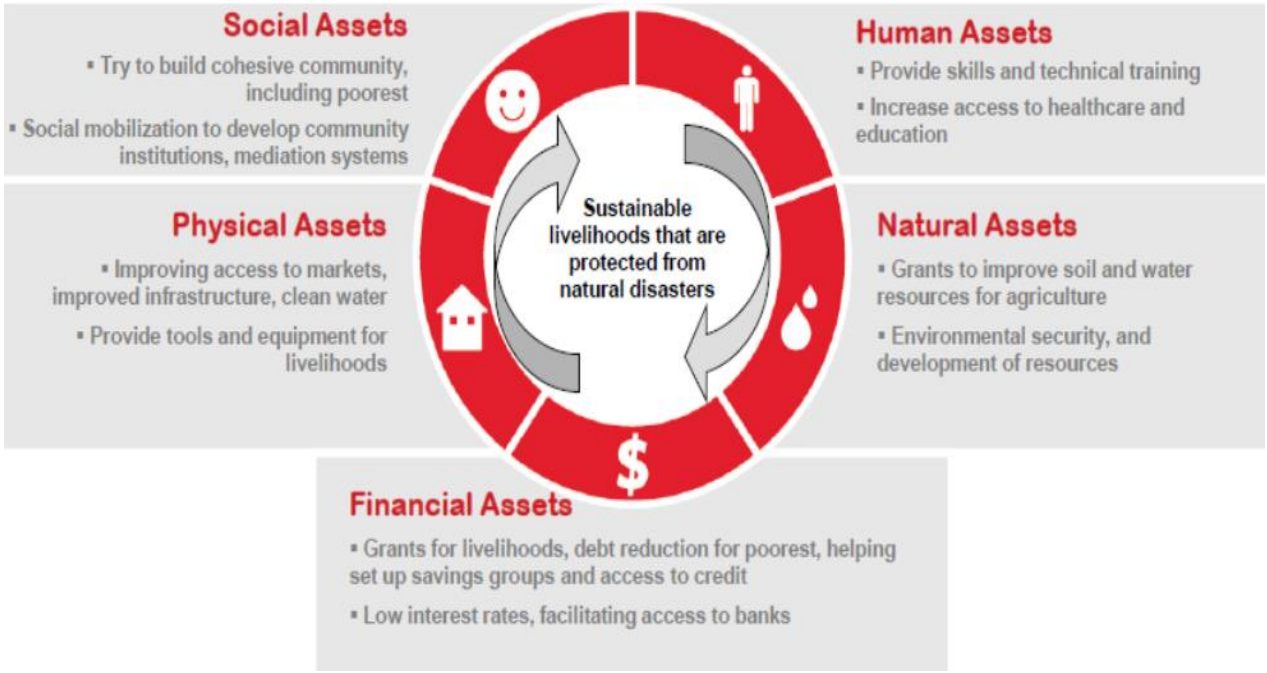


Figure 2.9: A summary of asset portfolio small-scale adaptation and livelihoods

***Source*:** McCormick (2015).

The portfolio of assets highlighted above has omitted certain dimensions of assets such as intangible and political assets as suggested by (Moser, Sparr, & Pickett, 2007). Previous research

findings on poverty noted that poverty was assessed based on tangible assets at the farmers' disposal (Moser, 2008). Accessibility to both tangible and intangible assets by poor small-scale farmers determines the degree of vulnerability to either internal or external stress. Pro-poor policies implemented by the government are crafted to capacitate poor small-scale farmers by strengthening their asset portfolios (Ebhuoma & Simatele, 2017; Schmidhuber Tubiello, 2007). The type of assets and quality of assets determines the adaptive capacity of every small-scale farmer Eakin & Bojorquez-Tapia (2008) noted that financial assets are the most important of them all because they can be converted into other assets in a short space of time (Adger & Kelly, 1999).

2.5.6 Zimbabwe climate change adaptation plan

The National Climate Response Strategy crafted in 2014 coupled with the National Climate Policy of 2016 were crafted to improve the adaptive capacity of small-scale in Zimbabwe. The Education 5.0 Framework also focused on innovation in agriculture to improve agricultural output even from the indigenous knowledge base. Zimbabwe was assisted with $3.9 million to improve its adaptive measures Global Environmental Facility (UNDP, 2016). The National Adaptation Plan improves on the adaptation strategies that already existed in the country (UNDP, 2017). In Zimbabwe rain-fed farmers may not realise their full potential capacity to improve their adaptive capacity due to weak climate institutions, poor infrastructure, bureaucracy, corruption, poor education, and unclear land tenure systems (IIED, 2012). The National Climate Policy aims to achieve high adaptive capacity and reduce vulnerability among farmers, particularly those in rural areas (IPCC, 2012). In low-income countries, if adaptation is delayed, the elderly and children are highly vulnerable to the negative impacts of climate change and variability (World Bank, 2011).

The impacts of climate variability are already visible in various sectors of the economy, particularly the small-scale farmers although it is incapacitated to take practical steps to reduce the impacts of climate variability and improve their resilience (GoZ, 1998). However, the objectives and aims of the Climate National Policy may be difficult to achieve because of several stifling factors such as dire poverty among small-scale farmers, lack of access to climate information, poor institutional support, and lack of appropriate knowledge (IPCC, 2007). Farmers in communal areas who are highly exposed and vulnerable should be given a priority in the national adaptation strategies (Clements *et al.*, 2011). Climate variability and weather information should be

ubiquitous and should be delivered on time at minimum or no cost if the adaptation strategies are to be successful (Di Falco *et al*., 2011).

Approximately 84.3% of communal farmers are subjected to poverty and about 42% are considered food insecure (ZimVac, 2017). If the asset-based adaptation framework is fully utilised by policy developers in any country, small-scale farmers will be able to increase their agricultural production (Moser, 2011; Simatele & Simatele, 2015).

The Government of Zimbabwe through its Ministry of Lands, Agriculture, Fisheries, Water and Rural Development, initiated the Green Climate Fund to improve adaptive capacity and spearhead smart agriculture in Zimbabwe. Climate-proofing was one of the main objectives of the Green Climate Fund. This was to be achieved through the dissemination of climate information to small-scale farmers through various channels. Increasing weather stations across the country and improving institutional personnel in rural areas were one of their objectives to achieve sustainable agricultural production in communal areas (UNDP, 2020). Swinkles *et al*., (2019) noted that in 2011-2012, approximately 3 million Zimbabweans were living in abject poverty, with 91% being rural farmers. This increases their vulnerability levels due to failure to adapt to the prevailing climate variability, leaving 69.1% of the household food insecure and relying on food aid from donors and other non-governmental organisations, with 98% poorly equipped to sustain their livelihoods (ZimVAC, 2019). Figure 2.10 shows food insecurity in Zimbabwe for three consecutive years from 2020 to 2022.

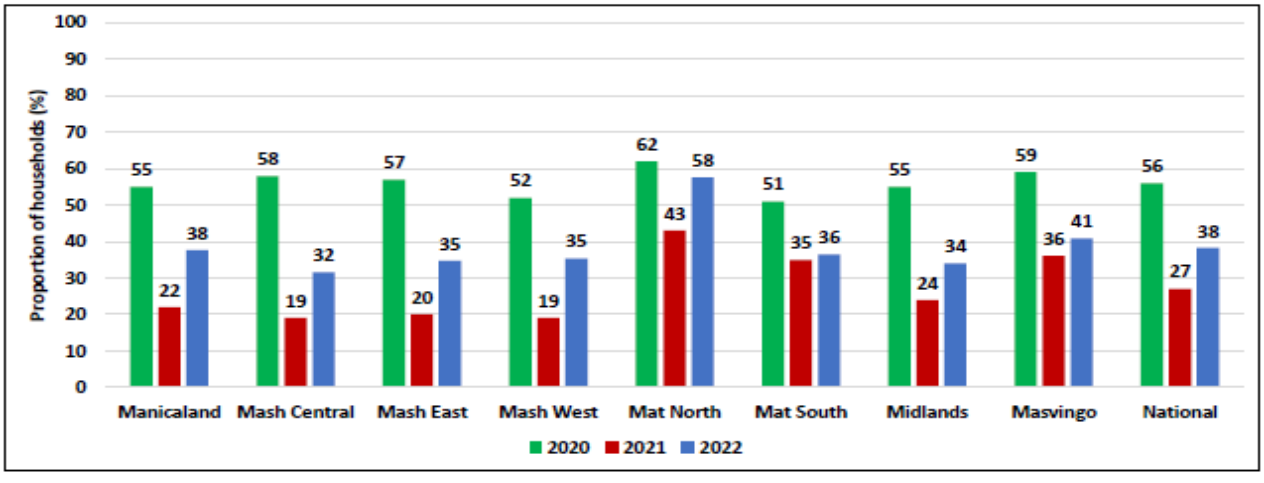


Figure 2.10: Food insecurity in Zimbabwe

Source: GoZ (2022).

Food insecurity has been a common phenomenon in Zimbabwe over the years as shown in Figure 2.10 shows that 2020 and 2022 are the worst years of food insecurity. Matebeleland South and Masvingo provinces were the most affected by food security. The impacts of climate variability can be felt at all levels from individual to continental, with varying degrees of vulnerability (Hellmuth *et al.*, 2007). Zimbabwe's National Climate Policy is committed to seeing the implementation of climate adaptation strategies through a holistic approach and making Zimbabwe a climate-resilient nation. The climate policy also aims to create a nation that is climate change-conscious, with few climate problems.

2.6 Identifying gaps in the knowledge and the relevance of the study

There is very limited evidence, if any, in the literature regarding the way how small-scale farmers in Gokwe South have applied their asset portfolios to fight against vulnerability resulting from climate disasters. Previous research findings have contributed to sustainable climate adaptation strategies (Chagutah, 2010; Bryan *et al.*, 2011; Beddington, 2012; Mudzonga, 2011). While their results are quite significant, they could not address climate problems specific to local conditions such as the Gokwe South district. However, in the context of Gokwe South, there is no documented evidence of various strategies on how small-scale farmers use their resources to improve their adaptive capacity in the face of climate change and variability. The IPCC (2007) observed that there are very few African countries with climate change scenarios which are developed. This is due to a lack of databases, qualified personnel, and lack of funding.

This study is significant because it attempted to search for pro-poor and sustainable adaptation strategies through a search for knowledge integration between indigenous and scientific knowledge systems in the Gokwe South district. The problem of climate vulnerability in Zimbabwe signifies a knowledge gap in terms of the appropriate knowledge to solve the problems resulting from it. Research findings have shown that there are no detailed documented research findings on various IKS that small-scale farmers in the Gokwe South district utilise to anticipate future climate change and variability (Fabiyi & Oloukoi, 2013). A lot of literature and publications were done on the regional and national level, but there is not much that has been done on Gokwe South to analyse the how small-scale farmers are impacted by climate variability (Gwimbi, 2009; Gwimbi *et al.*, 2010; Maburuse *et al.*, 2012; and Chifamba, 2012). According to Chifamba (2012), Gokwe has continued to witness food insecurity, devastating famines, water

scarcity, economic hardships, and poor health, among a host of problems. This study engaged the asset-based approach in assessing the vulnerability of small-scale farmers in Gokwe South. Given this gap, the study proposes a knowledge integration approach between indigenous knowledge and scientific knowledge.

This study realised the omission of political, technological, civic, and other intangible assets highlighted by the previous proponents. This view is shared by Gukurume (2013) and Shewemake, (2008) who noted that vulnerability is high among small-scale farmers because they depend mostly on natural assets and weak institutional interventions, a typical Gokwe South district situation. If adaptation is not embraced by most of the countries, the GDP of the affected countries particularly in African countries will drop by 4%, (World Bank, 2010). There is a need, therefore, to examine individual communities' capacity to cope and adapt (Assessments of Impacts and Adaptations to Climate Change (AIACC, 2010). The global research policy agenda is in its embryonic stage to assess the contribution of IK towards the development of climate variability adaptation strategy as reported for the first time in the (IPCC, 2015). In view of the above observation, the locally manufactured knowledge has a practical relevance in their local community, and it can be used for planning agricultural activities. Also, indigenous knowledge systems can allow dynamism in their application (Flavier, *et al*., 1995; Kalawole *et al*., 2014; and Orlove *et al*., (2014). Some research findings elsewhere in Malawi and Botswana indicate that indigenous knowledge is accessible and can be used in forecasting because of the vast knowledge which is accumulated in daily life experiences (Orlove *et al.*, 2010; Briggs & Moyo, 2012; Kolawole *et al*., 2014).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a discussion of the methods used in this study. The term methodology has been defined as a way of collecting, classifying, recording, and analysing data (Polit and Beck, 2004). It was also defined as an organised way of studying the phenomena in a geographical set-up; that involves the sample size and methods applied to collect data and analyse it (Bowling , 2002). It is a systematic pathway by which a research problem is addressed (Kothari, 2004). Therefore, the research methodology is a sequential process that outlines how the researchers collected the data to address the research problem. For a geographical study of this nature, it is important to adopt a comprehensive methodology through which the set research questions, aims, and objectives can be achieved. The chapter aims to present all data collection tools and methods employed in this study. This chapter has three sections to outline the research methods applied in this study. The first part is the introduction and discussion on the philosophical position of this study. The second section presents the research design, focusing on the research site, the target population, and the sampling procedure together with data instrumentation and data analysis. The chapter ends with methodological reflections.

3.2 Philosophical positionality

Takacs (2002:175) defines positionality as 'the disclosure of how an author's racial, gender, class, or other self-identifications, experiences, and privileges influence research methods' There are four major dimensions in the research process that make up the research paradigm: ontology, epistemology, axiology, and methodology (Patton, 2002; TerreBlanche & Durrheim, 2007). Paradigms include approaches, theories, models, traditions, the body of research, frame of reference, and methodologies (Creswell, 2009; Babbie & Mouton, 2010). Positionality is the philosophical stance taken by the researcher and participants that influence the research process. Positionality is affected by ethnicity or race, sex, family status, level of education, and family class (Skelton, 2001). The interaction between the participants and the researcher influences the research process and the outcome of the research (Twyman *et al.*, 1999).

Researchers can adopt various philosophical positions to carry out academic research. These are positivism, interpretivism, or critical philosophical positions (Asif, 2013). For this study, interpretivism philosophies were adopted to assess how small-scale farmers are modifying their assets to fight against the challenges of climate change and variability. Interpretivism is based on the ontological view that truth and reality are subjective, and individuals perceive things differently to construct reality (Iofrida, Luca, Strano, & Gulisano, 2016). Interpretivism respects differences in opinion between people and calls for respecting the differences between people therefore it is subjective in nature (Bryman, 2008). Researchers need to understand their positions about others, and they particularly need to be aware of the power dynamics that potentially exist between them and the researched (Takacs, 2002; Bourke, 2014). Positionality in qualitative research ultimately means that the researcher's attributes affect the research process starting from the questions asked, data collection techniques, and the reporting of the findings (Carling *at el*., 2013). During the research process, the researchers were aware of the outsider limitations regarding their culture, political affiliation and religions, particularly on issues to do with indigenous knowledge systems. We spent most of the time interacting and participating in fieldwork activities such as weeding, ploughing, and attending social gatherings to remove the locals' negative outsider perceptions. My positionality is undoubtedly over time due to interactions, rapport, empathy, and trust building.

Before the data collection process, the research assistants were given a lecture by the village elders about the cultural values and traditions of the local people. This study adopted the interpretive philosophical positionality because its basis originates from humanities and cannot be like those used in physical sciences. The general world population subjectively interprets the world, and whatever the actions of rural farmers are based on such interpretation humans have on their world, and their actions are based on such interpretations (Hammersley, 2013).

This study adopted the interpretivism philosophical position because it allowed researchers to get an understanding of the phenomenon and its diversity instead of trying to generalise knowledge of a given population under study (Creswell, 2007). The study of this nature used interpretivism because it allowed the diversification of views and ideas to investigate phenomena. Diversification of views allows methodologies such as grounded theory, ethnography, and use of case study approach to be relevant to answer the aims and objectives of the research (Tuli, 2010). Interpretivism allows researchers to investigate the interviewees' abstract thoughts, values, prejudices, perceptions, views, feelings, and perspectives (Wellington & Szczerbinski, 2007). Interpretivism generalise the complexity of the subject of study so that it can be clear to readers

(Cohen, Manion & Marison, 2011). Some scholars criticise the interpretivism approach on the grounds of its subjectivity (Mack, 2010).

Quantitative and qualitative methods were used to get information from the participants. This study was influenced by pragmatism whereby the basis of knowledge of the respondents is from practical activities and real experiences and experiments (Cresswell, 2014). The pragmatic approach used allowed the researchers to get real experiences of practical life which allows the formulation of climate adaptation strategies. Cresswell (2014) affirms that the mixed approach gives authentic outcomes because it involves qualitative and quantitative data sources. The differences inherent in both methods are from ontological (set of assumptions concerning reality under investigation), epistemological (knowledge of the reality), and methodological paradigms (Sale, Lohfeld & Brazil, 2002; Eriksson & Kovalainen, 2015). In a geographical study of this nature, we adopted both qualitative and quantitative methodological research because both types complement each other.

The research process used descriptive factors affecting the vulnerability of small-scale farmers, frequency of occurrences on importance of each asset to the small-scale farmers, and estimates perceptions, and generally dismisses the experiences of the individual but works with the mean of variables assessed (Curry, Nembhard & Bradley, 2009; Eriksson & Kovalainen, 2015). The ontological position is that there is only one truth and epistemologically the researched and researcher are independent of each other meaning there is no transference of influence in any way (Sale *et al*, 2002) and the data presented is normally numerical and ordered (Carr, 1994). A qualitative approach was used because it enabled the exploration of concepts or social phenomena and takes place in the natural setting where phenomena occur. This qualitative approach was used because it was interactive and humanistic thus, enabling the active participation of all stakeholders. This research used the qualitative approach because it allows interaction among researchers and the communal farmers and allows them to give their own experiences in their geographical area. The small-scale farmers were able to describe their practical experiences in their areas and the researchers had a clear picture of the geography of the Gokwe South district (Lather, 1992). Qualitative research was applied also because it sought answers by examining different social settings and the people within them to understand how humans organise themselves and make sense of their surroundings and settings (Berg, 1995). Qualitative research is based on analysing the object under study by collecting non-statistical data such as texts and images (Leedy & Ormrod, 2010; Flick, 2014).

Quantitative and qualitative research methodological approaches were applied because they produce a hybrid of the outcomes. The design of the research tools encompassed characteristics of both statistical and descriptive tools in the analysis, presentation, and interpretation of the results. Qualitative research allowed the respondents to fully answer the questions freely and express themselves in a more flexible manner (Randall *et al.,* 2011). The qualitative research approach was also used because it allows rigorous and systematic data collection which complements the quantitative approach (Randy & McKenzie, 2011). In this research, the quantitative approach allowed for precision and generalization, and this was complemented by the qualitative approach with its "nuanced approach" explaining as experienced by the research subject. The research used several participatory research methods such as questionnaires, interviews, and focus group discussions (Roncoli, 2006; Mertz, 2006; Tschakert & Sagoe, 2009; Van Aalst *et al*., 2008).

3.3 Research design

A geographical study of this nature adopted a case study approach focusing on how small-scale farmers were modifying their asset portfolios against problems resulting from climate variability, it permitted an in-depth exploration of the topic under research and the collection of detailed information over a period. Case studies are concerned mostly with investigating and interpreting characteristics, attributes, and behavioural patterns (Behr, 1983:104). The case study design approach has four key characteristics, first it can be applied in answering questions with a practical approach higher order questions which address "*how and why*" questions. It can also be used when the researcher has no control over the respondents' behaviour and attitudes. Thirdly, it can be used to get contextual information of the subject under study and finally when there is not a clear difference between the context and the subject under study (Yin, 2003). The case study approach allows a deeper analysis of individual areas being studied (Stake, 1995; Yin, 2009). Case studies are effective when collecting information on a micro scale (Fraser *et al*., 2006). In addition, case studies were used because data sources are both top-down and bottom-up (Jupp, 2006).

Case studies afford researchers opportunities to study complex topics within the contexts in which the phenomena occur (Baxter & Jack, 2008). During the study, the approach has the advantage of enabling data sources, and various data sources, and this strengthened the integrity of the data (Yin, 2003). Crabtree & Miller (1999) further argued that this approach affords interaction

between the researchers and the participants, and it allows the respondents to share their views and experiences freely because it allows the use of open-ended questions.

In view of the above observation, Gokwe South has been selected for various reasons. The first one is the fact that it is in regions 4 and 5 of the agro-ecological region , affected by climate variability. The second reason is that Gokwe South consists of many small-scale farmers. The other reason is that no research work has been done in Gokwe South to assess the impact of asset portfolios against climate variability on their agricultural production.

3.4 Description of the study area

Gokwe South is in the Midlands province of Zimbabwe in the North-Western area of the country of Zimbabwe. Gokwe South is politically divided into 32 administrative wards. According to ZimVac (2013), cotton and other cereals are grown in the Gokwe South district. This region was chosen because it has many small-scale farmers in the agro-ecological region 4 (Mugandani *et al*., 2012). Upon the attainment of independence, under the Government Growth Point Policy, the Gokwe Centre was pronounced a growth point. Another reason why Gokwe South was chosen is that it is experiencing climate variability challenges due to an agro-ecological shift as shown in Figure 2.2 and Figure 2.3.

The climatic conditions are suitable for small grain crop varieties and drought-tolerant crops such as cotton *(Gossypium)*. Cotton is the main cash crop grown in the district and attracted foreign and locally owned cotton companies like Cargill, Cottco, Grafax, and Olam. Maize and sorghum are grown on a small scale during the rainy season. Figure 3.1 shows the location of the Gokwe South district.

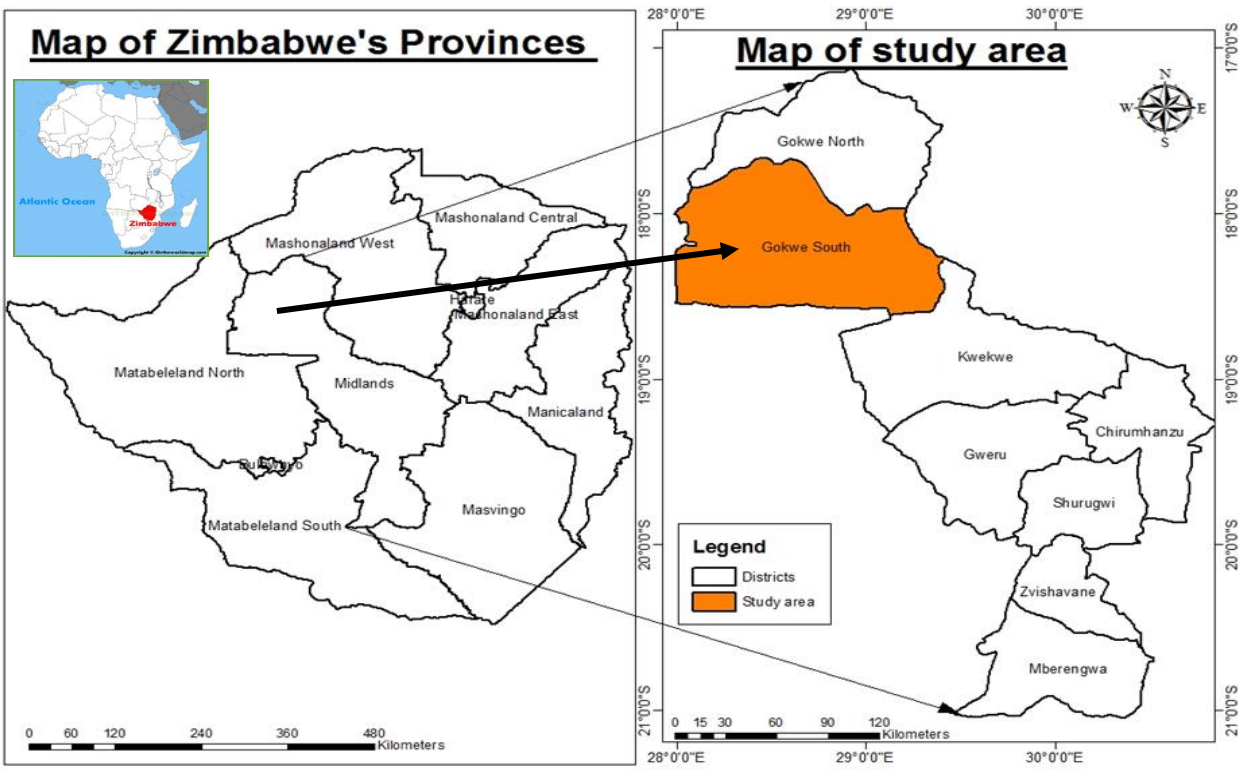


Figure 3.1: Location of Gokwe South district

***Source*:** Philips (2018).

Midlands has eight administrative boundaries called districts. The location of Gokwe South is shown in Figure 3.1. The main economic activity is traditional farming mainly mixed farming. Gwimbi (2009) carried out research in Gokwe to analyse how cotton farmers are adapting to the changing climate conditions.

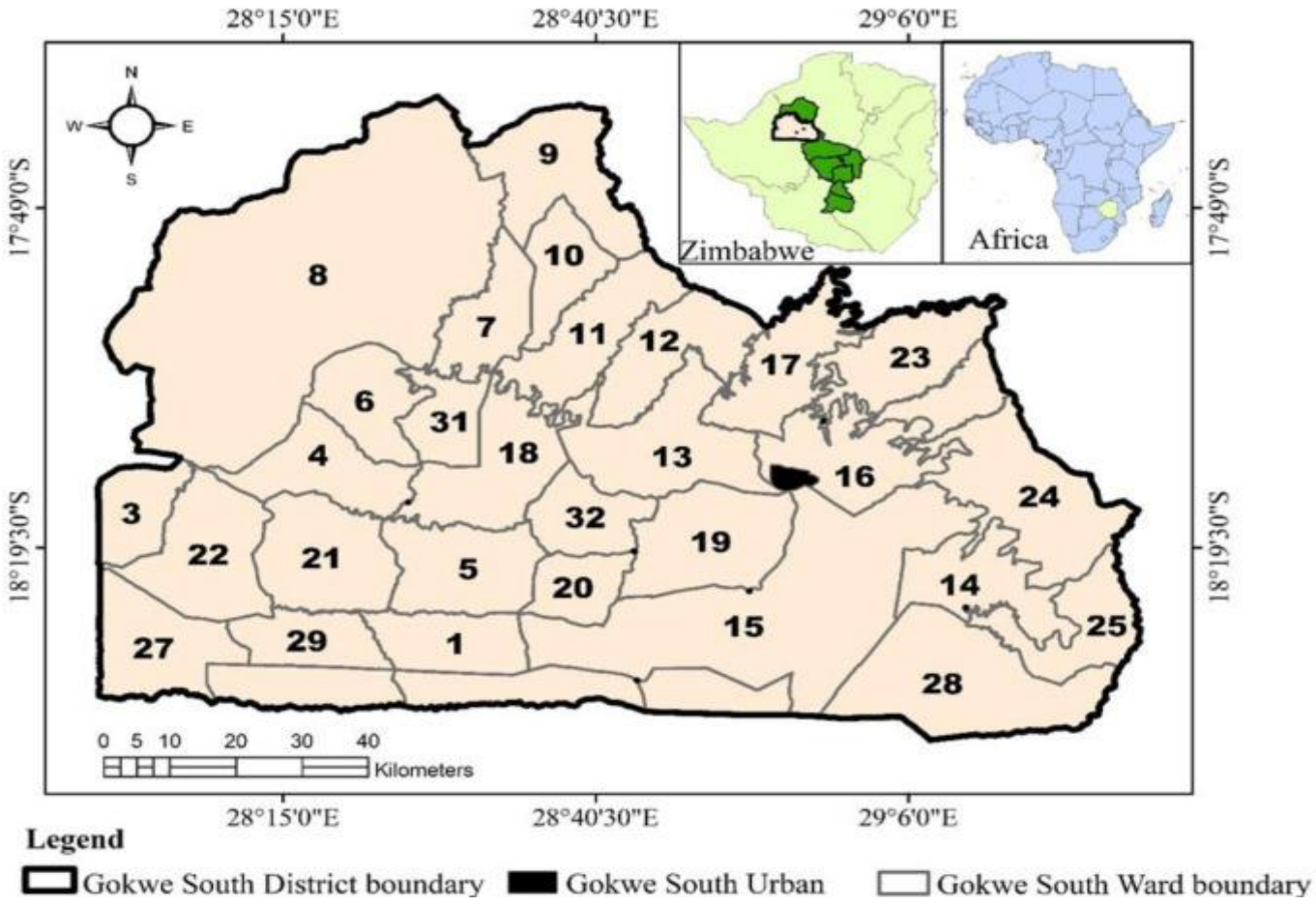


Figure 3.2: Constituencies and wards in the Gokwe South district

***Source*:** Zimbabwe National Statistics Agency (2012).

3.4.1 Sampling Procedure

a) Study population

A study population is defined as the total number of variables of unit data sampled, such as people, animals, activities, groups or administrative boundaries, or geographical areas (Parahoo, 2006), while Burns and Grove (2003) proposed that population as variables be part of the study. For this study, the target population involves 84 000 households in the Gokwe South district of Zimbabwe (Food Poverty Atlas, 2016). Due to time, financial and logistical problems, 225 participants were drawn from Gokwe Central Constituency, Sesame, Mapfungabutsi, Sengwa, and Kana constituencies. A sample has been defined as "a proportion of a population" (Polit & Beck, 2004). Purposive sampling was used to select the participants. For the participant to be selected, the criteria were that he or she should know about climate change and variability, be age-relevant, be a resident of the area and have the experience in farming activities in the district. The researchers were able to identify the respondents by constituencies: Mapfungautsi, Gokwe

Central, Kana, Gokwe, Sesame and Sengwa. Key informants for this study were drawn from government officials such as District Administrators (DA), (renamed District Development Coordinators, DDC), chiefs, and other stakeholders. The key informants were purposively chosen from academic institutions (Vansina, 1985). Focus groups were selected from each constituency and were made up of 5 to 13 participants. The age of participants was selected from 30 years and above. Gender balance was taken into consideration during the sampling process. In the Gokwe South district, women are the environmental managers in rural areas and play a key role in rural agriculture and sustenance in low-income countries like Zimbabwe (Binns *et al.*, 2012).

b) Sample size and sampling technique

Any research has its sample size which varies spatially and at a particular time. Boyd *et al.*, (1981) opine that the sample size for any research depends on several factors such as resources available, and time. A sample of 5% is representative of scientific research. Clark (1986) suggested that for a sample to be representative at least 10% of the target population is recommended. For this study, the unit of analysis was the small-scale farmers in the rural areas of the Gokwe South district. To calculate a sample size, this study applied Slovin's Sample Size Calculator, with random samples. The target population for this study is 84000 households and the minimum allowable sample size is 225 households. Participants were taken from each of these households, with a 95% confidence level and a 5% margin error. Cluster sampling was used to select 25 wards from which the respondents were drawn. Random sampling was used to elect some small-scale farmers in general. The sampled wards were based on the number of wards in each constituency. It was statistically agreed that 66% representation from each constituency would be required to get authentic results. The number of participants was based on the population size of each constituency, the higher the population the higher the number of participants, as shown in Table 3.1.

Table 3.1: Study population and sample size used to inform this study

Name of Constituency	Number of Wards	Sampled Wards	Number of Sampled Participants	Percentage of sampled participants (%)
Gokwe Centre	5	4	42	18.67
Sesame	7	6	48	21.33
Mapfungabutsi	7	5	45	20
Kana	8	6	45	20
Sengwa	6	4	45	20
Total	33	25	225	100

***Source*:** Author's field results (2020).

The main purpose of purposive sampling was to confirm that samples taken from constituencies were significant to achieve the aim and objectives of this study (Corbin & Straus, 2015; Bryman, 2016). The Zimbabwe 2012 Census report was used to verify data collected in the five constituencies. This study applied the purposive sampling technique because it enabled the discussion to give authentic results. Purposive sampling was the most appropriate for this bracket of respondents because it focused on specific groups of respondents to extract specific responses to analyse the nature and extent of conflict related to adaptive strategies used by the small-scale farmers towards climate change. However, the approach had a weakness of not giving all members of the population an equal chance (Cohen & Manion, 2011). Purposive sampling enabled the identification of key informants (Bryman & Bell, 2007), and the key informants were selected using both purposive and snowball sampling which enabled a representative sample to be used in the study (Bryman & Bell, 2007). Experts and stakeholders such as government officials, councilors, and traditional leaders were selected using a combination of purposive and snowball sampling which enabled a representative sample.

Data collected was sorted into age, sex, years in farming, household assets, livelihoods. The elderly respondents who are the custodians of indigenous knowledge were the key informants. Snowballing sampling also known as chain referral sampling, considered a type of purposive sampling was implemented during data collection, based on age, gender, farming experience, household assets and livelihoods and elderly participants. Snowballing is a sampling technique

that was also preferred in this study because it uses the appropriate respondents who are eligible and have the information required in the study. For this study, the researchers decided to group the constituencies into rural and peri-urban constituencies.

3.4.2 Data collection methods and instruments

Data collection is a process used by researchers to collect the information required to answer the research questions. Data collection methods are used to achieve set objectives in research Creswell (2014). Many data collection tools were implemented in data collection, which fell in line with the mixed method approach of the study discussed below.

a) Participatory research action

Participatory Research Action (PRA) was used because it is the most appropriate method to collect information in the rural area of the Gokwe South district. For this study, PRA is the suitable technique because it involves a range of methodological approaches, all to empower research participants, who are often community members. For a study of this nature, the participatory approaches were used because they have been shown to yield greater accuracy and results are more credible than external approaches (Banerjee *et al*., 2007). PRA is based on a social set-up whereby all stakeholders are involved in problem identification, and they look for possible solutions as a group (Maarleveld & Dungeon, 1999; Pretty & Buck, 2002). PRA is also important because it liberates, empowers, and educates. It also creates a mutual relationship that brings small-scale farmers into climate change discourse and validates their knowledge.

Participatory research methods allowed the indigenous people to be actively involved and share their practical experiences and find common solutions to the problems resulting from climate change and variability (Chambers, 1997). Participatory methodologies were used in this study as an attempt to ascertain how small-scale farmers' livelihoods in Gokwe South are affected by climate risks and disasters (Catley *et al*., 2008; Mubaya *et al*., 2012). The PRA methods are important because they allow the integration of scientific and traditional knowledge to come up with a hybrid of knowledge supported by two extreme knowledge bases in climate change discourses (Ballard & Belsky, 2010). Given the above observation, researchers assume the role of facilitators and learners and sought to advise small-scale farmers on the best adaptive strategies

against climate change problems (Chambers,1994). This study engaged the participatory approach because it allows the active engagement of rural communities or social actors and in the research, the process can stimulate social action (Ziervogel & Calder, 2003). With participatory methods such as Focus Group Discussions, vulnerable community groups may be capacitated to manage problems such as climate variability (Kothari, 2001). Rural communities in Zimbabwe rely on IK to develop coping and adaptation strategies against climate variability. The use of participatory approaches such as FGDs has been used in climate variability discourse (Roncoli, 2006; Van Aalst *et al.*, 2008); Mertz *et al.*, 2009; Tschakert & Sagoe, 2009).

Since climate variability results in a creeping hazard that occurs very slowly it was noble to apply PRA as the basis for study in the Gokwe South district since it acknowledges medium to long-term climate changes. PRA strengthened the understanding of indigenous knowledge and modern scientific knowledge creating a new thrust of adaptive strategies against the challenges of climate change and variabilities in the Gokwe South district. Modern scientific knowledge is highly applicable on a macro scale while indigenous knowledge is applicable on a micro scale such as in the Gokwe district. Given the above observations, this study proposed the integration approach in the quest for sustainable knowledge adaptation. Both knowledge bases, indigenous knowledge and scientific knowledge have weaknesses and strengths, and both are so dynamic that they change over time. This also explains the 'search for knowledge integration approach' titled above.

a) Key informant interviews

In-depth interviews were used as the main data collection tool. The in-depth interviews permitted the predetermined and anticipated questions to be addressed and it is flexible to incorporate new topics in the process of answering the main question and objectives of the study (Grenier & International Development Research Centre, 1998). In-depth interviews were very effective for interviewing key informants such as government officials, university lecturers, Agritex officials, and teachers (Appendix G). Interviews are widely used for collecting quantitative data (Minhat, 2015). Gill, Stewart, Treasure, & Chadwick (2008) propose that interviews are useful in exploring sensitive topics, instances where it is inappropriate to talk about experiences in a group setting as well as when detailed insights are required from individual participants. Various research questions, sampling methods, and strategies were used during data collection, as shown in Appendix F.

For the quantitative data, questionnaires were used to collect the data. Semi-structured interviews were conducted with a group of key informants which consisted of ward Councillors, Extension Officers, District Administrators, teachers, Environmental Management Officials, village headmen, and other village elders who were above 70 years. These elderly people were selected because they had observed climate variability for many years and had a deep knowledge of IKs in the area and their consequences in the district. The interviews were used because it was the basis for assessing the perception, beliefs, attitudes, and feelings toward IKs and their relevance. Most of the questions used were open-ended to allow the interviewee to give their own opinion on the subject matter under discussion (Creswell, 2013; Sarantakos, 2013). The texts were divided into meaning units that contained similar aspects from the interviews. These units were then shortened, without losing the core meaning of the content, in a process called condensation. The condensed phrases were then coded. The codes were grouped into categories based on their different relationships. A category answers the question "What?" and the categories were presented with results of the response to those categories.

b) Questionnaires

Bell (2013) argues that questionnaires are reliable because they have a greater level of impersonality. Kothari (2004) points out that questionnaires help in quantitative research, where results produced give empirical evidence to support given views and come up with judgments on results obtained. Questionnaires (Appendix, J) were given to 225 households. The questionnaires were used to collect data from households, both qualitative and quantitative data. The questions were divided into various sections with different themes such as personal details, farm ownership, sources of income, climate disasters farm inputs and outputs agricultural practices, climate information, and adaptation strategies used, crops and animals kept. This allowed content analysis. Descriptive statistics were used to analyse the data collected to obtain the mean and totals for various variables and this information was triangulated with qualitative data. The use of questionnaires was used to collect information on perceptions of vulnerability due to climate variability and assets portfolios used to improve the small-scale farmers' adaptive strategies.

d) Transect walks

Information from Focus Discussion Groups was supported with data collected from transect walks. The participatory approach also involves a transect walk, whereby the researchers walk the

area of study identifying evidence of the issues being researched (Pretty, 1995; Sallu *et al.*, 2009). A transect walk is a practical field survey that aims to physically observe the geographical features in question. obtain the description, location, and distribution of resources, and other geographical features in any area. To carry out transect walks, assistance from a ward officer, village elders, or farmers was sought to explore the features in the study area as proposed by De Zeeuw & Wilbers (2004), and INTERCOOPERATION (2005). Transect walks enabled us to know the natural phenomenological using natural phenomena. They can provide useful evidence for secondary data and provide satisfactory outcomes. The checklist was used to capture on-farm practices and other climate-related impacts.

e) Focus group discussions

The use of focus groups when using qualitative description as focus group interviews seems pertinent to get a broad insight into a subject matter (Neergaard *et al*., 2009), (Appendix F). A focus group discussion (FGD) has been defined as an interaction between researchers and participants to collect data (Parahoo, 2006). FGDs, has an advantage in that participant from the same background and experiencing the same climatic conditions can give their views and perceptions on the topic under discussion (Holloway, 2005). Focus Group Discussions brought group sharing of ideas, a concept that is not available in one-on-one interviews (Darlington & Scot, 2003). The FGD facilitated small-scale farmers and respondents to share different meanings and perceptions on climate change variability (Bryman & Bell, 2007).

The FGDs were used for a deeper understanding of the impacts of climate variability in the Gokwe South district. Further information was also obtained on how rural farmers adapt to the changing climate (Appendix E). The study was age and gender-sensitive in all constituencies (Table 4.1) and communities of various economic groups were considered in the selection process of the respondents (Hopkins, 2007). Through interviews, it was able to construct agricultural farming calendars in the Gokwe South district (Roncoli, 2007). Climate timelines are important because they give an insight into temperature and rainfall regimes for a particular study area and how agricultural activities are affected (Ziervogel & Calder, 2003; Van Aalst *et al.*, 2008). The climate data collected from small-scale farmers and other stakeholders was used to construct Table 4.7. The small-scale farmers who attended the FGD discussed types of assets that they used to depend on their livelihoods based on the pentagon of assets outlined on the SLF (Scoones, 1998).

f) Oral histories

Oral history has been defined as a critical method to reconstruct the past practices and events of the areas (Bryman & Bell, 2007). Historical data is considered important evidence in geographical studies, particularly in climate change studies (Powell, 2008). Oral data collection was done in the rural areas with the community elders to provide past climate experiences and their adaptive strategies to climate change and variability. Community elders such as traditional chiefs, headmen, grandfathers, and grandmothers were approached to give an oral history of their experiences in wards and constituencies, particularly on climate change and variability.

g) Expert interviews policy analysis

The key informants were purposively selected from various institutions and government departments were also approached (Appendix D). These experts were purposefully selected based on their knowledge of the climate changes in the country. Snowball sampling methods were used to select these key interviews to provide deep knowledge of climate change and variability (Bryman & Bell, 2007). Experts were also able to give detailed policy applications in Zimbabwe that affect their agricultural practices and food security using content analysis (Krippendorff, 2004). The researchers also clarified these policies to make the respondents understand the aims of the aims and objectives of the study.

h) Secondary Data

Secondary data was downloaded from the internet, particularly from the ZimStat publications of the census, Agritex Offices, Water and Rural Development, District Administrators, and Non-Governmental Organisations. A lot of data has been collected concerning extension services; assistance is given to vulnerable small-scale farmers in Gokwe South. Secondary data sources proved helpful during the research process such as those noted in the following points: fewer costs involved; secondary data sources were compared with data from primary data sources to come up with valid information. It is also believed that secondary data sources can provide accurate information (Crawford, 1997). The collection of data sources provided data that the researchers were not able to obtain during primary data collection. Table 3.2 shows the problems of relying on secondary data sources only.

Table 3.2: Problems with secondary data sources

Definitions	Definitions of terms vary spatially and temporarily. Researchers have different definitions for the same term or concepts. For instance, the concept of family in rural areas may mean different things such as the nuclear family or extended family. Another term that researchers define differently is farm size in which the figures to delimit size can be taken differently by various researchers even by the indigenous people of the area. The definitions of many terms are very dynamic and erroneous conclusions can be drawn on such a basis. Several aspects such as geographical boundaries, units of measurement, and grades may change over time. Therefore, the information recorded from secondary sources has challenges.
Measurement error	Variations in numerical values and inaccuracies from field research are not usually published in secondary sources. One problem is in data collection, particularly where the standard deviation is not considered.
Source bias	Most of the published literature is either subjective, or optimistic. The results published are adjusted to suit the demands of the researcher or the interests of the organisation or a country. Figures may be decreased or increased depending on the interest of the researcher.
Reliability	Numerical values published usually expire after a certain time frame without the knowledge of the reader. In social science, population figures can change over time such as birth, death rates, or even migration figures. In addition, administrative boundaries may also change with time. The reliability of the data collected also varies with time.
Time Scale	Data compiled during the fieldwork and the time of publication may undergo the process of degeneration. Therefore, after some years of publication, the data may become irrelevant to the present-day time. Statistical values collected in the field may change after some time. This is a challenge with secondary data.

***Source*:** Crawford (1997).

Given a plethora of disadvantages laid out in Table 3.2, the advantages of secondary data sources prompted us to use them extensively during data collection for the study. Table 3.3 shows strengths, weaknesses, and practical solutions to the methods used.

Table 3.3: Strengths, weaknesses, and practical solutions to methods used

Method	Strengths	Limitations	Practical Solutions
FGDs	Verified secondary data sources Aspects of vulnerability were discussed by the group.	Some participants were inactive during the discussions. Participants showed their animosity against each other during the discussions	Moderations and control allow equal chances for all participants. Gender-sensitive was observed throughout the discussions.
Key Informant interviews	Allowed a deeper analysis of the aims and objectives of the study	Challenges in picking up key informants.	Based on community leaders, traditional chiefs, and headmen. Government officials also provided more data to complement traditional knowledge.
Questionnaire survey	It was able to share knowledge between the researcher and respondent at minimum costs.	May be time consuming.	The researcher and research assistants controlled and moderated the discussion to make sure the participants will remain focused on the topic under discussion.
Interviews with experts: lecturers, extension officers, teachers	Gave expert data on climate change information and adaptation strategies for Gokwe South.	Experts are not easy to get, they value their time for other things.	One-on-one arrangements were organised through personal contacts.
Oral history	Rich in past experiences and livelihoods could be explored	Statistics were full of approximations and the data	Verified narratives with a household questionnaire. Recorded historical data from archives were made

	with problems encountered during the past decades	collected was very subjective.	available to verify the oral history of the respondents.
Government policy documents	Relevant policy documents were available, brought by experts	Accessibility of policy documents on a small scale is a challenge.	Used personal contacts in the ministries to get access to policy documents. Secondary data was of great assistance to the challenges outlined.
Transect Walk	To have first-hand data obtained from transect walks, and questionnaires and see the impacts of climate change on the livelihoods of farmers. Participatory research action for more evidence.	It's a quick method to address many aspects in a short time.	Aspects to do with the aims and objectives of the study were only addressed. Records were kept for future reference.

Source: Warrick (2009).

3.4.3 Data analysis

The data collected from all sources both primary and secondary were organised into relevant categories and themes. The content analysis was then used to analyse various categories of data as outlined in the aim and objectives of the study (Bowen, 2009). At this stage, the researcher analysed the content of the data collected, patterns of responses and the concerns raised by the respondents (Bender & Ewbank, 1994).

Thematic analysis of data involves reviewing all data gathered and analysing the trends and themes of the subject under study (Bowen, 2009). Data reliability was also verified through a comparison of primary and secondary data collected. The vernacular language was also used in cases where respondents were not able to communicate in English. It was then translated into the English language. During data analysis, qualitative data was coded and put in indexes and then analysed through content analysis. In some cases, some data were merged for easy analysis. (Saunders *et al.*, 2009). Quotations from respondents were valuable contributions and they gave more insights into the aim and objectives of the study. Various degrees of response for qualitative sources particularly variations in climate variability perceptions were analysed using the Linkert scale.

The use of databases enabled the research to be accomplished, and enabled they enabled retrieval for inspection and use whenever required. It improves reliability by tracking and organizing data collected through various sources. Computer-Aided Qualitative Data Analysis (CAQDA) was used to organise, analyse, and store data. These bins programs facilitated the storage and retrieval of the organised and processed data (Wickham & Woods, 2005).

Data analysis was done using IBM Scientific Package for Social Science-SPSS) which facilitated the statistical analysis together with Microsoft 365. Analysis of data was done in Predictive Analytic Software using descriptive statistics (Kinnear & Gray, 2012). The data collected were presented in graphs, tables, and charts. The IBM SPSS enabled text analysis, open-source extensibility, integration with big data, and seamless deployment into applications.
Its ease of use, flexibility, and scalability make SPSS accessible to users of all skill levels. What's more, it is suitable for projects of all sizes and levels of complexity and can help one find new opportunities, improve efficiency, and minimize risk.

The dependent variables were adaptation and coping strategies in the Gokwe South district. The independent variables also consisted of human factors such as gender, age, education, wealth groups household and farm size. The EpiData Software was used to enter the data and it helped in the management of the data by putting it into categories and producing relationships of the data collected, for example assets owned and the degree of vulnerability of small-scale farmers in the Gokwe South district. The analysis was done through five steps in a sequence: familiarisation, thematic framework identification, indexing, charting, and mapping and interpretation (Lacey & Luff, 2009).

i. **Familiarisation**: this involved transcription and reading of the data from questionnaires, focus group transcripts, participant observations, and transect walk as well as audio recordings from the interviews. Throughout the process, the researchers were familiar with the whole process and all the themes in the study area.
ii. **Thematic framework identification**: This is the second stage where the coding framework was developed emanating from both a priori and emerging issues at the familiarization stage. This stage involves critical and intuitive thinking. Judgments about the meaning and relevance and connectivity of ideas justifying the relevance of research questions and that the questions were correctly addressed.
iii. **Indexing**: A thematic framework was used for the data collected both in numerical and textual codes. A thematic framework was applied to the data, using numerical or textual codes to identify specific pieces of data which correspond to differing themes during coding. Indexing enabled the researchers to merge corresponding data to the main theme.
iv. **Charting**: The collected data was used to create charts and headings from the themes. Charts created include thematic categories from all participants. During the charting process, the researchers were guided by the objective of the study which included defining concepts, mapping the nature of phenomena, creating typologies, developing strategies, and giving full explanations.
v. **Mapping and Interpretation**: The researchers used recorded and coded, and were able to see the patterns, associations, concepts, and explanations in the data. The Framework Analysis was also utilised because it enabled the researchers to put across the ideas from the data recorded as an aid in testing interpretations. The analysis was used for comparison purposes between constituencies in the Gokwe South district. Percentage scores of each asset type were calculated per constituency. The overall scores were used to rank the assets according to the participants' responses.

3.4.4 Calculating the vulnerability indices

Vulnerability indices can be calculated using various methods, including asset availability and asset mix. Several research findings showed that there are three commonly used methods to calculate vulnerability (Brooks *et al*., 2005; Moss *et al.*, 2001) secondly, there is the arbitrary choice of equal weight (Lucas & Hilderink, 2004; O'brien *et al*., 2004; Patnaik & Narayanan, 2005) and lastly the statistical methods such as the principal component analysis or the factor analysis (Thornton., *et al.*, 2008). This study used unequal weights of assets to determine the degree of vulnerability. This is because the respondents were using subjective analysis of the influence of the assets to improve adaptive capacity or reduce vulnerability (Hebb & Mortsch, 2007). Given the variations of each indicator, a process of standardisation or normalisation is carried out by using a constant factor.

After normalising the indicators, the correct weight was then attached to each variable. This study used the unequal weighting system based on each indicator value of assets by small-scale farmers and other participants. The unequal weighting was appropriate because the results from the questionnaires showed that small-scale farmers and other stakeholders experience the value of assets differently, particularly on the social and financial assets. The participants indicated that rural communities belong to various social groups and different households receive financial assistance from various donors and other family members from abroad. The indicator methods are used to try and assess the degree to which farmers are vulnerable to climate variability by integrating the five assets and creating a composite index which was then used as the vulnerability index (Adger, 1999; Hahn., *et al.,* 2009). The method of assigning different weights is known to bring valid outcomes Vincent (2007) and input from household heads, see Table 4.3. The frequency of asset citing was used to obtain the weighting index. The vulnerability of a household was calculated using the model (Vincent, 2004). The vulnerability of each selected household was then calculated using the model (Eq. 3), (Vincent, 2004).

HLVI= (Snvi x *W*i) + (Hnvi x *W*ii) + (Fnvi x *W*iii) + (Pnvi x *W*iv) + (Nnvi x *W*v) Equation 3

Where:

HLVI = household livelihood vulnerability index

Snvi = normalised social asset sub-index

Hnvi = normalised human asset sub-index

Nnvi = normalised natural asset sub-index

Fnvi = normalised financial asset sub-index

Pnvi = normalised physical asset sub-index

Whereas Wi = weight is applied for each standardised value (Antwi, 2012).

3.5 Methodological reflections

There were many challenges encountered during the research process, and these include socio-economic, political, and environmental challenges. The research was time-consuming and lengthy as we constantly had to follow up on the participants. The nature of the participants was that they were never in one place at any given time. They would travel for various reasons, and we constantly had to reschedule appointments. The household questionnaire was the most tiresome to complete because most of the members of the household would be engaged in their activities. In most of the wards and villages, we constantly had to assure the participants that we were not journalists, environmental activists, non-governmental agents, or political partisans, as they were a bit sceptical of where our interests lay. I overcame this by carrying my student card as well as detailed information on my study as reflected in the participant information sheets, informed consent forms, and ethics clearance certificate. In some areas like the Mapfungabutsi constituency the terrain was very treacherous, mainly because of the plateau with steep slopes. Most of the households are scattered in valleys that were difficult to access.

Data collection, particularly interviews and Focus Groups Discussions were characterised by questions from the villagers, chiefs, and councilors. The chiefs and headmen would expect a token of appreciation after spending time with them sharing the information concerning the research. The interviews with the government officials went on well although we had to move from one office to the other according to their protocol. It was very difficult to get the full and most recent climatological information from the Meteorological Services Department because their information is commercialised. The interviewees were particularly interested to know which political party we belonged to. Gokwe South district was politically polarised to such an extent that the participants would ask me to provide my political party card. This was an opportunity where we would produce my student card and the Ethics Certificate Clearance. Most of the respondents were literate, which made it easy to fill in the participant information sheet, consent sheet, and questionnaire. Being able to communicate in the local language (*Shona*) was a huge advantage.

CHAPTER FOUR

EMPIRICAL EVIDENCE

4.1 Introduction

This chapter is dedicated to presenting the empirical evidence of the study. A study of this nature is important because it is from these research findings that conclusions and recommendations can be drawn. The data used in this study was collected from April 2019 to April 2020. The categories used were obtained through repetitive reading and reviewing of the content. The data obtained from this process was presented in various forms, such as excerpts from interviews, personal communication, tables, and charts. The first part presented the characteristics of the respondents and their perceptions. Factors influencing the choice of adaptation are analysed in this chapter. The respondents were able to give their perceptions of climate change and variability, particularly the impacts of climate change on small-scale farmers' livelihoods. The vulnerability of small-scale farmers was also assessed to find how the constituencies were affected by the portfolio of assets at their disposal. In this chapter, the adaptive strategies suggested by farmers were also discussed. This chapter also presents the types of crops and livestock reared in the Gokwe South district. Results of the causes of climate change and variability were presented. The chapter also investigated the factors limiting adaptive capacity in the Gokwe South district.

4.2 Demographic characteristics of participants

The questionnaires were targeting small-scale farmers with knowledge of farming in the area. It also targeted elderly people 30 years and above. The differences in culture, ethnicity, access to information, assets, and markets were also covered. The factors outlined in Table 4.1 are crucial in determining the vulnerability of small-scale farmers in the Gokwe district. During the survey, the questionnaire involved several variables targeting both sexes at different age groups as shown in Table 4.1.

Table 4. 1: Characteristics of respondents who were interviewed (N =225)

Variable	Gokwe Centre		Mapfungabutsi		Sesame		Kana		Sengwa		Total	%
	N^{0}	%	N^{0}	%	N^{0}	%	N^{0}	%	N^{0}	%	N^{0}	%
Number of Households Interviewed	42	18.67	45	20	48	21.33	45	20	45	20	225	100
Sex												
Male	28	66.7	22	48.9	26	54.2	23	51.1	25	55.6	124	55.1
Female	14	33.3	23	51.1	22	45.8	22	48.9	20	44.4	101	48.9
Age Group												
30-39	8	19.0	7	15.6	6	12.5	5	11.1	8	17.8	34	15.1
40-49	9	23.8	10	22.2	10	20.8	10	22.2	10	22.2	49	21.8
50-59	10	23.8	10	22.2	10	20.8	10	22.2	10	22.2	50	22.2
60-69	10	23.8	10	22.2	12	25	11	24.4	10	22.2	53	23.6
70^{+}	5	11.9	9	20	10		9	20	7	15.6	40	17.8
Education												
Adult Education	5	11.9	4	8.9	3	6.3	6	13.3	10	22.2	28	12.4
Primary	18	42.9	29	64.4	19	39.6	19	42.2	30	66.7	115	51.1
Secondary	12	28.6	10	22.2	16	33.3	10	22.2	3	6.7	51	22.7
College	6	14.3	2	4.4	7	14.6	8	17.8	2	4.4	25	11.1
University	1	2.4	0	0	3	6.3	2	4.4	0	0	6	2.7
Occupation												
Government Officials	10	23.8	8	17.8	9	18.8	7	15.6	8	22.2	42	18.7
Farmer	20	47.6	30	66.7	30	62.5	33	73.3	34	75.6	147	65.3
Employee	12	28.6	7	15.6	9	18.8	5	11.1	3	6.7	36	16

Source: Authors' field results (2020).

Table 4.1 shows that 65.3% of the small-scale farmers were able to answer most of the questions asked. A percentage of 55.1 % of the questions were answered by male respondents. Just over half (51.1%) of the respondents had attained primary education. The Government officials were also able to answer several questions and by occupation, they constituted 18.7% of the respondents. Some of the participants indicated that they were only able to answer the questions if they were given something in exchange for the information they will provide. On 15/04/2020, one female respondent in her 70s in Mapfungabutsi reported:

> "… A few years ago, one researcher came asking similar questions about our district and we were not given anything. We thought after the research, we were to get some inputs for our agricultural processes. Next time when you come back, we need a token of appreciation for the information that we give you."

Similarly, on 26/04/2020, another elder man in his 60s from Sesame said:

> "We are aware that when the people participate in the research process, they are given a token of appreciation, and considering that agriculture is not performing well, they use these opportunities to at least expect some money for their daily need."

This challenge was solved by providing evidence to show them that the research was for academic purposes and not sponsored by any organisation and therefore no monetary rewards due to participants. The researchers further elaborated that answering the questionnaire and participating in the focus group was voluntary and the respondent can leave without any problem.

4.3 Factors influencing small-scale farmers' adaptation strategies to climate variability in the Gokwe South district

Considering the nature of factors affecting the adaptation choices, the factors were grouped into demographic, social, economic, cognitive, political, and psychological factors (Hoa Le Dang, 2019). Several factors affect small-scale farmers to various degrees. During the data collection process, several factors such as age, educational level, gender, household size, income, access to agricultural extension, and information, were considered in the selection of the respondents. Factors such as age, gender, education level, household size, income, access to agricultural extension, credit, and information have been commonly used in investigating farmers' adaptive

behaviour in Gokwe South district. Therefore, the researchers obtained the numbers of appearances of the groups as shown in Figure 4.1.

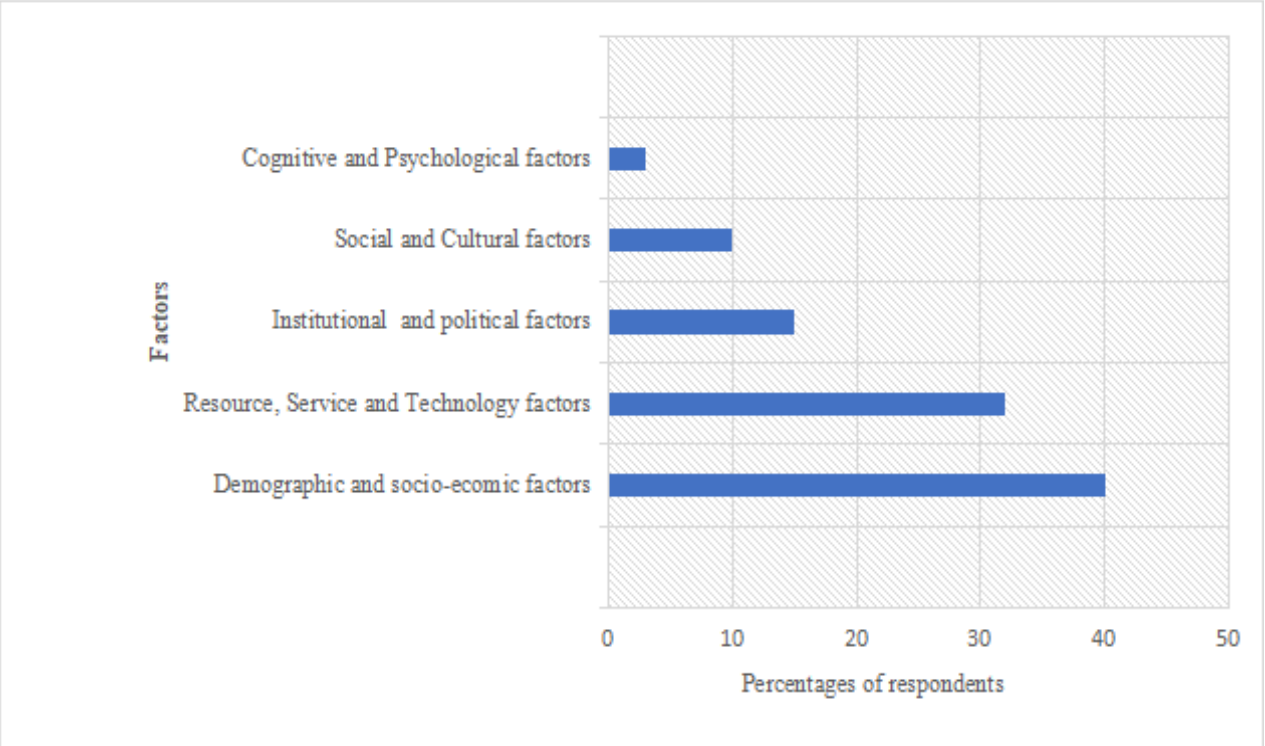


Figure 4.1: Factors influencing adaptation strategies

Source: Authors' field results (2020).

Through the Focus Group Discussions, interviews and questionnaires, the researchers identified several factors influencing the choice of suitable adaptation strategies. These were further grouped into five basic factors for better analysis. After grouping the factors, the dominant factors were as follows: human and economic resource, service, and technology factors; institutional and political factors; cognitive and psychological factors and social and cultural factors. These assets were identified as factors affecting adaptation at various levels from one constituency to the other and from one small-scale farmer to the other.

4.4 Contextualising the significance of indigenous knowledge in improving adaptive capacity against climate variability

The significance and success of the IK were noted in Sub-Saharan Africa where IK was an answer to the challenges of climate change and variability (Nyong, *et al*., 2007). Similar results

were noted in Gokwe South where IKs was regarded as helpful in their agricultural practices as shown by results in Table 4.15 compared with IKs.

An average of 61% of the respondents in the Gokwe South district relied on and used IKs as adaptive climate information. In Mapfungabutsi, 78% of the respondents indicated that traditional and indigenous knowledge was very useful, and they have relied on it from time immemorial and is the knowledge that they inherited from their ancestors. A significant proportion of the participants indicated that the IKs was readily available and reliable. Only two administrative areas near Gokwe town (Gokwe Centre and Sesame) indicated that they rely on scientific knowledge systems more than the indigenous with 53% and 62% respectively. This is mainly because these are peri-urban constituencies, and they rely more on knowledge from the Gokwe town. These two administrative areas reported that they also rely on information from the television, radios and cell phones since they have access to electricity and reception is better. They also get information from the Gokwe town aerodrome. Sengwa and Mapfungabutsi constituencies largest number of which indicated that they rely on indigenous knowledge systems more than the rest of the constituencies with percentages of 78% and 84% respectively. Results from Sengwa and Mapfungabutsi indicate that they use very limited scientific knowledge of weather and climate change information, with values of 22% and 16% respectively. Mapfungabutsi (smoking mountain) plateau is believed to produce some smoke during the summer season indicating the beginning of the summer season and planting preparations begin. Sengwa and Mapfungabutsi areas are remote and even agricultural extension workers are not pleased to live there, hence people rely mostly on indigenous knowledge systems. These areas have a history of tsetse flies causing sleeping sickness and nagana in livestock. The white settlers also avoided these places because of harsh climatic conditions and much of the areas were set aside as game reserves. Sengwa constituency shares its boundary with Chirisa Game Reserve, an area with poor climatic and agricultural ability.

The phenological indicators can be summarised in the following categories notably: meteorological; biological; incidences of pests and diseases hydrological parameters to determine the coming season. Rural farmers are most concerned about the amount of rainfall to be received, whether above or below average so that they can prepare accordingly by identifying what crop varieties to be grown for that season. In the same context, the use of natural phenology such as animal strange behaviour, and atmospheric indicators have currently changed in such a

way that it is no longer reliable and is misleading the small-scale farmers (Jiri *et al*., 2016). Table 4.2 shows the phenological indicators of indigenous knowledge.

Table 4.2: Phenological indicators of indigenous knowledge

Indicator	Significance/ Quality of season
Phenology	
Plant Phenology	
New foliage of peach and apricot tree flowers, budding of acacia species	Summer season approaching
Plant characteristics: sprouting *Aloe ferox*. Growth of new leaves	Poor rainfall patterns
Mango tree (Mangifera indica)	Below-normal rainfall and drought is looming
Trees break dormancy	Good rainfall figures
Water berry *mukute* significant flowering	Beginning of the rainy season
Animal Phenology	
Red ants, ant hills increasing, moist anthills (October-November)	Signifies normal rains expected
Birds and insects	
Flying sparrows	Rain is imminent and farmers should prepare
(Psalidoprocne pristoptera) preceding dark clouds	More than average rains expected
Certain birds' species in the area e.g.: Qualia White Stock (*Mashohori)* Butterflies (*Zvipembenene*) Crying Cuckoo Haya and Dendera	Imminent rainfall and above rainfall expected Heavy rains Approaching rain season Rainfall is imminent with thunder and lightning in a week
Many termites in the area	Imminent and above-average rainfall expected
Croaking frogs at night	The onset of the rainy season
Squeaking rabbits	Rainfall expected soon
Cicadas, day flying chafer (*Nyenze and mandere* respectively) Dragonflies	Normal to above rainfall Signifies imminent rainfall
Presence of millipedes, spiders, etc	Imminent rain
Atmospheric phenology	
Moon phases e.g., Crescent horns facing upwards	Means upholding water and facing downwards means rainfall is to be received in two days
Constellation of star	Rainfall in three to 7 days period
Circular moon halo	Above-average rainfall accompanied by diseases
Whirlwinds in August	Rainfall is imminent and in abundance
Northerly wind becoming south-easterly	Rainfall expected in weeks
Prevailing easterly wind	Drought is expected

Cold westerly wing	Dry or little rain
Circular ring around the sun or moon (*Dzivaremvura*)	Heavy rainfall is expected
Southerly wind in summer	Drought is expected
Mist and fog in the morning	Dry conditions
Red nimbus clouds in the morning	Imminent rainfall
Heatwaves or high temperature	Above-average rainfall is expected.

***Source*:** Vijfhuizen, (1997) (modified); Mugabe *et al*., (2010); Risiro *et al*., (2012); Shoko and Shoko., (2013); Mapfumo *et al*., (2015), Jiri *et al*., (2016).

The Early warning systems (EWS) are a form of anticipated adaptation whereby timely information is disseminated to small-scale farmers so that they can prepare for the climate hazard (UNISDR, 2009). The effectiveness of the early warning systems is measured by the interaction of four characteristics which are risk knowledge, monitoring, and warning services, dissemination, and communication, as well as response capability of the victims of climate variability. Each of the four elements must be effectively implemented to make the EWS successful. In the Gokwe South district, early warning systems (EWS) are a source of climate information. On 12/05/2021 one female respondent in her 70s from Gokwe Constituency reported:

> "If we see *Madambiramurove* (migratory birds) hovering in the sky around our area, it signifies that rainfall is imminent and in abundance. This is one of our early warning systems for the past years."

The vulnerability of each constituency in the study area was analysed to determine its vulnerability score. From the analysis of the questionnaire and interviews, the above results were obtained for the constituencies in the Gokwe South district. On average, the whole district is considered vulnerable due to poor asset endowment.

Vulnerability is an outcome of the interaction of three variables, and these are sensitivity, adaptive capacity, and exposure. Survey results showed that the ability to adjust to the impacts of climate variability depends on the availability of assets by each household. Access to climate information, institutional support and the ability to innovate to adapt to changing climates and manage shock are very important parameters to achieve adaptive capacity and resilience. Repeated climate-related shocks led to children leaving school, depletion of household assets,

malnutrition, and poor human health in the district. Figure 4.2 shows a graph of adaptation strategies in the Gokwe South district.

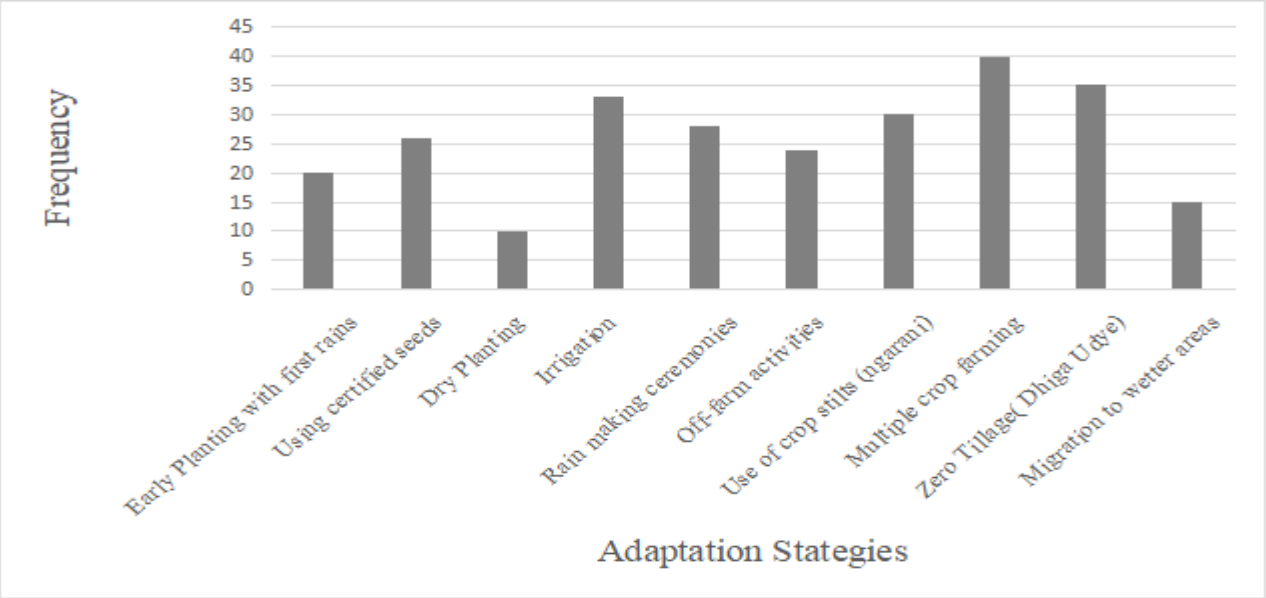


Figure 4.2: Adaptation strategies in the Gokwe South district

Source: Author's field results (2020).

Small-scale farmers also diversified production towards climate-proof agriculture and small grain crop varieties, practising irrigation in resettlement areas and along stream banks, outward migration in search of employment, selling livestock to buy food, and reducing exposure, among several adaptive strategies. Short term-maize varieties are drought tolerant and can do well in the short rainy season.

Multiple crop farming emerged as the dominant adaptation strategy used in the Gokwe South district. One strategy used to reduce vulnerability is diversification of their agricultural activities to achieve food security. Irrigation and zero tillage (*Dhiga Udye*) were also popular adaptation strategies that the respondents alluded to as the option to achieve sustainable adaptation in the district. The use of crop stilts (*Dara*), rain-making ceremonies, and planting of certified seeds were considered as ways to adapt to climate variability in Gokwe South as shown in Figure 4.2. Dry planting known as *kuparira*, in vernacular was the least preferred method, with a frequency value of 10. In dry planting, the poor small-scale farmers plant their crops before the rains and once early rainfall is received, seeds will automatically germinate (Chanza, 2014).

Table 4.3: Perceptions of climate change and variability over the past 30 years

Perception	Grand total	Gokwe Centre	Mapfung abutsi	Sengwa	Sesame	Kana	Total score	%
Sampled Respondents	225	42	45	45	48	45	225	100
Knowledge of climate change and variability	225	39	40	41	44	38	202	89.77
Decreasing amount of rainfall	225	41	44	43	47	43	218	96.8
An increasing amount of rainfall	225	1	1	2	1	2	7	3.11
Rainfall fluctuating	225	33	20	30	38	35	156	69.33
The shift in the rainfall onset	225	39	41	30	40	42	192	85.33
Rainfall starts later than usual	225	40	39	45	41	36	201	89.33
Rainfall starts earlier than usual	225	2	6	0	7	9	28	12.44
Temperature has increased	225	41	37	40	42	40	200	88.88
Temperature has decreased	225	1	8	5	3	5	22	9.77
Temperature fluctuating	225	30	33	29	20	30	142	63.11
Drought events	225	39	40	41	44	38	202	89.77
Flood events	225	10	8	8	11	9	46	20.44
Pests and crop diseases increased	225	40	42	35	28	20	165	73.33
Livestock diseases increased	225	34	29	20	17	19	119	52.88
Food production decreased	225	36	38	40	29	41	184	81.77

***Source*:** Authors' field results (2020).

The study found that most farmers experienced climate variations over the past few decades. Various adaptation strategies noted include diversification, irrigation, diversifying agricultural activities, drought-resistant varieties, changing planting dates, and off-planting season activities such as gold panning. The small-scale communal areas in Gokwe South are suffering from the impacts of climate variability.

An increase in temperature as shown in (Table 4.4) was also accompanied by an increase in the prevalence of pests and other diseases. In addition, an increase in temperature in Gokwe resulted in livestock disease which normally thrive in warm conditions prevailing in Gokwe. The proliferation of livestock diseases and invasive species such as the *Lantana Camara and Prosopis Juliflora* creates an impenetrable thicket that takes over pasture and farmlands. Such diseases and weeds reduce the asset adaptation of small-scale farmers in Gokwe, leaving many of them in an asset vulnerable state. Table 4.4 shows the types of insects and diseases observed commonly in the Gokwe South district.

Table 4.4: Types of insects and diseases observed (N=225)

Pests and diseases	Frequency	Percentage (%)
Maize Spider Mites (*Tetranychus urticae*.)	24	10.67
Maize Stalk Borer (*Busseola fusca*)	13	5.7
Aphids (Aphis spp Myzus spp)	29	12.89
Grasshopper (*Caelifera*)	14	6.22
African Bollworm (Hellicoverpa armigera)	41	18.22
Army worm (Spodoptera frugiperda)	23	10.22
Cutworm (Agrotis spp)	25	11.11
Grain weevil	31	13.78
Caterpillars	25	11.11

Source: Author's field results (2020).

According to the respondents the African bollworm is the most common type of worm destroying the crops in Gokwe South. Aphids are also a source of problems in Gokwe South as shown in Table 4.17. On 12/10/2020, one elderly farmer from Kana Constituency who is in his early 70s stated:

> "We used to receive abundant rainfall in time, and we were able to produce enough food for our families and sell our agricultural surplus to get money to pay our fees. From around 2000 there has been a notable change in the onset of rainfall and the total amount of rainfall has greatly reduced. Many of our children are out of school due to no-fee payments, resulting in early pregnancies. The seasons have shifted, and we are not sure when we are going to receive rainfall. We hope God and the ancestral spirits will be merciful this year."

4.5 Asset Portfolios vis-à-vis climate variability in the Gokwe South district

The higher the score value, the greater the adaptability of the respective constituency. Sengwa is the most vulnerable constituency, with a vulnerable index of 1.2. Gokwe Centre is slightly above average with a vulnerability score of 3.4. The nature of physical assets is quite deplorable in the Gokwe South district with an average score per asset of 2 out of the possible 5. The whole district is characterised by poor infrastructural development. Several study respondents indicated that they rely on natural assets which are not bought, hence it has a score value of 2.4 for all constituencies. Table 4.5 shows assets' availability versus assets' vulnerability.

Table 4.5: Assets availability versus assets vulnerability

Constituency	Pentagon of assets					Average score per constituency
	Financial	Human	Social	Physical	Natural	
Gokwe Centre	3	3	4	4	3	3.4
Mapfungautsi	1	2	2	1	1	1.4
Sengwa	1	1	1	1	2	1.2
Sesame	1	3	2	2	3	2.2
Kana	2	1	2	2	3	2.0
Average score per asset	1.6	2	2.2	2	2.4	2.04

1-Highly vulnerable; 2-Vulnerable; 3-Average vulnerability; 4-Adapted; 5-strongly adapted

***Source*:** Authors' field results (2020).

In the Gokwe Centre constituency, the average score of the whole district is 2.4, which means the whole Gokwe district is vulnerable to climate variability. The Gokwe Centre constituency has a score of 3.4 asset adaptability compared to the other four constituencies. Results from the survey have shown that Gokwe Centre has better asset adaptability compared to all other constituencies. Their physical assets are better off than those of other constituencies. Electricity, roads, radio and television reception and labour assets are much better because of its proximity to the town centre. Sengwa constituency has the least adaptation score of 1.2, which means the constituency is highly vulnerable to climate variability. Sengwa is the worst affected constituency with high asset vulnerability and the lowest scores for all assets. For Sengwa, four

of its five assets recorded a score of 0.5 and these are financial, social, human, and physical. Only natural assets recorded a score value of 1.5. The main business centre is Sengwa Bridge which is now a ghost business centre. Some residents find employment at Sengwa Mine. For the Sengwa constituency, it was clear that communal farmers relied more on natural assets more than the other four assets. Mapfungabutsi has also shown that it is also highly asset vulnerable with a score of 1.4. Kana had a vulnerability score of 2.0 which was below average and therefore it is highly vulnerable compared to some constituencies. Kana has a fair score for asset adaptability. However, its highest score is on natural assets with a value of 2.5. Results in Kana where high cases of AIDS/HIV were reported have shown that the human asset is a challenge. Sesame had an asset vulnerability score of 2.2 which is below the average of 3 in terms of the Likert scale shown above. Sesame is the second constituency in terms of asset adaptation since it is close to Gokwe town where small-scale farmers can get access to most of the inputs. Mapfungabutsi has shown a high degree of asset vulnerability due to its weak asset adaptability. Mapfungabutsi has one of the weakest with a score of 0.5 on financial, physical and natural assets. Assessment of household assets in Gokwe South to vulnerability to climate variability is reflected in Table 4.5 shown.

Table 4.6: Weighting system of assets in the Gokwe South district

Assets	Indicator	Frequency	Relative Value	Weights of indicators %	Rank	Components weighted %
Social Assets	Accessibility to information	18	8.26	8.00	5	28
	Membership in any social grouping	32	14.68	15.00	2	
	Availability of any extension	10	4.59	5.00	8	
Financial Assets	Farmers receiving remittances	20	9.17	9.00	2	39
	Ownership of	30	13.76	14.00	3	

	livestock					
	Access to the credit facility	34	15.60	16:00	1	
Human Assets	Educational level	12	5.50	6.00	7	10
	The health of the household	9	4.13	4.00	9	
Physical Assets	Access to irrigation facilities	25	11.47	11.00	4	13
	Ownership of radio, television, mobile phones	5	2.29	2.00	11	
Natural Assets	Land tenure system	14	6.42	6:00	6	10
	Size of farm holding	9	4.13	4:00	9	
	Total	218 (Including informants and experts)	100	100		100
NN = 200 households, [a]10 Key informants, [b]5 Extension Officers and [c]3 Experts						

[a] Key informants such as chiefs, assemblymen, village teachers, and youth leaders who are decision-makers in these communities.

[b] Government workers who advise small-scale farmers in rural areas

[c] Experts which included lecturers, and specialists in climate studies included academicians and other professionals in NGOs who have specialist knowledge in climate variability.

Source: Author's field results (2020).

Table 4.7 shows the asset vulnerability of Gokwe South constituencies.

Table 4.7: Asset vulnerability of constituencies

Assets	Gokwe Central	Mapfungabutsi	Sengwa	Sesame	Kana	Average Score of Vulnerability
Financial Assets	5	1	1	4	3	2.8
Human Assets	4	3	3	3	4	3.4
Social Assets	4	4	3	3	3	3.4
Physical Assets	4	2	2	4	3	3.2
Natural Assets	3	2	2	3	3	2.6
Average Adaptability	4	2.4	2.2	3.4	3.2	3.04

Source: Author's field results (2020).

Financial assets are resources that involve money that small-scale farmers receive from the bank, money lenders, and remittances from relatives to buy other assets and inputs to enable climate adaptation strategies. Credit facilities are hardly accessible for small-scale farmers. Financial insurance for their agricultural products is not affordable for small-scale farmers. Borrowing loans from financial institutions proved difficult due to a lack of collateral securities. There are several banks in Gokwe town such as Commercial Bank of Zimbabwe (CBZ), Stanbic Bank, First Capital Bank, and Central African Building Society (CABS). These banks at times give banks loans to small-scale farmers.

Physical assets include infrastructural developments and physical resources that are accessible to the farmer to carried productive farming activities. Availability and accessibility of physical assets give a competitive advantage in the implementation of climate adaptation strategies and reduce the level of vulnerability amongst small-scale farmers. Scotch carts, mouldboard ploughs harrows, planters, and livestock which are used as draught power, are indispensable to the successful adaptation of small-scale farmers' livelihoods. The recurrence of droughts and floods stifle efforts of the small-scale farmers to achieve food security in the Gokwe South district. The nature of roads to and from the market help to facilitate carrying of products to, and inputs from the market. Irrigation equipment allows the farmer to diversify agricultural activities and grow crops throughout the year. Earth dams, boreholes, and perennial rivers are the major sources of

water used for irrigation. Communication channels such as radios, television, and cell phones assist the farmers in getting climate information from the experts. Storage facilities are also a challenge in the district.

Human assets are at the centre stage of climate adaptation strategies because if all other assets are used correctly, the level of vulnerability will worsen. Human assets can control all other assets and make sure that they are efficiently and appropriately used to improve adaptive capacity. The level of education, age, sex, and health status all contribute to the unsustainable implementation of climate adaptation strategies. All other resources might be available but if they are not correctly mixed, the vulnerability will not be reduced. Sickness and disability in the household stifle efforts to achieve climate variability adaptation. The number of labourers also makes work lighter for the family. Genders are highly respected in the Gokwe South district. The scientific method of agriculture also depends on the level of education.

Social assets refer to community associations and bonds created among people to enhance climate adaptation strategies among small-scale farmers. The social groupings give rise to shared visions, labour costs, and experiences in the constituency. Membership in clubs and churches are some of the societal groups that enhance climate adaptation strategies. Social groupings assist in collective support by members of the group to households and individuals. Social capital has been observed to play a significant role in the climate adaptation strategies in the Gokwe South district. Relatives, social networking and traditional chiefs, the size of the labour force in the family, all play pivotal roles on the climate change adaptation strategies in the district. Social assets are intangible assets that are normally taken into consideration, yet they play a very significant role in climate adaptation (Moser *et al.*, 2010).

Natural assets are resources with natural existence such as water, pastures for livestock, and forests. The natural assets can be converted into other assets or sold to improve financial assets. The quality of the land and its fertility is paramount to the success of adaptation to climate variability. If the soil is infertile, their harvest will be poor, thus further exposing the small-scale farmers. Financial assets can also be used by natural assets. The quality of the rangeland is also important to sustain the livestock and livelihoods of small-scale farmers. Overgrazed forests expose livestock to starvation, which increases the small-scale farmers' vulnerability to climate variability. Figure 4.3 shows the pentagon of asset adaptability per constituency in the Gokwe South district.

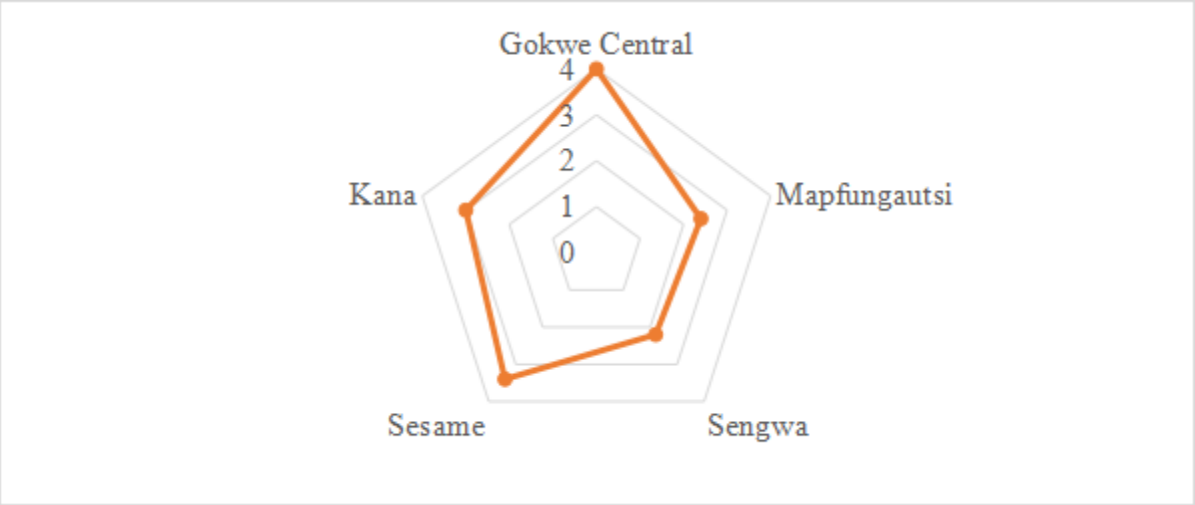


Figure 4.3: A pentagon of asset adaptability per constituency

***Source*:** Authors' field results (2020).

The assessment of asset vulnerability and adaptability was done in the five constituencies. Figure 4.3 shows that most of Gokwe South's small-scale farmers are prone to climate variability. Results shown in Figure 4.3 indicate that the lower the score value of the constituency means the higher the vulnerability of the constituency to climate change and variability. A higher score means better adaptability to climate change and variability. Figure 4.4 shows the overall asset adaptability for each constituency.

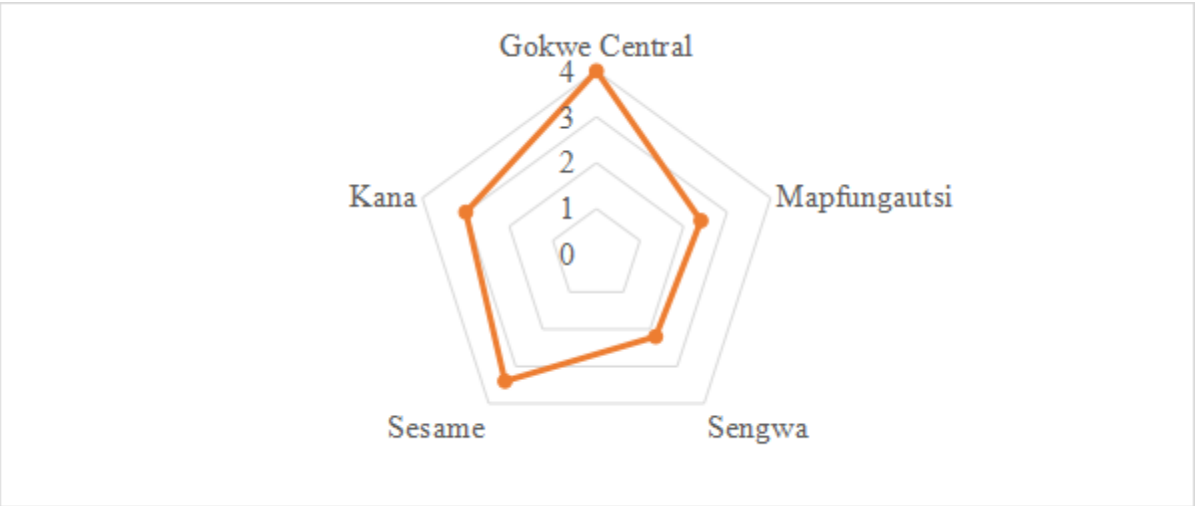


Figure 4.4: Overall asset adaptability for each constituency

***Source*:** Authors' field results (2020).

It emerged that physical assets and financial assets are the most important requirements for asset adaptation to be successful in the Gokwe South district. According to Figure 4.4, the larger the assets the better the adaptability. The overall perception of the respondents is that Gokwe South small-scale farmers have a vulnerability score value of 3.

4.6 Adaptive strategies implemented by small-scale farmers in the Gokwe South district

The participants were able to present their knowledge, perceptions even the understanding of climate change impacts in the Gokwe South district. Adaptation of farmers to climate variability was categorized into two aspects depending on the degree of the factors. The survey showed that erratic rainfall manifests in different ways that include late arrival of rains, heavy rainfall events, droughts during the rainy season, and early ending to the season. This has led to increasing uncertainty about the timing and number of rains, making it challenging for the communities to come up with acceptable planting activities. Erratic rainfall affects crop productivity, leading to shortages of staple foods such as maize and sorghum and feed for livestock. Sporadic rainfall also causes the wastage of labour and other inputs that were invested in planting crops. Climate variability resulted in many small-scale farmers being more vulnerable. Figure 4.5 below, shows the adaptation strategies against temperature variability in the Gokwe South district.

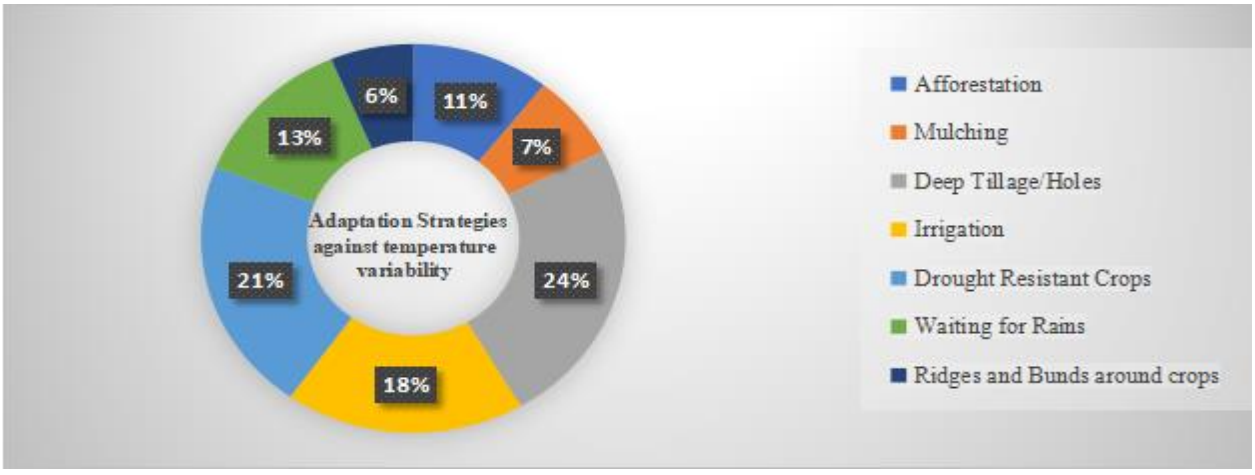


Figure 4.5*:* Adaptation strategies against temperature variability in the Gokwe South district (N=142)

***Source*:** Authors' construction (2020).

Many small-scale farmers in Gokwe South are not passive victims of climate change, particularly in temperature variations. Zero tillage *(Dhiga Udye*) was the most proposed

adaptation and adopted strategy with a percentage of 24% of the respondents supporting this adaptation. Currently, the government is encouraging this adaptation strategy which is called (*Dhiga Udye)* meaning dig and eat adaptation strategy. This adaptation strategy enables the soil to keep moisture which will enable them to do early planting. The use of drought-resistant crops with 21% of respondents recommending it, as particularly suitable for small grains was suggested to be an acceptable adaptation strategy in the district. Waiting for the rains was also preferred by 13% of the respondents as a viable adaptation strategy against temperature variability. The small grains and early maturing cultivars were the most recommended. Ridges and bunds around the crops were proposed by those who practice micro irrigation as an adaptation strategy. Afforestation and mulching were not popular as adaptation strategies in the Gokwe South district.

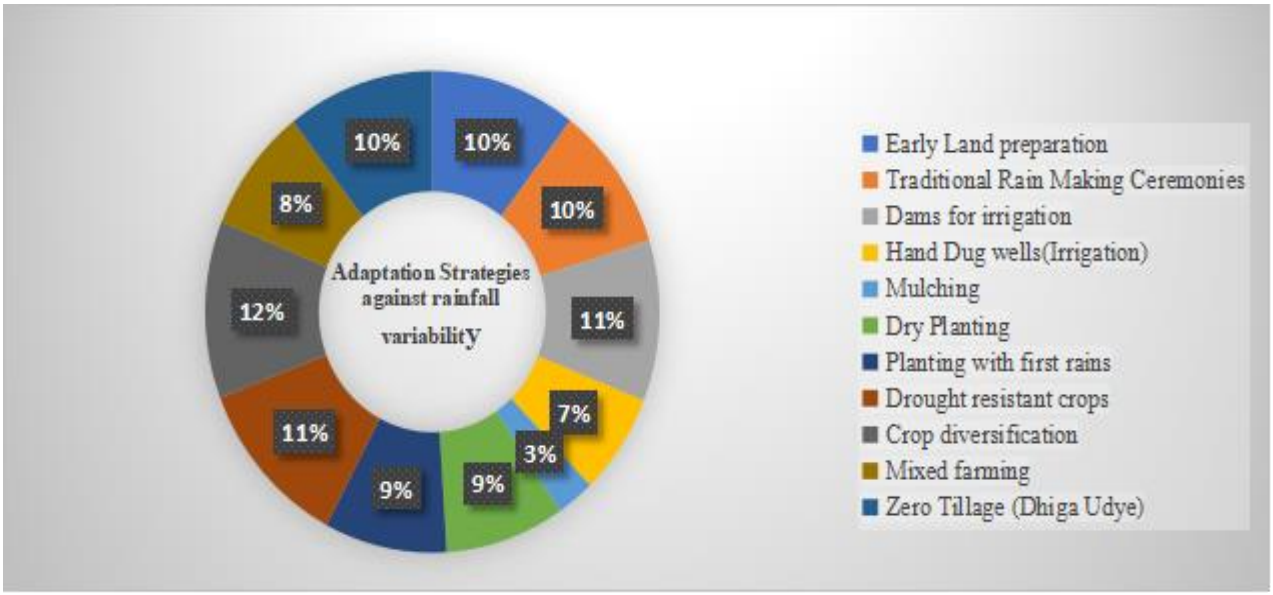


Figure 4.6 : Adaptation strategies against rainfall variability in the Gokwe South district (N =220)

***Source*:** Authors' construction (2020).

Twelve percent of the households believed that the best adaptive strategy was to grow drought-resistant crops The construction of earth dams for irrigation was also suggested to adapt to rainfall variability with a percentage contribution of 11% which is a significant proportion. Dry planting is becoming significantly important with a percentage of 10%. Zero tillage has been widely introduced by non-governmental organisations to conserve the soil (Table 2). Zero tillage is a common adaptative strategy in Gokwe and most of the Zimbabwean districts. In this regard,

some agricultural conservation strategies such as *Dhiga udye (Dig and eat)* have been regarded as an ideal adaptation strategy. Non-governmental organisations such as Care International, Red Cross, Christian Care, Oxfam, and Plan International are bringing various adaptation strategies to local small-scale farmers.

Many local small-scale farmers indicated that the government of Zimbabwe through the Ministry of Lands, Agriculture, Fisheries, Water, Climate and Rural Development through its various departments and Extension Officers introduced the *Pfumvudza* programme also known as the "*Zai Pits Technique*." In this programme, a 60cm - 90 cm deep hole is dug to catch moisture and manure before the rains. In the holes put organic and inorganic fertilizers. This *Pfumvudza* Programme (Shona*)* or in *Intwasa* in Ndebele, was introduced as a Climate Proofed Presidential Input Support Scheme to assist the poor small-scale farmers. This conservation agriculture was done as a pilot programme in the 2019-2021 agricultural season. This is a technique that originated in North Africa to reduce the effects of desertification. In Zimbabwe, the *Pfumvudza/Intwasa* Programme is a conservative agricultural programme aimed at improving agricultural production from minimum inputs. Figure 4.7 *Pfumvudza/Intwasa* Programme in Kana constituency.

Figure 4.7: *Pfumvudza/Intwasa* Programme in Kana Constituency

***Source*:** Authors' Field Photo in Charama (2019).

In some cases, irrigation can be done if small-scale farmers have the water to irrigate the plants. The Pfumvudza/Intwasa programme is a government effort to climate-proof crop production for vulnerable small-scale farmers in the Gokwe South district. The holes dug have the advantage that they will keep all the manure and water to be utilised by the plant grown in it. It is very economical and makes sure that the plant has all the nutrients and moisture required for it to grow well.

The lack of productive assets stifles successful adaptive strategies in the Gokwe South district. Inputs such as fertilisers, certified seeds, draught power, ox-drawn plough, and agrochemicals are not affordable to most of the small-scale farmers in the district resulting in persistent food insecurity. Figure 4.8 shows villagers receiving presidential inputs for farming.

Figure 4.8: Small-scale farmers getting inputs Nemangwe ward

Source: Authors' Field Photo (2019).

The inputs are transported to the Grain Marketing Board at Gokwe Centre and are then distributed to various constituencies and wards in time so that the small-scale farmers will be

ready for the first rains and planting begins. However, this Presidential Input Scheme was politicised and some of the inputs were sold instead of being given for free to poverty-stricken rural farmers. The communal small-scale irrigation schemes are essential in reducing the level of poverty in the Gokwe South district. At Gwehava, in the Gokwe Centre constituency, the local farmers grow vegetables, tomatoes, beans, and potatoes with the help of Agricultural extension officers who advise them with conservation agronomic practices. The water for irrigation is pumped by solar-powered boreholes in some cases, however, in most cases, irrigation is done using buckets. Each family is allocated a piece of land to grow crops of their choice. Gardens ensure food availability throughout the dry season. Some of the products like green mealies, potatoes, and beans are sold at Gokwe Centre to get money for their children's school fees and to buy other assets household assets. The adaptive initiative has proved helpful for small-scale farmers in many wards and villages.

Figure 4.9: Small-scale irrigation scheme at Gwehava (Gokwe Centre constituency)

***Source*:** Authors' Field Photo (2019).

The climate-proofed agriculture with the appropriate technology will enable the production of vegetables and other crops, thus improving their food security through improved adaptive capacity in the Gokwe South district at Gwehava in the Gokwe Centre constituency.

Cultivation of legumes was becoming a very popular adaptation strategy in the Gokwe South constituencies Mapfungabutsi, Sengwa, and Sesame areas. Results in Figure 4.6 indicated that 10.9% of the respondents think that crop diversification can minimize the risks of climate change. There was an indication that different crops require different amounts of rainfall. Mixed farming and mixed cropping were also adaptation strategies adopted by small-scale farmers in the Gokwe South district. Several small-scale farmers are engaged in various livelihood activities such as menial part-time jobs, petty trading, and commercial activities. The practice of *maricho* is another adaptation strategy in the rural areas of Gokwe. During the survey, typologies of rainfall in Gokwe were also discussed with the ward elders as shown in Table 4.8.

Table 4.8: Typologies of rainfall in the Gokwe South district

Rainfall name in vernacular language	Period	Description
Bumharutsa	October	Rains that clear the burnt stuff during field preparation
Mvumiramutondo	Mid-October	Which facilitates new foliage leaves
Gukurahundi	October/early November	Usually comes after the *bumharutsa* meaning to clear the burnt stuff.
Nhuruka	November	This signifies that small-scale farmers can start growing.
Gumbura	February	Destructive rains that destroy crops.
Bvunambuya	April	Drizzle coming at the end of the main rain season
Mavhurachando	May/June	Rains marking the beginning of the winter season

Source: Authors' field results (2020).

The *Bumharutsva* (Rains that clear the burnt stuff during field preparation), was believed to come later than usual as shown in the Table above, 89.33% said that rainfall comes later than usual. The *Gukurahundi* (Rain that clears the chuff) was believed even to come in late November which shows the variability of rainfall. The *Nhuruka* (Coming forth) signifies the onset of the planting season. According to the survey, this type of rainfall is now occurring even in December. In their calendar, the next type of rainfall was the *Gumbura* (Causing anger) also comes later to destroy the crops during harvest time. *Bvunambuya* (which rains on the elderly woman) This is a drizzle coming at the end of the rainy season. The last typology is the

*Mavhurachando "*which marks the opening of the winter season" research evidence showed that this type of rainfall may not occur at all which shows climate and variability. Rainfall in Zimbabwe now exhibits high variability across the country. However, according to some respondents, these common rain typologies are fast disappearing. On 23/03/2021, one male respondent in his 50s from the Sesame area said:

> *"Mhepo inobva nokumavirira ndiyo inounza mvura kuno"* (Wind coming from the West is the one bringing rainfall in our area). *Mhepo inobva nokuChamhembe kana Maodzanyemba haiwanzotipa mvura yakawanda kazhinji rinenge riri guti,* (He went on to say, the wind coming from the North or South does not bring enough rainfall and its normal drizzle)."

Through Focus Group Discussions, the researchers noted that communal farmers in the Gokwe South district had a farming calendar full of activities all year round as shown in Table 4.9. This is a shift in the timelines affected farming activities which are clear evidence of climate variability.

Table 4.9: Seasonal farming calendar of Gokwe South district

Farming Activity	30 years back	Current
Winter ploughing	June-September	July - October
Sowing Seeds	October - December	December - January
Weeding	November - December	January to March
Harvesting	March - May	April - June
Processing	May - July	June - August

***Source*:** Authors' field results (2020).

Climate changes have distorted the indigenous indicators to give accurate predictions over the past decades of years. Indigenous indicators, need to be supported by science to give accurate forecasts of climate variability in a district or country. On 20/04/21 one specialist respondent from the Climate Change Management Department in his late 50s said:

> "In recent decades, it's very difficult to have accurate rainfall forecasts and it is very unreliable. Rain-fed agriculture is at risk because rainfall is very erratic. Sometimes we receive above normal rains and some years we receive below normal rainfall."

Table 4.10: Respondents on weather and climate information

Variable	Categories	Percentages of the Respondents					
		Gokwe Centre n = 42 %	Mapfungabutsi n = 45 %	Sesame n = 48 %	Kana n= 45 %	Sengwa n = 45 %	Total Average = 225
Access to weather information	Yes	34	08	33	25	05	21
	No	66	92	67	75	95	79
Source of Information	Radio	20	38	25	20	36	27.8
	Television	12	5	8	6	4	7
	Cell phone	20	30	22	14	10	19.2
	Fellow Farmers	70	80	64	75	92	76.2
General Content	Poor	62	17	60	78	20	47.4
	Average	10	6	13	7	15	10.2
	Good	15	6	23	5	3	10.4
	NA	13	71	4	10	68	33.2
Delivery Channel	Poor	50	67	48	52	22	47.8
	Average	25	7	4	12	0	9.6
	Good	10	1	38	20	0	13.8
	NA	15	25	10	16	78	28.8
Time of delivery	Poor	39	50	40	44	56	45.8
	Average	9	8	38	16	4	15
	Good	43	2	18	20	2	17
	NA	9	40	4	20	38	22.2
Language used	Poor	40	62	40	48	20	42
	Average	14	12	15	7	1	9.8
	Good	30	10	36	38	3	23.4
	NA	16	12	9	7	76	24.2

***Source*:** Authors' field results (2020).

Climate and weather records were collected to assess if the small-scale farmers were receiving accurate and timely information. Figure 4.3 presented the results of participants on the variable of climate information in the Gokwe South district. For the five constituencies, the time of delivery of the information was presented, and the language used was also assessed as whether poor, average not applicable. It was also assessed to find out whether small-scale farmers had good access to climate information. Sources of information such as radio, television, or cell

phones and the general content were also verified to see how many of those facilities receive the weather information for the season. Table 4.11 shows the percentage distribution of farmers' perceptions of causes of climate variability.

Table 4.11: Percentage distribution of farmers' perception of causes of climate variability

Sex/Age	Human Activities	God's Punishment	Angry Ancestors	Other reasons
	Sex			
Male	54.4	40.6	3.8	1
Female	45.6	48.4	4.2	1.8
Age-group				
30-39	52.4	39.2	6.4	2
40-49	48.4	44.8	4.3	2.5
50-59	49	40.3	10.2	0.5
60+	30.8	40.3	26.1	2.8
Total	46.76	42.26	9.16	1.76

***Source*:** Authors' field results (2020).

According to the results shown in Table 4.11, most of the respondents (46.76%) believed that human activities were the major causes of climate variability. The interviewed respondents from Gokwe South had varied reasons for the causes of climate variability. These included human causes, God's punishment, angry ancestors, and other reasons. One respondent pointed out that modernisation and Christianity have negatively affected their allegiance to their *masvikiro* (spirit mediums). It was interesting to note that the elderly-aged group believed in the power of God's punishment. He went on to say some of the climate challenges they experience are a punishment from their ancestral spirits. The respondent in Mapfungabutsi said, *Vadzimu vakatsamwa* (Ancestors are angry), referring to the causes of drought and pestilence in the area.

Figure 4.10: Maize field affected by a dry spell in Mapfungabutsi constituency

***Source*:** Authors' field photo (2019).

Table 4.12 shows the types of crops grown in the Gokwe South district by the percentage of respondents (N=225 respondents**)**

Table 4.12: Types of crops grown in Gokwe South district by the percentage of respondents (N=225 respondents)

	Percentage of the respondents									
	Gokwe Centre		Mapfungabutsi		Sesame		Kana		Sengwa	
Type of crops grown	n=42	%	n=45	%	n=48	%	n=45	%	n=45	%
Maize	42	100	45	100	48	100	45	100	45	100
Cotton	20	47.6	35	77.8	33	68.8	38	84.4	40	88.9
Sorghum	22	52.4	30	66.7	30	62.5	28	62.2	39	86.7
Sunflower	15	35.7	17	37.8	19	39.6	15	33.3	19	42.2
Groundnuts	40	95.2	39	86.7	37	77.1	40	88.9	40	88.9
Cowpeas	19	45.2	30	66.7	30	62.5	35	77.8	39	86.7
Sweet potatoes	20	47.6	15	33.3	16	33.3	13	28.9	12	26.7
Sugarcane	10	23.8	9	20	15	31.3	13	28.9	20	44.4

Banana	15	35.7	8	17.8	20	41.7	18	40	19	42.2
Cassava	8	19.0	4	8.9	3	6.3	4	8,9	5	11.1
Beans	10	23.8	9	20	11	22.9	10	22.2	6	13.3
Watermelons	12	28.6	18	40	10	20.8	13	28.9	12	26.7

***Source*:** Authors' field results (2020).

The staple crop for Zimbabwe is maize. Results of the survey in Gokwe South show that all constituencies grow maize (100%) as evidenced in Table 4.10. Due to the lack of proper storage facilities for the harvested maize, and other crops, the small-scale farmers improvised the traditional maize storage structure called (*Dura)* to store their maize. This is a traditional method to preserve their maize which may not require any chemicals. Given the above observation, small-scale farmers can modify their assets to improve their adaptive capacity against the challenges of climate change Figure 4.11 shows the traditional maize storage (*Dara*).

Figure 4.11: Traditional maize storage (*Dara*)

***Source*:** Authors' field photo (2020).

The small-scale farmers have their traditional way of storing agricultural harvests (Chanza, 2014). However, with time, their traditional granaries were no longer reliable to keep their

produce. The traditional maize storage is built on stilts some metres above the ground to avoid the maize being destroyed by rains. Traditional granaries are plastered with a cow-dung lining, before being filled with the grain (Chirimuuta & Mapolisa, 2011). Traditional granaries show indigenous knowledge to control pests, rodents, and moisture which destroy the harvested food crops.

According to the community members, floods have been damaging settlements along main rivers such as Sengwa, Lutope, Sesame, Svisvi, Manyoni, and Sengwa. They also impact crop production, inundating crops, damaging cultivated land, and causing the siltation of fields. The major impact of flooding is damage to infrastructures such as roads and irrigation canals, causing interruptions in transportation and reducing the effectiveness of irrigation systems. Stream bank cultivation is also very common in the district. Farmers in rural areas have adjusted to climate change by making small vegetable gardens near rivers and wetlands. They grow vegetables which they will sell along highways. One of the female vegetable vendors in her 40s interviewed on 22/05/2021 at Bomba said:

> "There is a lot of money here at Bomba if you have the stuff to sell' 'One can sell things worth US$40 per day. *Tinobhadharira vana vedu mafees nemari yokutengesa zvirimwa nemichero*," (We can pay school fees through crop and fruit vending).

Bomba is a bus-stop on the highway in chief Njelele's area where household members sell vegetables, fruits (domestic and wild), green mealies, sweet potatoes, and milk from livestock.

4.6.1 Chief's Granary (*Zunde raMambo*)

There are traditional ways practised by locals as safety nets to reduce vulnerability due to climate variability. The Zimbabwean concept of (*Zunde raMambo)* is taken to mean a field owned by the chief. It is set aside, used for growing crops to be given to vulnerable families during famine. The word "*Zunde"* is a vernacular concept referring to gathering for common labour refer to produce granary reserves kept by the headman or the chief so that he can give his people during the time of famine. Gukurume, (2014) and Mutasa, (2011) postulate that Zunde raMambo is used to feed the chief' guests. The *Zunde raMambo* also ensures that the agricultural calendar is strictly followed. The prominent chiefs in Gokwe South are: Njelele, Mukoka, Sai, and Nemangwe and these are also regarded as the custodians of IKs and responsible for passing it on to the next generations. They also coordinate the *Zunde raMambo*. The *Zunde raMambo*

encourages social cohesion and enhances their social assets in Gokwe South and this allows communities to withstand the effects of famine. This was an adaptive mechanism to cushion many families who would have failed to harvest enough for the family. The significance of *Zunde raMambo* is to enable that the chief ensures that all households in his jurisdiction indigenous have food to sustain their families.

4.6.2. Complementing labour shortage through free communal common labour (*Nhimbe*)

The households also have a social support system whereby individuals and households that find themselves in crisis are supported by other community groups with food, loans, and the re-stocking of their herds. The households also assist each other when work per household is overwhelming. Free communal common labour effort in villages called "*Nhimbe"*, was a common phenomenon in most of the constituencies. This was found to be a very strong social adaptive asset for most of the households surveyed. The concept of *Nhimbe* was mentioned in many constituencies. Household members assist each other in jobs like ploughing, weeding, harvesting, particularly cotton picking. The concept of *Nhimbe* was quite popular in Gokwe Mapfungabutsi, Sengwa, and Kana. The *Nhimbe* social net assisted deficiencies in social and human assets.

4.6.3 Rain-making ceremonies (*Mukwerera*)

The traditional rain-making ceremony called *Mukwerera* was meant to invoke the spirit mediums called Mhondoro to bring rainfall when it delays according to their traditional calendar. The chiefs and elders concurred that rain making (*mukwerera*) was one adaptive mechanism that was inherited from their ancestors since time immemorial. The rain-making ceremony is done to cause rainfall to fall at the appropriate time. The delay of rainfall or failure of rainfall was attributed to reasons like taboos committed in the area like incest *(chemina*), breaking traditional taboos, indecent burial for the victims of murder, working on sacred days in the region, (Thursday – *China*) (a day set aside for rest), abortions, desecrating sacred sanctuaries or hills (*kupunjira)*. Households contribute approximately a bucket of finger millet or sorghum (*zviyo or mumera*) which is used to brew traditional beer. The traditional beer is brewed and the *svikiro/ manyusa* / (spirit mediums) manages the brewing of the beer. The traditional beer for this ceremony is brewed by old women in the non-bearing child age group. Thus, the rain-making

ceremony, *mukwerera/umtolo* in Ndebele, has been practised before or at the onset of every rainy season so that communities have abundant rains and harvests. There is a belief that the land should be cleansed of any wrong things that have been committed by the people of the area. After petitioning God via the ancestors for rain and returning from the mountain, the *svikiro* (spirit medium) oversees the whole ceremony. Table 4.13 shows adaptation through traditional and communal practices.

Table 4.13: Adaptation strategies through traditional and communal practices

Traditional and Communal Practices	Constituencies					Average Score
	Gokwe Central n=52	Kana n=50	Sesame n=51	Mapfungabutsi n=50	Sengwa n=52	N= 255
Chief's Granary *Zunde raMambo*	10	10	9	18	18	25.49%
Rainmaking Ceremonies *Mukwerera*	8	10	10	12	10	19.60%
Free Communal Common Labour Effort *Nhimbe*	14	15	13	12	15	27.05%
Piece Work *Maricho*	20	15	19	8	9	27.84%

***Source*:** Authors' field results (2020).

4.6.4 Cash crop production in the Gokwe South district (cotton)

Cotton is a cash crop that generates a lot of money for the small-scale farmers in the Gokwe South district. Cotton growing in Gokwe was also facilitated by contract farming as discussed in Chapter 6. Sorghum is also popularly grown in the district since it is drought resistant crop. Cassava, bananas, and sugar cane are grown in the flood plain of rivers in Gokwe where they can access a lot of water for irrigation. The results of the survey in all five constituencies indicated that they grow cotton for cash purposes which will enable them to buy other inputs. Cotton (cash crop) is very cost intensive for rural farmers to grow because they do not have the agrochemical to successfully grow it. Because of this some small-scale farmers preferred contract farming (CF) in which most of the inputs are supplied by the contractor on a loan basis and in turn the

farmer will sell the output to the contractor. The inception of contracting farmers in Gokwe South, allowed many local and foreign companies to invest in the cotton business. Figure 4.12: shows the picking and packing of cotton in bales.

Figure 4.12: Picking and packing cotton in bales

***Source*:** Authors' field photo (2020).

Contract farming is common in Gokwe South where the farmer and the company enter into an agreement in which case the company supplies the inputs, and the farmer does the processes. After harvest, the company buys the cotton and deducts the costs of inputs they loaned to the farmers during the growing season. Figure 4.13 shows a small-scale farmer transporting his cotton bales to a market at Cotton Marketing Depot in ward Nemangwe.

Figure 4.13: Cotton bales transported to the market

***Source*:** Authors' field photo (2020).

Without the cattle and other assets like scotch carts, it was difficult to transport the cotton bales to the Cotton Marketing Board. The picture (Figure 4.13) shows a small-scale farmer transporting cotton bales to the marketing board. Cotton bales are weighed and graded according to quality and then the price is determined per kilogramme. The average weight of each bale is 200kg.

Figure 4.14: Cotton bales at the Cotton Marketing Board (CMB) at Nemangwe Depot

Source: Authors' field photo (2020).

The cotton company of Zimbabwe (COTTCO) is one of the main cotton buyers in Gokwe South at Nemangwe where there is a depot. Cotton bales are stockpiled (Figure 4.14) at Nemangwe before they are transported to the newly opened cotton ginnery in Gokwe town and Sanyati. The Cotton Company of Zimbabwe also practices contract farming for the local cotton growers, leaving the farmers with extraordinarily little or no option to sell their cotton to other competing cotton buyers.

4.6.5 Livestock assets

Livestock plays a pivotal role in the adaptation of communal farmers in Gokwe South. Cattle are an important asset in communal farming and are used for various purposes like milk provision, as draught power, and provision of organic manure, meat, and hides as terminal products. Selling cattle can generate more financial assets. Table 4.1 shows that cattle command the second highest percentage of 84.4% because of their multi-purpose in communal areas. In the Shona culture cattle, play an important role in socio-cultural values, including bride price (*lobola*) payments and as draught power. Small-scale farmers can also exchange their cattle or loan to neighbours to enhance kinship ties. Most of the respondents (96%) keep poultry in the Gokwe South district. Many respondents also keep goats as indicated by 79.6 % in Table 4.11.

Table 4.14: Distribution of livestock by constituency per household

Type of livestock	Constituencies in Gokwe South					Frequency	Percentage of household
	Gokwe Centre	Mapfungabutsi	Sesame	Kana	Sengwa		
Cattle	40	42	41	39	28	190	84.4
Donkeys	20	28	29	18	10	105	46.7
Goats	40	38	33	30	38	179	79.6
Sheep	15	18	22	15	10	80	35.6
Pigs	9	5	3	8	3	28	12.4
Poultry	41	43	45	44	35	208	96.9
Total	165	174	173	154	124	179	79.6

***Source*:** Authors' field results (2020).

Livestock provides many products required by the family for livelihood in households. It is a source of barter and cash. During transect walks, lantana camara was common in Mapfungabutsi, Sengwa, and Kana. Livestock also suffers the effects of droughts and erratic rainfall due to difficulties in accessing water and fodder, leading to poor animal health, weight loss, and sometimes death. Floods cause injury or death of animals, particularly poultry and inhibit access to fodder. Livestock dung was highly mentioned in terms of its significance as the source of manure, income after selling, and floor polish for traditional rural houses. The small-scale farmers reported various livestock diseases in the Gokwe South district such as blackleg, anthrax, and skin diseases. Drugs to treat livestock are so expensive that many farmers cannot afford them. Several small-scale farmers keep donkeys because they are drought-resistant animals. Many farmers have increased goat keeping since they noted the risks associated with hedging on cattle which succumb to drought more in comparison to goats and poultry. Figure 4.15 shows income from livestock.

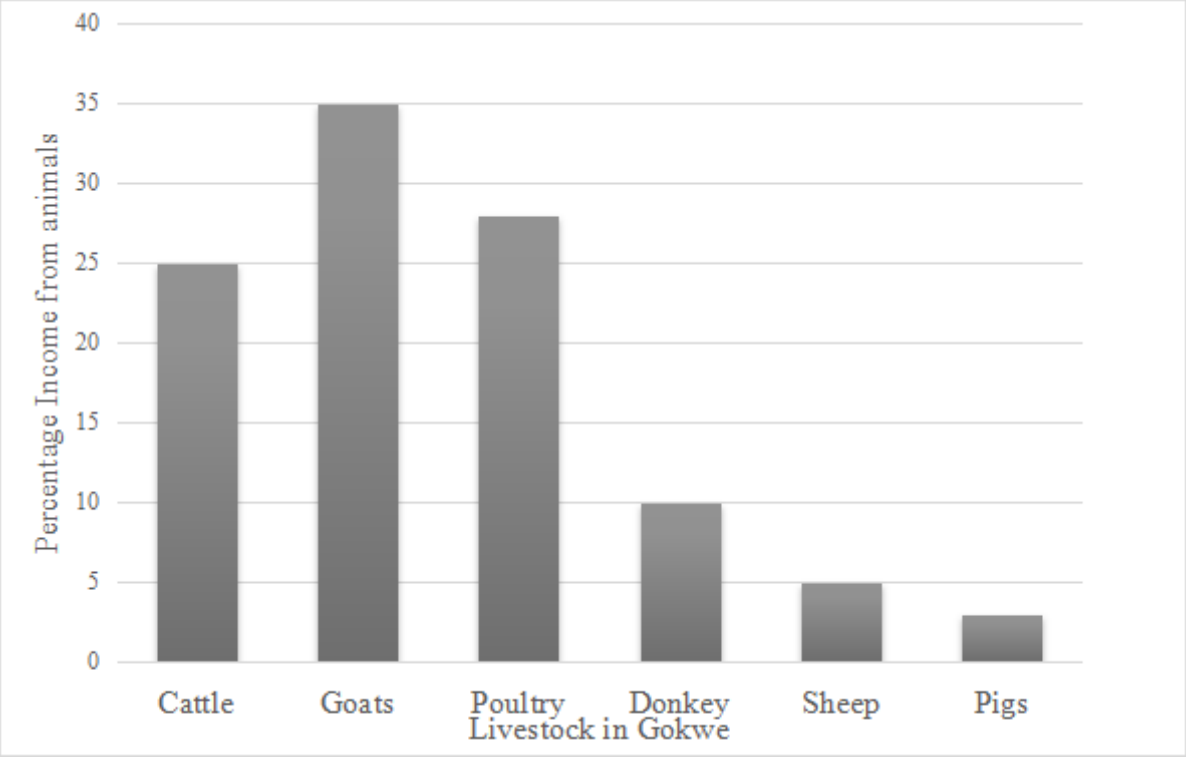


Figure 4.15: Financial income from livestock

***Source*:** Authors' field results (2020).

In Gokwe South, as shown in Figure 4.15, goats are the highest source of income. Goats are quick to sell, unlike other livestock. Most small-scale farmers rear goats because they quickly raise money for school fees, and they breed quickly. This brings the concept of asset adaptation to small-scale farmers in the Gokwe South district. The more livestock they have, the less the vulnerability to climate variability. On 20/08/2020 one male respondent in his 70s in Kana Constituency said:

> "…. *Mbudzi ne huku zvinokurumidza kutengwa kana uchida kuwana mari pane kutengesa nómbe"* (Goats and chicken can be quickly bought if you want to get quick cash than selling cattle).

Farmers keep cattle for draught power, milk, and manure unlike goats and other small livestock which can be quickly sold for cash. Cattle are rarely slaughtered or sold because they are the main source of draught power in the district. Survey results also showed that very few people can buy cattle in communal areas. However, cattle are used in marriage ceremonies for paying the

bride price (*lobola)*. Figure 4.16 shows a picture of livestock fodder (*Mutanhu*) where livestock fodder is kept for feeding during the winter season when the grass is dry.

Figure 4.16: Picture of livestock fodder (*Mutanhu*)

***Source*:** Authors' field photo (2020).

Livestock is an important physical asset in communal livelihood because they are multipurpose. Due to climate variability, small-scale farmers face dire challenges to feed their livestock due to frequent droughts and floods, hence during winter farmers keep fodder for their livestock. Small-scale farmers designed a fodder stalk (Fig. 4.16) to feed their livestock during the winter season. Maize, beans, groundnuts, sorghum, and finger millet (*rapoko*) stalks and remains are usually kept for feeding the animals during the dry winter season.

Table 4.15: Small-scale farmers perceived climatic indicators of changing seasonal patterns

Climate Variable	Observed Changes	Perceived impacts
Rainfall regimes	Low and erratic precipitation	Shortage of water: most of the water sources will be dry. Limited chances to prepare the fields during the winter season and labour is limited. Sporadic and unreliable rainfall patterns distorting the agricultural calendar. Delays in early planting. Food insecurity during the winter season. Food shortages, pastures will be dry resulting in the loss of livestock.
Wind direction	Changes in wind directions mean a lot to small-scale farmers	Indicates the amounts of rainfall and small-scale farmers start to prepare inputs. Off-farm activities, for instance, gold mining. Small-scale farmers buying food in the nearby constituencies and some practising food for work.
The onset of winter and summer temperatures	Fluctuating early summer temperatures or prolonged winter season	Delayed onset of rainfall and hunger is looming. Anti-social activities and drug abuse due to a lack of meaningful and productive occupation.
Atmospheric humidity	Very high humidity	Results in livestock and crop diseases and pests. Promotion of moulds and gnats Water will not evaporate Poor air circulation Enervating weather leads to weakness in the body leading to laziness.

Source: Authors' results (2020).

This information was collected from government officials, community leaders, and elders. The perceived impacts of changes in seasonal patterns were also noted. Some of the indicators were also observed during transect walks in the wards and villages. The village elders noted the change in the wind direction resulting in dry conditions in the area. Several dry rivers and gullies were observed during the transect walk. Most of such fields in Nemangwe are along the Sesame River and its tributaries such as Svisvi, Boyi, Kasuwe, Furidza, Kaverere, Tosvi, Sungwiza, Muzara, Tare, and Gwave rivers, among others. Table 4.16 shows the use and reliability of scientific and indigenous systems**.**

Table 4.16: Use and reliability systems of scientific and indigenous

Constituency	Scientific Knowledge (%)	Indigenous Knowledge (%)
Gokwe Centre	62	38
Mapfungabutsi	16	84
Sesame	53	47
Kana	42	58
Sengwa	22	78
Total Average for Gokwe South District	39	61

Source: Authors' field results (2020).

The respondents also compared the reliability of scientific knowledge and indigenous knowledge systems. Most (61%) of the respondents in Gokwe South indicated that they find IKs reliable. Research findings have shown that in New Zealand the majority of the Maori indigenous people still rely on indigenous knowledge due to their interaction with their natural environment (Faulkner & Becker, quoted in Hewitt , 2012). However, indigenous knowledge systems have their constraints as will be discussed in Chapter 6. Drawing from the results in Table 4.16 , there is a need to create a hybrid of knowledge integration between the IKs and the SKs. The knowledge integration can improve the small-scale farmer's adaptation process and efforts as alluded to in the preceding chapter. Table 4.17 shows a summary of limiting factors to climate change adaptation.

Table 4.17: A summary of limiting factors to climate change adaptation

Factor	Observed /Perceived	Likert Score value
Climate Variability	Erratic rainfall, decrease in rainfall, increase in temperature	5
Soil fertility	Crop failure, erosion, stunted growth, decreasing yields,	3
Pests and diseases	Cotton ball worms, whiteflies, grasshoppers. Aphids, livestock diseases	3
Destructive animals and birds	Stray animals, elephants from the Chirisa game reserve, wild pigs, baboons, and monkeys	3
Institutional Factors	Politicising inputs, weak social groups, top-down approach	4
Low financial capacity	Lack of collateral security to acquire loans Interest rates are too high Poor remittance inflow Cash crop (cotton) not well paying	5
Lack of inputs	Lack of agrochemicals Politicisation of inputs Delayed supply of improved seeds	5
Top-down approach	Small-scale farmers not involved in new programmes Lack of farmer training	4
Unreliable Climate information	Rainfall figures are not realistic Temperature figures are not reliable Some farmers are not getting weather information at all	5
Poor agronomic practices	Poor agricultural implements Zero tillage Draught power Lack of winter ploughing Old methods of farming	5
Lack of Climate	Some farmers are in the denial stage of climate change	5

adaptation knowledge	Lack of training on adaptation mechanisms Compromised adaptation mechanisms	
Weak social safety nets	Poor social groupings Traditional ceremonies disappearing Urbanisation (emigration of manpower)	3
Competing knowledge systems of indigenous and scientific knowledge systems	Lack of incorporation of modern and scientific knowledge systems Lack of weather stations Indigenous knowledge is a system readily available	5
Market failures	Products are being bought at low prices Markets are very far away from most farmers Transport challenges	5

***Source**:* Author's results (2020).

Strongly disagree=1; Disagree=2; Not sure=3; Agree=4; Strongly agree=5Strongly

***Source*:** Authors' field results (2020).

From the above summary of limiting factors, it can be noted that climate variability, low financial capacity, limited climate data, competing knowledge of indigenous and scientific systems, market failures, poor agricultural practices, and inadequate climate information are the major stifling factors affecting the ability of small-scale farmers to cope with climate change and variability. All the limits pointed out above can be summarised into asset limits. Table 4.17 summarises the limitations that the people of Gokwe are facing in various degrees of the Likert scale.

4.7 Government institutional and policy frameworks that exist in assisting small-scale farmers in building resilience against climate variability

4.7.1 The Vision of the Zimbabwe National Climate Change Strategy

The vision of the Zimbabwe National Climate Change Strategy is creating a climate-resilient country and climate proofed economy for all stakeholders in the country. This vision is to be

achieved through various objectives, such as promoting climate-proofed agriculture for farmers, effective climate information which is accessible to all stakeholders and stimulating further research in agricultural development to ensure food security in the country. Yet objective of the National Climate Change Strategy is to introduce climate change information in the education system. The climate variability in Zimbabwe also focuses on technology development transfer even to rural areas to improve their adaptive capacity. Another objective of the climate variability strategy is to improve research and development in the field of agriculture. Setting up appropriate institutions even in communal areas is also one of the thrusts of the government in order to capacitate farmers who rely on rain-fed agriculture. The government of Zimbabwe also considered climate change governance as one of its pillars to achieve climate variability adaptation through an effective institutional framework. Resource mobilisation and equitable distribution of inputs and climate information are some of the government's top priorities to achieve a climate-resilient nation. The National Climate Change strategy has also a guiding principle that proposes the incorporation of indigenous knowledge in the quest for climate change adaptation.

4.7.2 The Zimbabwe National Climate Policy

Zimbabwe ratified the UNFCCC protocol but there is a lack of implementation of the statutes for which it was formed. The Zimbabwe National Climate Policy complements regional and continental programs the Zimbabwean Vision 2030 and the African Union Agenda 2063 where the thrust is to reduce the impacts of climate variability and decrease the temperature by 2^0C and reduce the vulnerability of small-scale farmers. The Government of Zimbabwe crafted the strategy and policy documents to implement climate-proof agriculture in communal areas. The Zimbabwean government launched an economic blueprint, called Zimbabwe Agenda Sustainable Socio-Economic Transformation (ZIMASSET) which seeks to optimise the use of scarce resources to enable indigenization and maximise employment creation. The government aimed to achieve a climate resilient agriculture and improve food security. The development of infrastructure was to ensure that adaptation strategies can be successfully implemented.

The significance of IKS in climate adaptation was used by many scholars in research conducted in Zimbabwe (Gukurume, 2013; Mubaya & Mafongoya, 2017; Nyahunda & Tirivangasi, 2019; Chanza *et al.,* 2019; Mashizha , 2019).

The GoZ (2019) had the mandate to support Zimbabwe's resilience to climate-related problems by all stakeholders inclusive of public-private sector involvement in the implementation and build capacity for climate challenges through adaptation strategies that shall be pursued concurrently with climate change mitigation programmes. It is also mandatory that climate policy is wholly owned by all citizens irrespective of gender and age.

4.7.3 Climate change adaptation policy framework

The government of Zimbabwe acknowledges that climate change is a serious issue (GoZ, 1998). In Zimbabwe, the government cannot currently implement a clear response strategy on climate change. Despite the expected impacts of climate change in Zimbabwe, its policy response is slow and is given a peripheral priority (Chagutah, 2010). While the climate change policy in Zimbabwe is well documented, the challenge is in implementation since there are no comprehensive programs for climate change. The aim of the policy:

> "… to make sure that all developmental projects are climate-proof all development investments in Zimbabwe to address the national challenge of reducing Zimbabwe's vulnerability to climate and climate-related challenges while developing in a low carbon pathway." (GoZ, 2017: 3).

The policy guided the country's stakeholders on how to implement climate adaptation and make Zimbabwe a climate-resilient country and the same time ensure food security in the country. The policy also ensured that there is the domestication of global policies which improves climate change adaptation strategies.

4.7.4 The National Agricultural Policy Framework (NAPF)

Agricultural activity in Zimbabwe plays a crucial role to alleviate rural poverty. The political landscape of Zimbabwe was perceived to influence the adaptation ability of small-scale farmers. The NAPF was developed under the parameters of the United Nations Food Agricultural organisations. The government of Zimbabwe is committed to upholding all climate agreements on climate change and mitigation to stimulate agricultural development and to meet the expected values of Vision 2030. The NAPF was crafted to fulfil the vision, values, and targets of various international agreements on climate change such as the New Partnership for Africa Development the United Nations Agenda 2063 for Sustainable Development Goals, the Comprehensive Africa

Agriculture Development Programme and SADC to mention a few (GoZ, 2018). In this context, Zimbabwe is expected to mise the climate-compliant funds to support climate adaptation initiatives.

In Zimbabwe, National Agricultural policy Framework (NAPF) was synchronised with various organs such as Zimbabwe Agricultural Investment Plan (ZAIP) and the National Climate Policy and Agricultural Gender Policy to make such climate adaptation a success. While all these policies were crafted to fight against the climate change challenges, the major limitation was due to lack of funding, the political landscape in the country, drought, and the fact that the government had other priorities. At the continental level, Zimbabwe partnered with other stakeholders such as the African Development Bank, Vision 2063 for Africa, and Feed Africa to make sure that climate change adaptation was achieved. Globally, Zimbabwe sought funding from World Bank Union and International Monetary Fund to finance its climate change activities at all levels. In Zimbabwe, the major problem is decreasing levels of flows of investment in agricultural production resulting in food shortages. The NAPF discussed the challenges of implementation under the nine pillars shown in Figure 4.17.

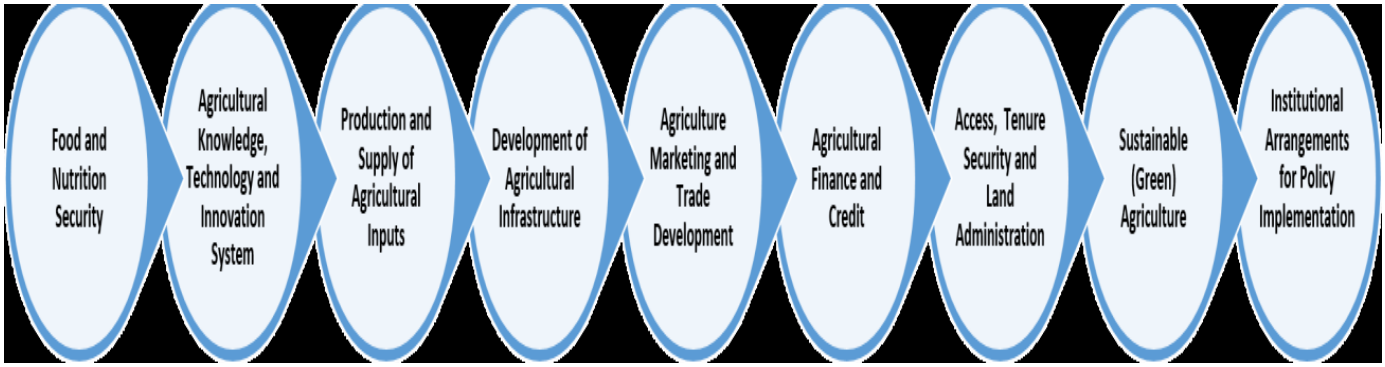


Figure 4.17: National Agriculture Policy Framework (2018-2030).

Source: GoZ (2018).

From the first pillar to the last pillar shown in Figure 4.17. The pillars proposed and being implemented had been facing challenges

4.7.5 The Fast Track Land Reform Program (FTLRP)

Zimbabwe's Fast Track Land Reform Program was an effort to take the former white commercial farms and give them to the indigenous small-scale farmers to increase agricultural

production and rehabilitate traumatised war veterans. One of the aims of the FTLRP was to redistribute land to more than 150,000 small-scale farmers who were congested in drought-stricken reserves under two models of farming practices, model A1 and model A2. The A1 was meant for small-scale farmers with an average size of an acre for growing subsistence crops and pastures. A2 was strictly for commercial farmers to practice agro-business small-scale farmers using some assets and inputs from the government. In Zimbabwe, crop production dropped by about 75% leading to critical food insecurity, resulting in a country importing food from neighbouring countries. Many commercial agro estates were put into disarray resulting in a 16% reduction in cash crop production with most of the plantations ceasing to function (Moyo, 2011).

FTLRP changed the right to land ownership in Zimbabwe. It was started on July 15, 2000, that the FTLRP was aimed at increasing agricultural production by utilising the land that they thought was underutilised and improving the welfare of poor small-scale farmers. More than 10 million hectares of land were transferred to between 170,000-220,000 households, on small-scale (A1) and medium-scale (A2) farms (Moyo, 2011; Mkodzongi *et al*., 2019). However, the farmers lacked several asset portfolios to produce as expected. The new farmers did not have collateral security, and as such, borrowing from banks was limited. The concept of a land reform program was a noble idea because it was meant to acquire land property rights and enhance the farmers' adaptive capacity (Yegbemey, *et al*., 2013).

The newly settled small-scale farmers were not given a guarantee on the ownership of the land and as a result, it threatens their security of tenure. In Zimbabwe, the resettled small-scale farmers were given ninety-nine-year lease permits. The lack of tenancy hurts many small-scale farmers they because are not willing to utilise their full asset portfolios to realise the full potential of their land. Some authors have the opinion that the aim of the FTLRP to increase production can only be realised when the small-scale resettled farmers have been given full land tenure rights (JIMAT, 2008). In the process of land reform, animal production was greatly affected since most of the small-scale farmers had limited knowledge of livestock production. The land reform resulted in the decline of both crop and animal productivity post-2000, though it began to rise selectively from 2006. In a similar situation, in South Africa, the way the was acquired was chaotic in such a way that it disrupted the livelihoods of the people (Mandleni & Anim, 2011). Most of the cash crops grown, like soya beans, sunflowers, tobacco, and wheat were greatly affected by the chaotic land distribution in Zimbabwe. The planted area as well as

output levels were reduced because of poor land use, poor irrigation facilities, and lack of experience and resources among the new farmers (Moyo, 2004).

The critics of the FTLRP in Zimbabwe noted several challenges, such as the lack of secure land tenure, high politicisation and chaotic manner resulting in poor investments and no infrastructural development. The chaotic nature of the FTLRP in the year 2000, had a ripple effect because it attracted sanctions for Zimbabwe, and agricultural production in Zimbabwe decreased drastically. The LTLRP created land-use and environmental conflicts in rural communities such as mining and tourism. Land valuation and audits are still incomplete, resulting in underutilisation and environmental degradation of the former white commercial farms.

4.7.6 Accelerated National Irrigation Development Programme (ANIP)

As part of pro-poor climate adaptation measures, the GoZ targeted to utilise 350000 hectares under irrigation by 2025. The government realised that agricultural production through irrigation was seriously affected since the small-scale farmers had no appropriate knowledge to carry on with the irrigation facilities left idle by the former white commercial farmers, as evidenced in the Gokwe South district. The government through the Ministry of Lands, Agriculture, Fisheries and Rural Development launched the Accelerated National Irrigation Development Programme (ANIP) to rehabilitate and revitalise the irrigation systems in the country as seen at Gwehava in Gokwe Centre constituency. This was a way to improve the small-scale farmers' resilience and adaptive capacity against the challenges of climate variability (Mudzonga & Chikwawa, 2009). Poor capital funding and corruption by various stakeholders resulted in food insecurity in many parts of Gokwe South such as the Sengwa, and Mapfungabutsi areas. In this context, the government's pro-poor policies did not yield as positive results as expected.

4.7.7 Zimbabwe's Vision 2030 in perspective

The government of Zimbabwe crafted Vision 2030, through Transitional Stabilisation Programme (TSP) in which its economic ideology is underpinned by austerity measures. This programme aims to enhance Vision 30 whereby Zimbabwe is targeting to be in the Upper Middle-Income Country by 2030. The Zimbabwe Coalition on Debt and Development

(ZIMCODD) proposed that agricultural policies should be pro-poor through discussions between the small-scale and the policymakers (ZIMCODD, 2019). Policymakers consisted of members from all ministries and government department which deals with agriculture, water, parliamentarians, academics, and marketing services. The ZIMCODD meeting was appropriate and well-timed to prepare small-scale farmers to future climate hazards by engaging both private and public players. This was at aimed at improving the farmers' adaptive strategies against climate change variability (ZIMCODD, 2019). In 2020, Zimbabwe launched the Climate-Smart Agricultural Investment Plan (CASAIP) which modelled future climate change impacts (rainfall, temperature) on crop yields, livestock incomes and diseases. The CASAIP recommends technology packages and investments to crime-proof agriculture in different agro-ecological regions. In 2022, Zimbabwe expects to launch a National Adaptation Plan (NAP) that will seek to mainstream climate change into national and sub-national planning processes in relevant economic and social development sectors.

4.7.8 Zimbabwean Government Loans through Command Agriculture

A pro-poor policy to alleviate the small-scale farmers' Command Agriculture was created by the government. The Command Agriculture enables small-scale farmers to be productive and ensure adequate food for poor communal farmers because it provides the inputs and assets that the farmers may lack in their agricultural practices. To date, the Command Agriculture took place for three consecutive years supporting small-scale farmers in Zimbabwean rural areas. The Zimbabwe contract farming (CF) was tasked to supervise the Command Agriculture in rural areas. The small-scale farmer was supposed to enter an agreement to sell and agreed on quantities of yields to the Grain Marketing Board. The Command Agriculture was a fulfilment the Zimbabwe Agenda of Sustainable Socio-Economic Transformation (ZIMASSET). As a pro-poor policy, the government offered loans through the "Command Agriculture" programme. The programme targets three categories of small-scale farmers, these are farmers with irrigation facilities and adequate farming equipment, farmers without equipment for irrigation, and those relying on rain-fed agriculture (Scoones, 2018). The 'Command Agriculture' assisted several small-scale farmers with assets to enhance their adaptive capacity from the 'Command Agriculture. These include seed varieties, fuel coupons, cattle, fertilizers, chemicals, agricultural information, and tillage services. Products would be collected at the nearest Grain Marketing Board depots (GMB). The Command Agricultural programme was criticised for various reasons including that the programme was polarised and politicised to achieve political ends. Seed

varieties were being distributed without regard to the agroecological regions and it was a challenge for most of the communal farmers. Other challenges faced by the Command Agriculture include natural disasters in the form of drought or floods stifling agricultural production and exposing the small scale to climate vulnerability. The small-scale farmers are not able to access the inputs due to a lack of collateral security and they believe that lose due to external factors agriculture is a gambling business in which a farmer can either win or lose. Results from the FGD noted that the Command Agriculture was so highly politicised that very few small-scale farmers were able to access the facility. Figure 4.18 shows the amount of money spent on Command Agriculture trying to improve small-scale farmers' adaptation strategies.

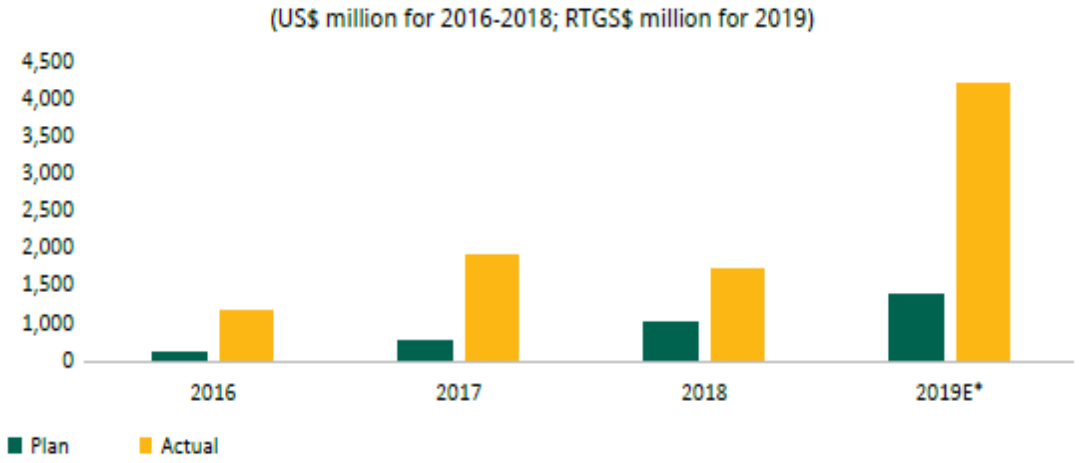


Figure 4.18: Planned and actual spending on Command Agriculture

***Source*:** Zimbabwe Parliamentary Report (2019).

Through Command Agriculture, the government of Zimbabwe planned to assist small-scale farmers with various inputs and other services. The government went beyond the planned budget to assist the farmers as shown in Figure 4.18.

Gokwe South constituencies also received some financial assets from the government. The Command Agriculture is a pro-poor scheme done by the government to assist small-scale farmers in rural areas with assets mainly financial, and physical. These assets are distributed in form of money, agro-chemicals, and marketing services. The commercial banks, the Ministry of Agriculture, the Command Agriculture Task Force, and the Input Supplies would loan out the inputs based on agreed guidelines to the small-scale farmers and close monitoring by the Command Agriculture Task Force (Figure 4.19). The Ministry of Agriculture, through the Grain Marketing Board, would assist in the marketing of the crops harvested. Figure 4.19 shows that

flows of financial, physical assets, and marketing and monitoring services to assist the small-scale farmers to realise their full potential in agricultural production and reduce food insecurity in the Gokwe South district.

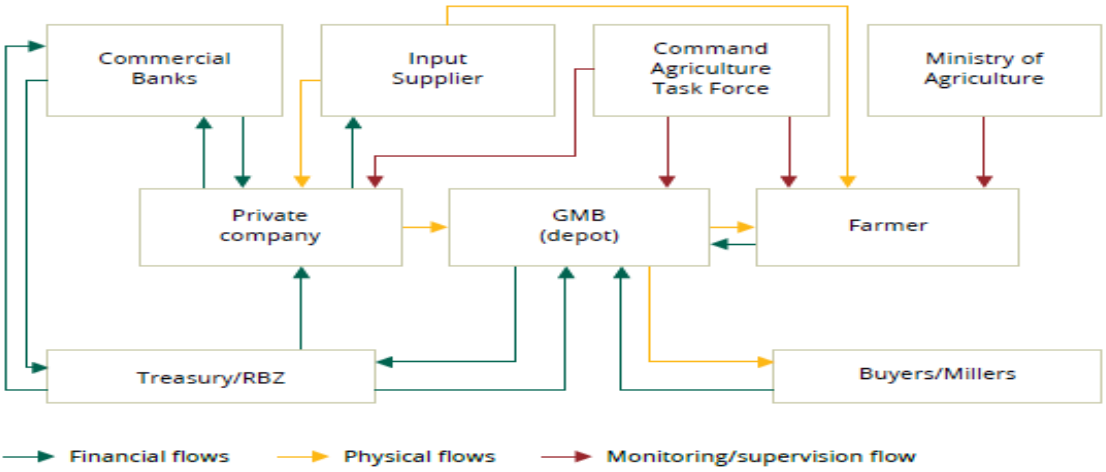


Figure 4.19: The Flow diagram of Command Agriculture in Zimbabwe

***Source*:** Zimbabwe Parliamentary Report (2019).

4.7.9 Access to markets

The Government of Zimbabwe assists poor small-scale farmers through marketing services. The Agricultural Marketing Authority (AMA) under the then Ministry of Agriculture Lands, Agriculture and Rural Development (CAP 18:24) with a broad mandate to regulate the participation in the process of crop production, processing of agricultural products, selling of the products, and determining the process of crop product in Zimbabwe. The AMA must control and mediate between the farmer and the buyer of their agricultural products, it also assesses the quality control in liaison with the international markets (Feresu, 2011). The AMA's is also expected to have an equitable distribution of services and products vision. Its mission is to provide quality service delivery to the agricultural sector. This assisted many small-scale farmers in the Gokwe South district.

4.7.10 Smallholder irrigation in Zimbabwe

Small-scale farmers in the Gokwe South district reported that they experience food insecurity due to the impacts of climate variability such as droughts. Frequent droughts in the country forced the country to embark on irrigation schemes in communal areas to ensure food security

and improve the small-scale farmers' livelihoods. The seasonal shift in Zimbabwe caused problems for small-scale farmers who are not able to change and keep pace with the rate at which the climate is changing Brüntru & Tsegai (2017) and mid-seasonal droughts are common even in years of normal rains (Nangombe, 2015; UN, 2017). The GoZ embarked on the revitalisation of micro irrigation countrywide including the Gokwe South district to realise the expected outcomes of Vision 2030, through agriculturally based projects. Some of the smallholder irrigation schemes are Gwehava Irrigation Scheme in Gokwe South, Dewure Irrigation scheme in Gutu, Mushaviri Irrigation Scheme, Tokwe-Mukorsi Irrigation Scheme, and many others across the country.

Since its independence in 1980, the GoZ tried to capacitate the small-scale farmers in various regions in Zimbabwe, including the Gokwe South district. Due to irrigation schemes, many communal farmers were able to grow different crops and the production was throughout the whole year. With irrigation schemes small-scale farmers can produce enough food for themselves and many households where food is secure in those constituencies (Nhundu, 2010). Such agro economies created safety nets for extreme weather conditions such as drought. Rukuni *et al*., (2006) expressed the various challenges facing irrigation schemes, for example, poor marketing activities, erratic water sully, high operational expenses, lack of continuous support from the government, and poor governance. Thus, poor governance in form of the absence of viable control over irrigation systems stifled the pro-poor irrigation systems in Zimbabwe. Chazovachii (2016) in research on conditions influencing the sustainability of smallholder irrigation schemes in Masvingo, noted that several irrigation schemes of small-scale farmers revealed that marketing their agricultural products is a challenge. Sometimes their crops are bought at low prices, which makes it difficult to buy inputs for the next growing season.

4.7.11 Contract farming schemes

Contract Farming is a farming agreement between the producer and the buyer who supplies inputs to the farmer where conditions are set to the effect that the producer will sell the agreed amounts to the supplier of inputs at an agreed price (Little & Watts, 1994). Some international organisations like the FAO and the international monetary fund (IMF) view contract farming as a mechanism to end poverty among small-scale farmers and at the same time, the failure of the farmer to pay back the loans, the farmer will see him caught in a vicious cycle of poverty FAO (2012). These schemes are controlled by Cottco where 55000 small-scale cotton producers in the

Gokwe South district. Some believe that Contract Farming favours the supplier of inputs rather than the farmer who will remain poor, as noted in Chile by Karovkin (1992) who argues that Contract Farming results in "dependent capitalisation" which means small-scale farmers will not be successful. However, Clapp (1989) opines that contract farming will get small-scale farmers rich and improve their standard of living. In Zimbabwe, Hove (2014) noted that small-scale farmers particularly cotton farmers, will remain poor in the face of this Contract Farming. Several small-scale farmers remain indebted to their contractors, leading to some of their assets like livestock being confiscated, after failing to pay back the loan inputs.

4.7.12 Agricultural mechanisation

The GoZ created the Department of Agricultural mechanisation to enhance adaptation strategies in communal areas of the country. Zimbabwe's agricultural mechanisation policy was shaped by state-capital relations or interests favouring powerful groupings linked to politics and economics (Toendepi, 2019). For Adekunle (2015), mechanisation can improve agricultural output; can quicken agricultural activities; increase power to crop processing, irrigation, and infrastructure development; compensate for labour shortages, and mitigate drudgery. In rural areas of Zimbabwe, agricultural development, including agricultural mechanisation remains constrained by adverse incorporation and primitive capital assets. The policy implementation on mechanisation had many challenges including repairing the machinery, buying parts of which most of which were not available in Zimbabwe. Lack of fuel to fully implement the irrigation process, poor funding and lack of technical skills to operate the machinery. Underutilization of irrigation equipment was common in most of the resettled farmers in former commercial farms. Poor infrastructure and inadequate access to appropriate technologies for mechanisation, irrigation, and post-harvest management remain low. The thrust of the government was to ensure that the Agricultural, Technology, and Innovation Systems are fully implemented in Zimbabwe (GoZ, 2018).

4.7.13 Government policy towards IKs

The government of Zimbabwe has been very positive in the inclusion of indigenous knowledge in all its sectors, particularly in education and agriculture. The IPCC (2015) indicated that it has just started to assess the role played by indigenous knowledge in climate adaptation strategies.

Indigenous knowledge is significant in the decision-making process because it enhances climate adaptation among indigenous people (Ford *et al*., 2010). The indigenous knowledge systems are still yet to be fully accepted by climate scientists and policymakers (Jain, 2014; Hiwasaki *et al*., 2014). The government of Zimbabwe is trying to fuse the two knowledge systems that will benefit the stakeholders, particularly the small-scale farmers who are the immediate victims of climate variability. The idea of integration between scientific knowledge and indigenous knowledge was also supported by other researchers (Mahoo *et al*., 2015).

4.7.14 Summary of pro-poor interventions by the Government

The government of Zimbabwe has managed to assist small-scale farmers in several ways ranging from financial loans, machinery, and the construction of dams to facilitate irrigation to farmers, especially in rural areas. Introduction and/or improved access to subsidies, incentives, and crop insurance provisions to support farmers to adapt, was one policy that the government of Zimbabwe attempted for rural small-scale farmers. Through various government agencies, the government tried to utilise early warning systems for timely predictions and dissemination of climate information to all stakeholders. The government, through radio and television tried to disseminate climate information outreach programmes. However, most of the attempted policies by the government were not very successful because of natural and financial assets constraints. Climate change and variability involve explicit relevancy to communal farmers in Africa and participation that prioritize climate change and variability strategies (Lesolle, 2012). The Agricultural Rural Extension Services (AGRITEX) and other cooperating stakeholders encourage drought-resistant crops, paddocking, water harvesting techniques, and conservation agricultural techniques (GoZ; UN, 2017).

CHAPTER 5

DISCUSSION OF THE FINDINGS

5.1 Introduction

This chapter presents a discussion of the results presented in Chapter 4. The discussion is based on the objectives of the study which are divided into six sections. The first part analyses the factors influencing the climate variability adaption strategies in the Gokwe South district. The second part of this chapter focuses on the quality and quantity of assets available to small-scale farmers in the Gokwe South district. The perception of small-scale farmers to climate variability was analysed in the third section of this chapter. The significance of the indigenous knowledge system in the quest to reduce the vulnerability of small-scale farmers to climate variability was analysed in this chapter. This chapter also presents a proposal for an asset and knowledge framework to reduce vulnerability to climate variability. It also highlights the possible integration of knowledge to complement the vulnerability adaptation approach. A comparison of indigenous and scientific knowledge systems was also done in this chapter.

5.2 Perspectives on factors influencing the choice of adaptation strategies by the small-scale farmers in the Gokwe South

Empirical evidence from the Zimbabwean context indicates that indigenous knowledge is becoming more of a reactive adaptive strategy than a proactive adaptive strategy. For adaptation to be successful and sustainable, its strategies should take a progressive process from spontaneous adaptation to planned one through to a proactive one (Chanza, 2014). If a household has a high number of people, it means the work can be done quickly bringing economies of scale in the agricultural production Croppenstedt *et al*., (2003), which means there will be no need to hire external labour that increases agricultural production costs.

Gender was included in explaining the adjustments in doing business and the adoption of improved technologies or adaptive measures (Anyoha *et al*., 2013; Asfaw & Admassie, 2004; Nhemachena & Hassan, 2007). Male small-scale farmers quickly adjust to new farming methods and technologies (Asfaw & Admassie, 2004). Female small-scale farmers take time to adjust.

These factors greatly affected the asset vulnerability of small-scale farmers. Income received by farmers contributes a lot to the adaptation of new farming strategies which can fight against climate change challenges. The higher the income received by the farmer, the higher the ability to adopt new technologies and embrace new farming practices (Franzel, 1999; Knowler & Bradshaw, 2007). Various factors such as the type of assets, resources, and technology at the farmer's disposal affect the farmer's adaptive capacities and decisions (Antwi-Agyei *et al*., 2015; Biggs, Tompkins, Allan, Moon & Allen, 2013).

As shown in Figure 2.1 the cognitive and psychological factors had the least effect as shown by their percentage of 3%. Social and cultural factors can also be a barrier to climate change adaptation strategies IPCC (2007) and this has been supported by Adger *et al*., (2009). In Gokwe South, social assets were also considered very useful in the adaptation process.

There is a plethora of factors affecting the adaptive behaviour and resilience of small-scale but for this thesis, only five factors shown in Table 2.1 were selected based on their influence in the Gokwe South district. Several factors age, education level, household size loan facilities, and climate information have been commonly used in investigating farmers' adaptive behaviour in Gokwe South (Hassan & Nhemachena, 2008; Bryan *et al.*, 2009; Deressa *et al.*, 2009; Gbetibouo, Hassan & Ringler, 2010; Deressa *et al.*, 2009; Hassan & Ringler, 2010; Hisali *et al.*, 2011; Fosu-Mensah *et al.*, 2012; Ndambiri *et al.*, 2012; Esham & Garforth, 2013). Table 5.1 shows the factors affecting the choice of a farmer's adaptation strategy.

Table 5.1: Factors influencing farmer's adaptation strategy

Number	Groups of influencing factors	Influencing Factors
I	Demographic and Socio-economic factors	Age, education level, income, received resources, the size of the farm, and experience in farming.
2	Capitals and appropriate technology	Availability, accessibility, and affordability of funds and irrigation technology and infrastructural development.
3	Government and Political factors	Government departments with their policies on land and marketing policies.
4	Behavioural Factors	Social resources and cultural aspects
5	Cognitive and psychological factors	Climate change denial. Perceptions of climate change risks.

Source: Dang *et al*., (2019).

Results in Table 4.9 revealed that small-scale farmers perceive that the climate has changed, and it affected their food production. Most of the respondents agreed that rainfall was decreasing over the past three decades. Most of the respondents agreed that the temperature was increasing in the Gokwe South district. This indicates a high climate variability in the district. Most of the interviewed people were saying rainfall was starting much later than usual. One other phenomenon which was a measure of climate variability was the incidence of drought. About 89.77% of the interviewees said that they were now experiencing frequent droughts in the recent past. A small percentage of respondents said that rainfall totals were increasing in the last 30 years. The overall perception of small-scale farmers testified that there was a serious decrease in food production in the district. Results from Table 4.8 show that 79% of the respondents have no access to scientific weather information. Regardless of the challenges of indigenous knowledge, most small-scale farmers rely on indigenous weather information. Sengwa constituency is the worst affected where 95% of the respondents said that they do not get any scientific weather information, hence its vulnerability is very high compared to other constituencies in the Gokwe South district. The channels in which the weather and climate information is disseminated are quite modern and are out of reach of small-scale farmers. Most farmers do not have a radio or television. Those with radios and television, still do not have access to weather forecasts due to lack of communication channels. The reception signals for radios, television, and cell phone are very poor.

Households who received weather information pointed out that they are receiving it from their cell phones. Radios and television are very effective channels of communication, however, there is a challenge in the language in which it is communicated which most rural farmers cannot understand (Mubaya *et al.*, 2012; Uzuegbu, 2016). About 47% of the respondents said that the general content of the weather information is poor as shown in Table 4.8. The results also show that 47.8% said the delivery of the information was poor and 45.8% said the information was also untimely. The respondents also said that the language used was not very appropriate for them since a section of the respondents said there is a communication breakdown, as shown in Table 4.8.

The major barrier to adaptation in the Gokwe South district is a lack of access to information that would facilitate effective climate risk management. This has been supported by Deressa *et al.*, (2009) climate information, agro-ecological characteristics, and financial base also affect the small-scale farmers' choices of adaptation to climate variability. This includes climate and

weather information, as well as information on markets and other services. The effectiveness of efforts to improve access to climate information and financial services will be maximized by parallel adjustments in livelihood strategies to reduce risks and improve the quality and availability of climate-sensitive resources, notably practices to increase soil fertility on agricultural land and to improve management of water resources. The factors affecting the choice of climate change adaptation are mainly based on age, household size, sources of information and income, as observed in Osun State (Adesoji & Ayinde, 2013). In Gokwe South, households that are disadvantaged in terms of mobility, climate information access, and assets have low adaptive capacities and are therefore vulnerable to climate change disasters.

Inaccessibility to climate information has been a challenge to most communal farmers in Gokwe South (Roncoli *et al.,* 2009; Mberego & Sanga-Ngoe; 2012; Kolawole *et al*., 2014; Roudier *et al*., 2014; Mapfumo *et al.,* 2015). To achieve sustainable climate change adaptation in low-income countries, there is a need for effective and efficient communication between small-scale farmers and the climate specialist (Goddard *et al*., 2010; Hansen. *et al.,* 2010). The challenge in low-income countries regarding climate information is its accessibility due to limited weather stations and obsolete equipment used to record weather elements (Ogallo, 2010).

Availability of agricultural extension services, and loan facilities, are other key enablers to achieving climate adaptation strategies (Hassan & Nhemachena, 2008; Balew, Agwata & Anyango, 2014). The respondents highlighted that in their quest for climate change adaptation information was very important.

5.3 Value of indigenous knowledge in reducing impacts of climate variability

The research findings result in Table 4.15 reveal that most of the small-scale farmers are using indigenous knowledge, not by choice, but the scientific sources of weather and climate information are not available or are out of reach. Those with access to scientific sources of weather data, do so at schools where there are some weather stations. Most of the weather stations used in schools were not functional and the records were in shambles. The research findings that most communal farmers in Gokwe have no option for a source of weather and climate information except their indigenous knowledge which is readily available from village elders and traditional chiefs.

Past research findings indicate that small-scale farmers were slowly adapting to climate change relying on indigenous knowledge (IKs), (Nyong *et al*., 2007; Pareek & Trivedi, 2011; Al Mamun *et al*., 2014; Bola *et al.,* 2014; Nkomwa *et al.,* 2014). The education that the small-scale farmers received, enabled them to adapt to smart agriculture using appropriate technology Deressa *et al*., (2009), and the effect of education was quite positive in the adaption process by the small-scale farmers (Deressa *et al.*, 2011).

In some cases, EWS is disseminated to the communities after a thorough consultation with the spirit mediums. Research has shown that early warning systems have been effective in reducing infant mortality and morbidity in many low-income countries (Ebi *at el*., 2005). As noted in Malawi and Botswana, farmers highlighted that indigenous knowledge is more user-friendly and less expensive than scientific knowledge systems which require complex equipment and educated personnel with expertise in using them (Briggs & Moyo, 2012; Kolawole *et al*., 2014). The significance of IKs is now taking centre stage in climate change international forums (IPCC, 2015).

The knowledge gaps in scientific knowledge can be complemented by indigenous knowledge systems. Communal farmers in the Gokwe South district rely more on their local knowledge than scientific knowledge for several decades (Kalowe *et al*., 2014; Roudier, *et al.,* 2014). Communal farmers are dependent on various natural phenological phenomena ranging from cosmic, animals, wind, to vegetation signs to forecast weather events (Orlove *et al.,* 2010). Much emphasis is put on IKS which are becoming paramount in climate adaptation initiatives. There is a proposal that scientific knowledge should be integrated with indigenous knowledge instead of phasing it out (Jain, 2014; Joshua *et al*., 2011; Maconachie; 2012). Indigenous knowledge in Gokwe South is regarded as vital in climate adaptation practices which can affect livelihoods and food security. Indigenous knowledge (IK) still is vital in the African culture for it is used in crop production, veterinary, and even human medicine. Some research findings believe that IK play a role in fostering climate adaptation in low-income countries (Mafongoya and Ajayi (*eds*), (2017). Indigenous knowledge by its nature is not recorded and therefore it is suffering gradual erosion in the face of scientific knowledge invasion. The IPCC (2015), through the IPCC agenda, is beginning to consider the IK in its climate adaptation agenda.

IK forecast climate and weather changes are criticised on the basis that it is suffering a lot of erosion due to the technological advancement in the scientific knowledge systems and the fact

that most of the climate change indicators are disappearing due to climate change. Some policymakers and climate specialists view the indigenous climate knowledge system as unauthentic and that it gives false information that could not be relied on (Briggs & Moyo., 2012; Saitabau, 2014). However, IK has proven indispensable to the communities in the Gokwe South district. Its generally believed that indigenous knowledge is participatory, not expensive, and promotes conservation agriculture (Agrawal, 1995). The IK has suffered a lot of criticism from the public domain. Some authors criticise indigenous knowledge for its inefficiency, primitiveness, outdatedness, and inferiority Kelkar (2007), and some even consider it a stumbling block to scientific developments, Agrawal (1995) or a hindrance to progress (Nygren, 1999). Nyong *et al.,* (2007) also noted that little to nothing has been effectively done on international forums to implement IK knowledge at various scales. Traditional climate change indicators cannot be universally applied because of differences in ecological systems as well as interpretation of phenological indicators, and variations in culture. Small-scale farmers in Zambia still believe that IK is crucial in climate change and variability adaptation efforts (Jiri *et al*., 2015; Kolawe *et al.,* 2014; Roudier *et al*., 2014).

The local knowledge could be very useful if used in a holistic approach as shown by Deckens, (2007) in Figure 5.1.

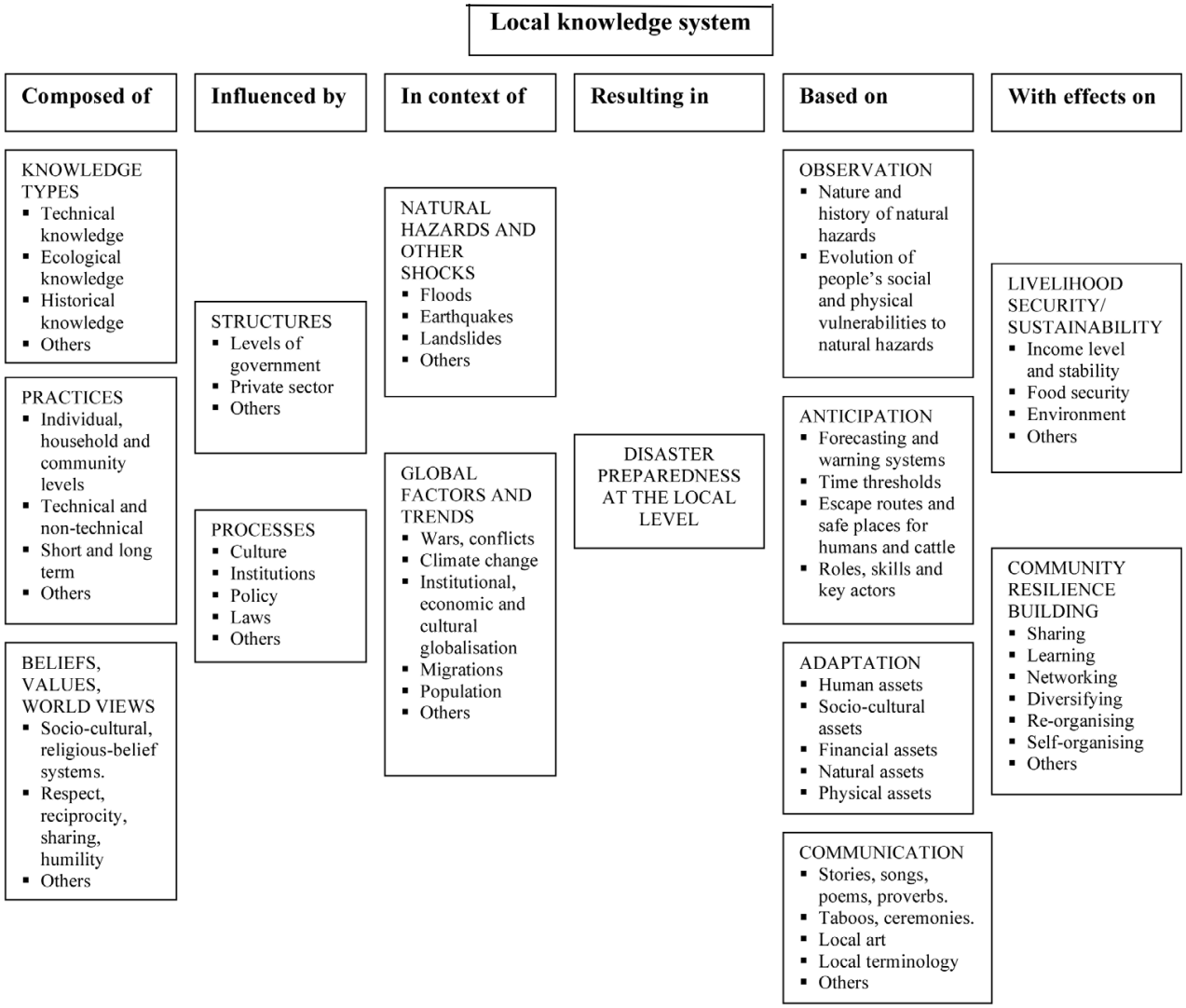


Figure 5.1: A framework for local knowledge for disaster preparedness

Source: Deckens (2007).

While Deckens (2007) referred to her framework as Disaster Preparedness and this study would prefer to refer to it as 'Vulnerability Reduction and Adaptation using local knowledge. The small-scale farmers in Gokwe South has vast knowledge and rich culture which can be fully utilised to improve their adaptive capacity. Several challenges in using IK can be observed. The young generation has been completely absorbed into the western culture to such an extent that they are forgetting their culture and they also consider indigenous knowledge as very backward. This has been supported by Ngulube (2011) who noted that the death of IKs was due to lack of database at any level of the community, even at the national level. The lack of documentation and storage of IK has stifled the inclusion of IK in various learning institutions. Therefore, it is the onus of the older generation to transfer IK to the contemporary generation through oral channels.

Western scientists criticise the IK saying it is pseudoscience without tested and approved results. In low-income countries has also been criticised as archaic, not dynamic, and cannot be allied universally because the interpretation varies from one region to another or from one continent to another. IK suffers a lot of criticism and is regarded as inferior, marginalised, exploited, not effective, and is seen as an object of cultural imperialism (Young, 1988, 1990; Laws, 1994). From the African perspective, IK is none of those. The small-scale farmers observe the pattern of the indicators of climate change and then produce a calendar of farming activities based on the trends observed over a long period (Mapfumo *et al.,* 2015). Phenology, the behaviour of animals, and the conditions of the atmosphere may erroneously give weather forecasts thus jeopardising small-scale livelihoods and agriculture (Jiri *et al*., 2016).

Research findings noted that if indigenous knowledge is not documented and stored in the retrievable database, there is a danger that it may become extinct (Ngulube *et al*., 2011). A proposal has been made to create indigenous knowledge repositories that would be used by future generations. The IK is being eroded and suffering disappearance due to the advancement of technological developments in Africa. Indigenous knowledge is fast eroded since the elderly people are dying and no transference of knowledge to the younger generation, (Mapfumo *et al*., 2015). However, relying on IK as the sole source of climate change adaptation strategy is again criticised in the sense that it is unreliable and suffers from the fact that human beings have short memories which result in the loss of knowledge (Mberego & Sanga-Ngoie, 2014; Masinde, 2015).

The fact that most small-scale farmers continue to be vulnerable to climate change and variability led some farmers to lose confidence in IK, (Mugabe *et al*., 2010). The current potential threats to indigenous knowledge are massive, including that IK is backward; disrupted by technological developments; traditional indicators are disappearing, and some are changing (Jiri *et al*., 2016). The IK is also suffering erosion because of the current religious teachings and scientific developments that discredit its value (Makwara, 2013; Nakashima *et al*., 2012).

Sustainable climate change adaptation can only be applicable when it follows a sequence of four steps, namely, identifying factors affecting vulnerability: identifying both scientific and indigenous adaptation strategies and finally developing an integrated adaptation strategy (Figure 5.3), (Mercer, 2012). In a similar view, Chad (2014) noted that the PRA framework should take

into consideration the community priority; develop an infrastructure for collection, recording, and monitoring data; and finally integrate scientific and indigenous knowledge forecasting systems. Table 5.2 shows a comparison between scientific and indigenous knowledge domains.

Table 5.2: A comparison between scientific and indigenous knowledge domains

Conceptual Differences	Scientific Knowledge System	Indigenous Knowledge System
Methods and Knowledge differences	It's rational and objective It's an open type of knowledge system It builds on the previous achievement Reductionist (Linear)	It is closed and subjective and non-systematic Based on new experiences Based on Intuitive
Dissemination	Documented Digital	Oral and repetitive
Type of data	Objective Quantitative Synchronic	Subjective Qualitative Diachronic
Monitoring	Top-down approach Controlled policies Scientists collect data	Consensus-based, self-regulated Resource users collect and utilize data (decentralised, grassroots)
Mode of learning	Didactic Reading Experimental	Storytelling Hands-on Experimental
Context	It is divorced from the epistemic framework in search of universal validity	Peculiar to a particular area and its inhabitants
Substantive Differences	Daily people's activities are removed	More to do with people's daily livelihoods

Sources: (Berkes 1994; DeWalt, 1994; Berneshawi; 1997; Howard & Widdowson, 1997).

Table 5.3 shows the complementarity between science and traditional seasonal climate forecasts.

Table 5. 3: The complementarity between science and traditional seasonal climate forecasts

Concept	Justification
Diachronic systematic complementarity	Science collects dynamic data in a time series over a large area e.g., the use of COFs in Africa. IKS focuses on diachronic data and long-term series in small areas e.g., the use of indigenous indicators of forecasting in African villages or districts.
Based on mean values versus outliers	Scientific data is based on the analysis of figures. Iks is usually based on qualitative data complementing the scientific data which is important in climate studies.
Numerical (quantitative) data versus Descriptive (qualitative) data	Scientific is based on numerical value and traditional data is based on descriptive measures thus complementing each other
Hypothesis versus mechanisms	The IKS is based on hypothesis in solving problems and science uses the apparatus to explain the mechanisms thus complementing each other's weaknesses to produce authentic data.
Objectivity versus Subjectivity	Scientific data is objective while IKS is subjective and together they bring advantages of a mixed approach in data collection.

Source: Moller *et al*., (2004).

The complementarity of data from science and IKS is important in climate change adaptation because it helps to clear the weaknesses of each approach, giving reliable data to small-scale farmers. Therefore, knowledge integration between scientifically based and IK-based sources can produce a holistic type of knowledge in climate change adaptation.

5.3.1 Significance of Scientific Knowledge Systems

The results in Table 4.15 revealed that 39% of the respondents rely on scientific knowledge in their climate and weather forecasts as well as agricultural calendar. Constituencies in the peri-urban areas such as Sesame and Gokwe Centre had a higher percentage of the respondents relying on scientific knowledge with 53% and 62%, respectively of the respondents relying on scientific knowledge. The reasons for their reliance on SK are that they live very close to Gokwe town where they can easily access climate and weather information. Respondents in Gokwe

Centre and Sesame constituencies testified that they rely on radios, televisions, and cell phones to get weather and climate information. The respondents gave various reasons why fewer small-scale farmers were not using scientific knowledge was considered superior to indigenous knowledge in most climate discourses and their application to the farming industry (Walker *et al*.,1999). The scientific knowledge domain uses the Global Climate Models (GCM) developed from atmospheric circulation and phenomena. The models used are based on the generation of greenhouse gases (GHG) which vary spatially. The data collected is quantitative which makes it difficult for indigenous people to comprehend. The Meteorological Department is responsible for the Meteorological data in Zimbabwe. However, the information can only be accessed through television or radio, otherwise, the data is not for free. One must pay to get climatological data. Therefore, the information is not easily accessible to everyone in Gokwe South. However, using scientific knowledge systems, weather forecasts can be done in different time spans with some degree of accuracy depending on the quality of the equipment used (Lutgen *et al*., 2010). Scientific weather forecasts can be easily accepted by rural communities, mainly small-scale farmers. This is mainly so if they are blended with traditional knowledge and come up with a hybrid of knowledge that can be used to solve the problems of climate change and improve food security for small-scale farmers.

One notable challenge for scientific sources of climate knowledge is that modern technology is very expensive. There was evidence from nearby schools like Tare (St Bornface) Secondary school, Kasango Secondary School, Njelele Secondary School, and Sai Secondary School which use obsolete equipment which may not give accurate information. Most of the weather stations observed were in a dilapidated condition and their records were in shambles and could not be relied on. Scientific weather forecasts can also be misleading, particularly in developing countries where accessibility of weather data is a challenge. Some of the equipment is quite obsolete and cannot read the atmospheric composition and phenomena accurately (Aguado & Burt, 2010). Scientific forecasts have regional challenges, and it is very difficult to apply at very low communal strata such as villages (Adejuwon, 2007; Chang'a, 2010). Successful application of scientific knowledge will take time to be assimilated by small-scale farmers because it is difficult to interpret, especially the numerical values. The scientific knowledge is usually mathematical and uses complicated symbols for small-scale farmers to comprehend (Adejuwon, 2007; Joshua *et al.,* 2011). Some authors believe that indigenous knowledge is more rational, accurate, and reliable than modern scientific knowledge at local scales (Ziervogel, 2001; Nyong *et al*., 2007; Kalanda-Joshua *et al*., 2011). Indigenous knowledge "exists in parallel to Western

science" In rural areas, there is a shortage of scientific weather instruments to do weather forecasting and as result, small-scale farmers are very sceptical about the reliability.

The results from the FGDs and traditional leaders showed that most of the small-scale farmers are not able to access scientific data. The weather and climate information by various government departments are not reliable to the satisfaction of rural farmers. Communal farmers face several challenges including accessibility, affordability, and timely reception of climate information (Frimpong , 2013).

Unreliable scientific climate information is a serious problem for small-scale farmers to achieve a successful climate change adaptation. The weather and climate forecasts continue to give a wide variance, particularly in small regions (Goddard *et al*., 2010; Gong *et al.,* 2003; Kalowe *et al*., 2014; Roudier *et al*., 2014). Generally, only two out of five constituencies rely on scientific knowledge in their agricultural activities. Given the above analysis, this study proposes the integration of scientific and indigenous knowledge into holistic climate adaptation strategies, in the Gokwe South district as alluded to in the next sub-section.

5.4 Unpacking asset portfolios building resilience in the face of climate variability

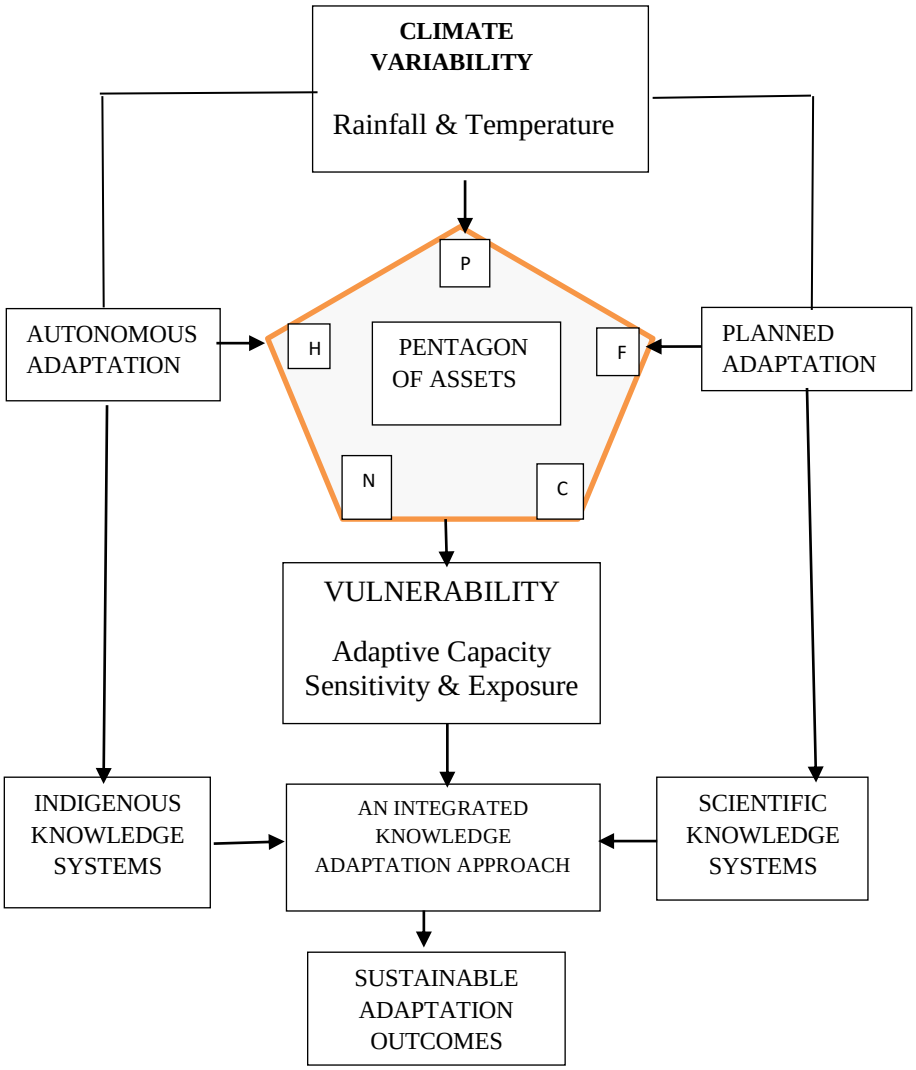
A quantitative analysis was done to assess the effect of the portfolio of assets to see how they affect the vulnerability of each constituency. It has been observed that the average degree of vulnerability in Gokwe South was 3.04 out of the highest value of 5. The lower the value, the higher the degree of vulnerability to climate variability. Mapfungabutsi and Sengwa Constituencies have average scores of 2.4 and 2.2, respectively, and both constituencies are therefore regarded as highly vulnerable. Gokwe Central and Sesame show average scores of 4 and 3.4, respectively, which is above average. This is a result of being peri-urban constituencies where they have better access to some of the assets like financial, and physical. From the results in Figure 4.3, the most crippling is the shortage of natural and financial assets with average scores of 2.6 and 2.8, respectively.

Financial assets are the most flexible assets and command the greatest influence because they can be converted and used to improve other assets to achieve sustainable adaptive capacity. Financial assets can be used to buy food for the community and improve food security in rural areas. Finance can be used to import food from other countries without growing the crops.

However, it is difficult for rural communities to access financial assets even to borrow money from the bank, because most of them do not have collateral security to access the loans. It was also discovered that human assets and social assets share the same influence of 3.4, which means they are important in reducing vulnerability to extreme weather events. Therefore, the higher the score value, the higher the adaptive capacity and the less the vulnerability to climate variability.

Results from Table 4.15 show that Mapfungabutsi, Sengwa, and Kana constituency rely more heavily on indigenous knowledge than they use of scientific knowledge. In the Mapfungabutsi constituency, 84% of the respondents depended on indigenous knowledge and in Sengwa 78% rely on local knowledge for their farming practices. For the whole district, an average of 61% of the respondents testified that they rely on indigenous knowledge for their communal farming activities. An average of 39% of the respondents said they relied on scientific knowledge for their agricultural knowledge. Peri-urban constituencies such as Gokwe centre and Sesame relied on scientific knowledge systems 62% and 53% respectively. Given the above results, this study proposes an integrated approach for both scientific and indigenous knowledge so that a hybrid of knowledge will improve their resilience and adaptive capacity.

While the Pentagon of Assets has been used over the years, it was not able to stand the test of time. It is high time it incorporated other essential assets, such as civic assets, technological assets, political assets, and other important things like cell phones, televisions, radios and other technological gadgets that will enable farmers in rural areas to know more about markets for their crops and livestock. The pentagon of assets framework which has been used for years omitted some new assets which are being used by small-scale farmers. Figure 5.4 shows a proposed asset and knowledge-integrated framework.



Key: P-Physical assets; C-Capital assets; H-Human assets; Social assets and N-Natural assets.

Figure 5.2: Proposed asset and knowledge-integrated framework

***Source*:** Authors' construction (2019).

While the pentagon of assets has been used as an approach to improve the resilience of small-scale farmers, it has proved to be incomplete because it did not include intangible assets. The civic and political assets were not effectively included in the framework. The political asset is vital in climate change adaptation initiatives. The political landscape in Zimbabwe is highly tilted towards the ruling party. The DFID Livelihood Approach (2000) shown in Figure 2.9, could not yield the intended results because the climate continued to change beyond the reach of the assets proposed. The results indicated in Figure 4.2 revealed that Sengwa and Mapfungabutsi have a vulnerability score value of 2.2 and 2.5, respectively. Sengwa region has a high vulnerability value, compared with other constituencies. From the pentagon of assets surveyed,

Gokwe Centre and Sesame have better assets adjusted to climate variability with score values of 4 and 3.4, respectively. Kana is also asset vulnerable to climate change challenges with a score value of 3. This study emphasises paradigm shift from asset vulnerability to asset adaptability. For successful climate adaptation strategies and sustainable food security, a perfect asset mix is key as noted by other authors (Simatele & Simatele 2015; Tawodzera, 2012).

Household asset portfolios are not static but dynamic over time and depend on the economic and social status of the breadwinner in the family. Thus, households can either be secure or vulnerable due to internal changes linked to external economic, political, and institutional variability. Asset portfolios are important because they form the basis of this study. Results in Table 4.4 shows that financial assets and social assets have the greatest influence in vulnerability, with a weight of 39% and 28% respectively.

The degree of climate vulnerability is directly proportional to the asset portfolios that are at the farmers' disposal. Small-scale farmers with better assets are less vulnerable to the negative impacts of climate variability. The more assets household has the less vulnerability to climate variability. Figure 5.3 shows levels of vulnerability as they are affected by the asset mix

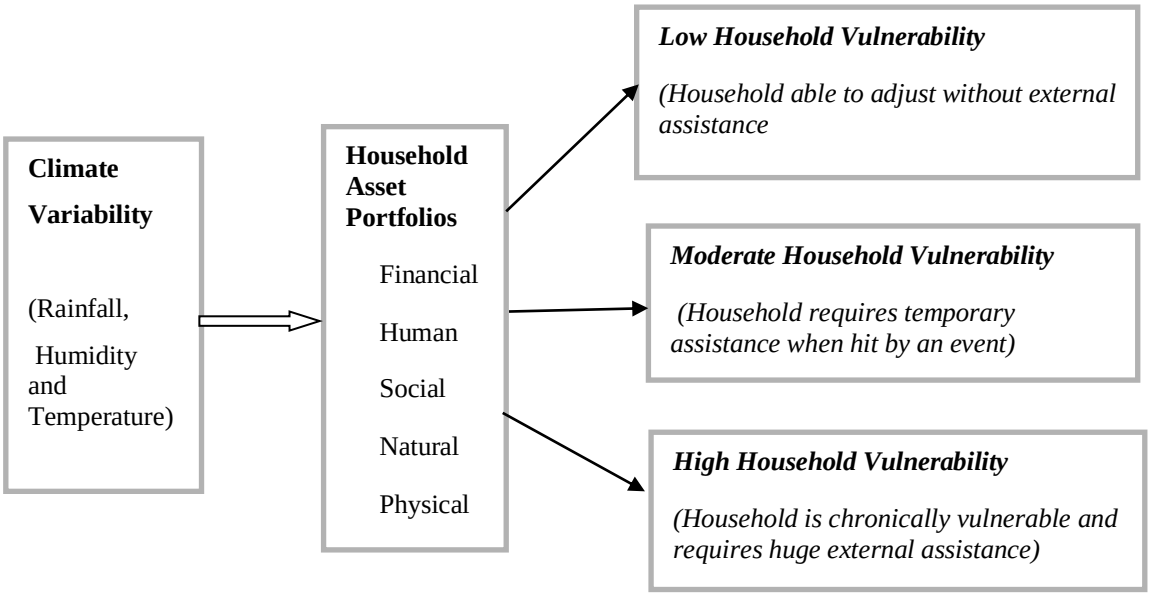


Figure 5.3: Levels of vulnerability

Source: Authors' construction (2020).

Gokwe South has an average vulnerability index of 3.04, which shows a very weak asset adaptation ability. Sengwa and Mapfungabutsi constituencies have 1.2 and 1.4 vulnerability

indexes, respectively, which means they are the most vulnerable in Gokwe South. It will be challenging for these to change from asset vulnerability to asset adaptability due to low asset endowment. The results revealed that in Gokwe South, the commonly reported assets and factors of climate adaptation are the financial bases that can enable small-scale farmers to overcome other climate change adaptation barriers (IPCC, 2007). Multiple cropping, zero tillage, and irrigation were the most preferred adaptation strategy options in the Gokwe South district as revealed in Figure 4.4. "Human activities" and "God's punishment" were also among the respondents' perceptions of causing climate change and variability in the Gokwe South district study. Results also revealed that three of the five constituencies rely mostly on indigenous knowledge for their climate adaptation strategies. The government's pro-poor policies should be expedited in the Gokwe South district before the situation deteriorates.

The small-scale farmers are affected by asset portfolios with various degrees of vulnerability as shown in Figure 5.2. Each asset will have its degree of effect on different households. Climate change vulnerability depends on asset availability; therefore, households are affected to differing degrees such as low vulnerability, moderate vulnerability and high vulnerability.

5.5 Perceptions of small-scale farmers on climate variability in the Gokwe South district

Climate variability is measured by two variables, and these are rainfall and temperature. Results in Table 4.5 revealed that small-scale farmers perceive that the climate has changed, and it affected their food production. A high percentage of 89.77% of respondents were aware of climate variability. Most of the respondents (96.8%) perceived that rainfall was decreasing over the past three decades. About 88.88% of the respondents perceived that the temperature was increasing in the district. This indicates a high climate variability in the district. A shift in the onset of rainfall was acknowledged by 85.33% of the respondents. Most of the respondents (89.33%) were saying rainfall was starting much later than usual.

One other phenomenon which was a measure of climate variability was the frequency of droughts (89.77%) of the respondents said that they were experiencing frequent droughts in the recent past. A small percentage of 3.11% perceived that rainfall totals were increasing in the last 30 years. About 63.33% perceived that rainfall fluctuations are noted in the district which is clear evidence of climate variability in the Gokwe South district. Approximately 88.88% of the respondents perceived that the temperature has significantly increased in the Gokwe South

district and, only 9.77% of the respondents perceived that the temperature had decreased. One climate variable that was investigated was the fluctuation of temperature. About 63.11% of the respondents perceived for the past three decades. that temperature figures were no longer stable. Given the above observations, some climatological hazards are noted in the Gokwe South district, and these are droughts and floods. A high percentage of (89.77%) of the respondents perceived that the frequency of drought has greatly increased in the Gokwe South district. A low percentage of (20.44%) testified to the occurrence of floods.

Results from Table 4.8 show that 79% of the respondents have no access to scientific weather information. Regardless of the challenges of indigenous knowledge, most small-scale farmers rely on indigenous weather information. Sengwa constituency is the worst affected, where 95% of the respondents said that they do not get any scientific weather information, hence its vulnerability is very high compared to other constituencies in the district under study. The channels in which the weather and climate information is disseminated are quite modern, it is out of reach of small-scale farmers. Most farmers do not have a radio or television. Those with radios and television, still do not have access to weather forecasts due to a lack of communication channels. The reception signals for radios, television, and cell phone are very poor.

The major barrier to adaptation in the Gokwe South district is lack of access to information that would facilitate effective climate risk management (Deressa *et al*., 2009). Climate information, agro-ecological characteristics, and financial base also affect the small-scale farmers' choices of adaptation to climate variability. This includes climate and weather information as well as information on markets and other services. The effectiveness of efforts to improve access to climate information and financial services will be maximized by parallel adjustments in livelihood strategies to reduce risks and improve the quality and availability of climate-sensitive resources. An example of this could be for example through practices to increase soil fertility on agricultural land and to improve management of water resources.

The factors affecting the choice of climate change adaptation are mainly based on age, household size, sources of information, and income, as observed in Osun State (Adesoji & Ayinde, 2013). In Gokwe South, households that are disadvantaged in terms of mobility, climate information access, and assets have low adaptive capacities and are therefore vulnerable to climate change disasters.

Inaccessibility to climate information has been a challenge to most communal farmers in Gokwe South as noted by some authors (Roncoli *et al.*, 2009; Mberego & Sanga-Ngoe, 2012; Kolawole *et al*., 2014; Roudier *et al*., 2014; Mapfumo *et al.*,2015). To achieve sustainable climate change adaptation in low-income countries, there is a need for effective and efficient communication between small-scale farmers and the climate specialist (Goddard *et al*., 2010; Hansen. *et al.*, 2010). The challenge in low-income countries regarding climate information is its accessibility due to limited weather stations and obsolete equipment used to record weather elements (Ogallo, 2010).

Availability of agricultural extension services, and loan facilities, are other key enablers to achieving climate adaptation strategies (Hassan & Nhemachena, 2008; Balew, Agwata & Anyango, 2014). The respondents highlighted that information was very important in their quest for climate change adaptation.

5.6 Bridging the gap between indigenous and scientific knowledge systems in resolving climate variability challenges

An assessment of results from Table 4.15 shows that 61% of the participants in Gokwe South rely on indigenous knowledge systems (IKs) compared to 39% who said were using Scientific knowledge systems (SCs). Mapfungabutsi had the highest number (84%) of the respondents saying they were using indigenous knowledge systems in their agricultural activities. Sengwa respondents (78%) said they still rely on IKs to fight against the impacts of climate variability on their livelihood. Conversely, Sesame had 53% of the interviewed people saying they are using scientific knowledge for assessing weather and climate variability. Findings from this study have shown that both sources of knowledge, the IKs, and SCs have their challenges. Therefore, there is a need to integrate the two sources of knowledge to complement each other's weaknesses and come up with a hybrid of knowledge that can reduce the vulnerability of small-scale farmers in Gokwe South.

Most of the respondents indicated that they find IKs highly reliable. Indigenous knowledge adds value and has a significant contribution to those researchers who seek to integrate scientific and indigenous knowledge and produce holistic knowledge with cultural backgrounds (Ajani *et al*., 2013). Indicators of IKs are not recorded and disappear fast, they therefore need to be integrated with SCs. This analysis brings the idea of the search for an "Integration Approach of

Knowledge" Most of the farmers indicated that, as part of their physical assets, technology was crucial in the adaptation process.

The IPCC acknowledges that indigenous knowledge is an authentic source of information that can be utilised in various regions as climate adaptation knowledge by small-scale farmers (IPCC, (2014). Of several small-scale farmers who rely on rain-fed agriculture in Africa, 60-70 % of them are using IK to forecast seasonal weather patterns, however, they are willing to integrate the scientific weather forecasts in their quest to improve resilience and adaptations against challenges created by climate variability.

Several authors acknowledge the significance of indigenous knowledge in climate change adaptation in Zimbabwe (Gukurume, 2013; Mubaya & Mafongoya, 2017; Nyahunda & Tirivangasi, 2019; Chanza, *et al.*, 2019; Mashizha, 2019). The idea of complementarity between indigenous knowledge systems and scientific knowledge systems is observed in their common grounds of production, such as observation, experimentation, and validation of both knowledge systems (Hinkel, 2007; Kalowe *et al.*, 2014). Moreover, both indigenous and scientific knowledge in weather forecasting is produced through observation, experimentation, and validation, suggesting that there is a meeting point between the two forms of knowledge (Kolawole *et al.*, 2014). The concept of a search in knowledge integration is in the experimental stage in some of the communities in western Kenya Ogallo, (2010) and in Malawi, Kalanda-Joshua *et al.*, (2011) where the climate scientists and traditional knowledge custodians are fusing the two knowledge systems to create climate change adaptation strategies. Figure 5.4 shows a schematic diagram of the knowledge adaptation and mitigation approach.

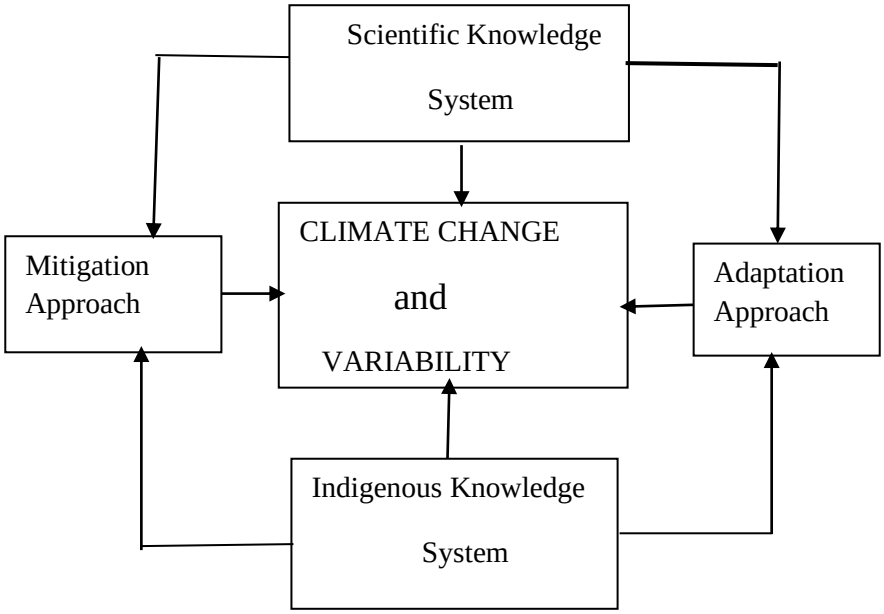


Figure 5.4: **Schematic diagram of knowledge adaptation and mitigation approach (KAMA)**

Source: Authors' Construction (2020).

Small-scale farmers are willing to combine their traditional climate forecasting systems and scientific knowledge forecasting systems, and they believe the integration of knowledge will help improve their adaptation strategies (Orlove *et al*., 2010). The reliability of IKS has been doubted by several communal farmers despite efforts to recognize and incorporate local knowledge in climate change adaptation practices (Joshua *et al*., 2011). This has been echoed by Bohensky *et al*., (2011) who supported the idea of merging the two types of knowledge with several advantages due to small-scale farmers in their quest for adaptation strategies.

The integration approach of local and scientific knowledge removes the dominance of scientific knowledge over indigenous knowledge, and the results of their combination will give a holistic and inclusive approach which is the Multiple Evidence Base (MEB) approaches (Tengo *et al*., 2014). The MEB (Figure 5.5) is a compromising approach unifying the scientific and traditional knowledge forecast systems and generating a universally acceptable approach towards climate change problems. It places both knowledge systems on an equal footing base and contributes toward an integrated knowledge system production.

The MEB has been seen as a viable approach to reducing the degree of vulnerability due to climate variability because there have been frequent droughts and floods in the Gokwe South

district. The small-scale farmers in the district have been victims of drought and floods hence the MEB (Figure 5.5) can be used to reduce their vulnerability. Therefore, the search for a knowledge integration approach is partly answered by the MEB approach. Figure 5.5 shows the Multiple Evidence Based approach.

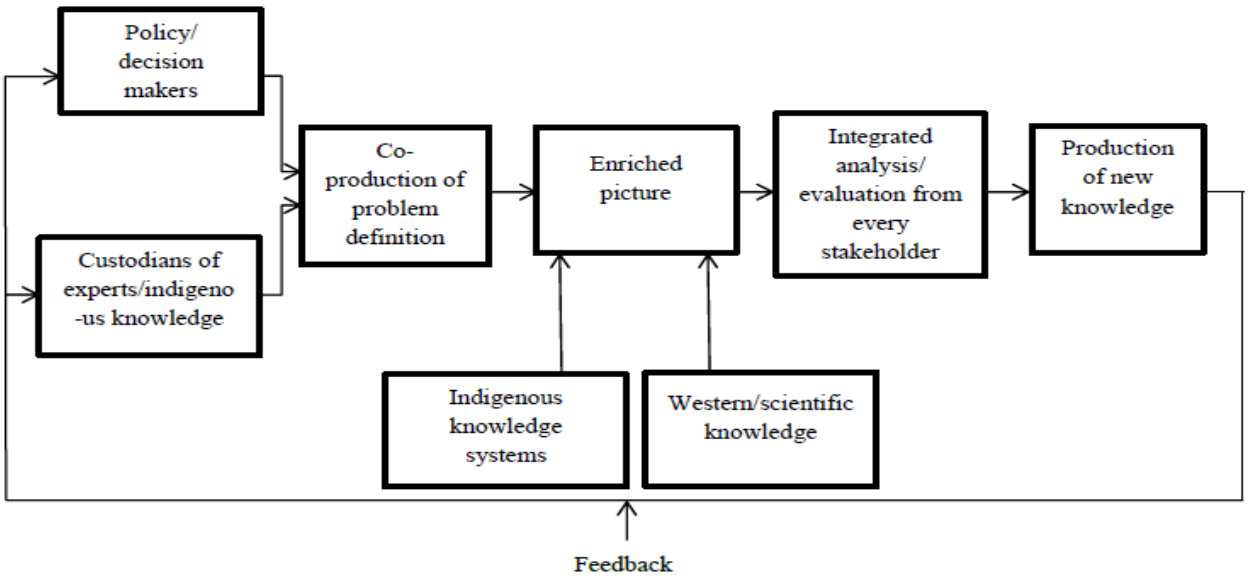


Figure 5.5*:* Multiple Evidence-Based (MEB)

Source: Tengo *et al*., (2014).

This study recommends that the (MEB), can be a starting point to consider for an integration process between local systems and scientific knowledge systems to achieve a sustainable climate change adaptation strategy. The reason for the integration and use of the MEB is that it removes the hegemony of one type of knowledge system on the other type. The feedback has a holistic approach where the two knowledge extremes give an enriched knowledge base that can be utilised by rural farmers to fight against the challenges of climate variability. The advantage of the MEB approach is that it combines the western and indigenous variables and therefore becomes more acceptable in the African culture. The ideas of the western policymakers and the knowledge of the custodians are both taken into consideration during this quest for the knowledge integration approach. Knowledge integration and hybridisation of indigenous and scientific knowledge aim to achieve sustainable climate change adaptation strategies which increase adaptive capacities and resilience (Shizha, 2006).

Knowledge hybridisation and integration will complement the two knowledge system's weaknesses and result in a knowledge base that is credible and sustainable (Mercer, 2012). In the

Limpopo River Basin, 3% of Zimbabwe's communal farmers rely on the Meteorological Services Department for climate information FAO (2004). The difference between IK and SK is important for the generation of hybrid knowledge. The view that indigenous knowledge is viewed from a social science perspective and Scientific Knowledge from the modern sciences, makes modern scientists find it difficult to acknowledge the contribution of local knowledge to climate change adaptation. The knowledge reconciliation between scientific and indigenous without one knowledge system overriding the other is highly credible in the quest for climate-proof agriculture, Mercer (2012). The idea of integrating scientific and indigenous knowledge has been supported by Mutasa, (2011) who argued for the positive contribution of indigenous knowledge to agricultural practices.

Small-scale farmers have built trust in their traditional leaders as they believe that chiefs and other elderly villagers have a close link with spiritual leaders and ritual specialists, and therefore they respect their instructions (Kolawe *et al.*, 2014; Roudier *et al.*, 2014). Although scientific climate and weather forecasts are regarded as accessible and accurate, small-scale farmers continue to respect information from their forefathers and community. Some elders also noted that scientific forecasts require electricity and sophisticated equipment to be accessible to most of the communal small-scale farmers. Figure 5.6 shows the future projection use of indigenous knowledge.

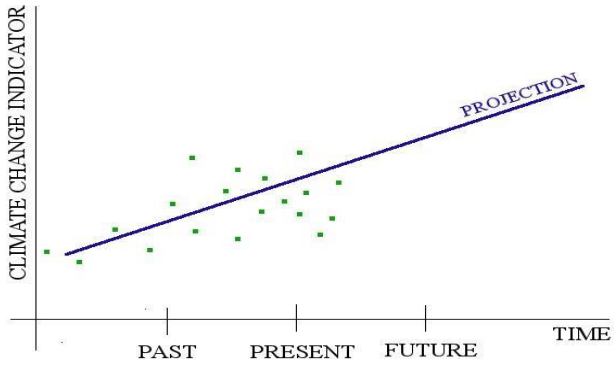


Figure 5.6: Future projection use of Indigenous knowledge

Source: Nawrotzki *et al.*, (2010).

Figure 5.6 shows that with time, indigenous knowledge will be widely used and increase in importance. Indigenous knowledge differs from scientific knowledge through certain characteristics (Lalonde, 1993; Gadgil *et al*., 1993; Ellen, Parkes & Bicker, 2000). Therefore, this type of knowledge might not apply and be transferable to other places because each region

may have its traditional values and culture on which the indigenous knowledge is hinged. Most indigenous knowledge is empirical and intuitive rather than theoretical and analytic knowledge. In most cases, the IK is usually asymmetrically distributed according to gender and age. Indigenous knowledge is distributed fragmentarily. The perception is that indigenous knowledge is holistic, integrative, and situated within broader cultural traditions. The IK has a moral and spiritual dimension in its execution as opposed to scientific knowledge which is more mechanistic. The IK is criticised by some scholars as a close-ended type of knowledge source that is very archaic and culturally based (Ellen & Harris, 2000). For the IK to be used by the future generation, there is a need to document it, digitally store it, and effectively distribute it in a way that can be understood by communal farmers to enable the blending of the two knowledge systems (Ponge, 2013).

For the small-scale farmers in SSA, including Zimbabwe's Gokwe South, there is an urgent need to narrow the divide between indigenous and scientific knowledge systems and come up with holistic knowledge that will resolve the challenges of climate variability, as noted by Mahoo *et al*., (2015) who stated that dual relationship of the two knowledge systems compensates each other's weaknesses. Given the above observation, Tengo *et al*., (2014), proposed that both indigenous knowledge systems and scientific knowledge systems should be treated as authentic sources of knowledge that can be utilised by small-scale farmers to improve their agricultural production.

Several small-scale farmers in Zimbabwe have lost faith in indigenous and scientific climate predictions and forecasts thus increasing agricultural losses. The inclusion of indigenous knowledge in the public domain may be overdue. Sentiments from some small-scale farmers in the Gokwe South district are that instruments used by the Meteorological Department of Zimbabwe are obsolete and they do not give reliable information in their climate and weather forecasts. Figure 5.7 shows a four-step framework for integrating indigenous knowledge and scientific knowledge.

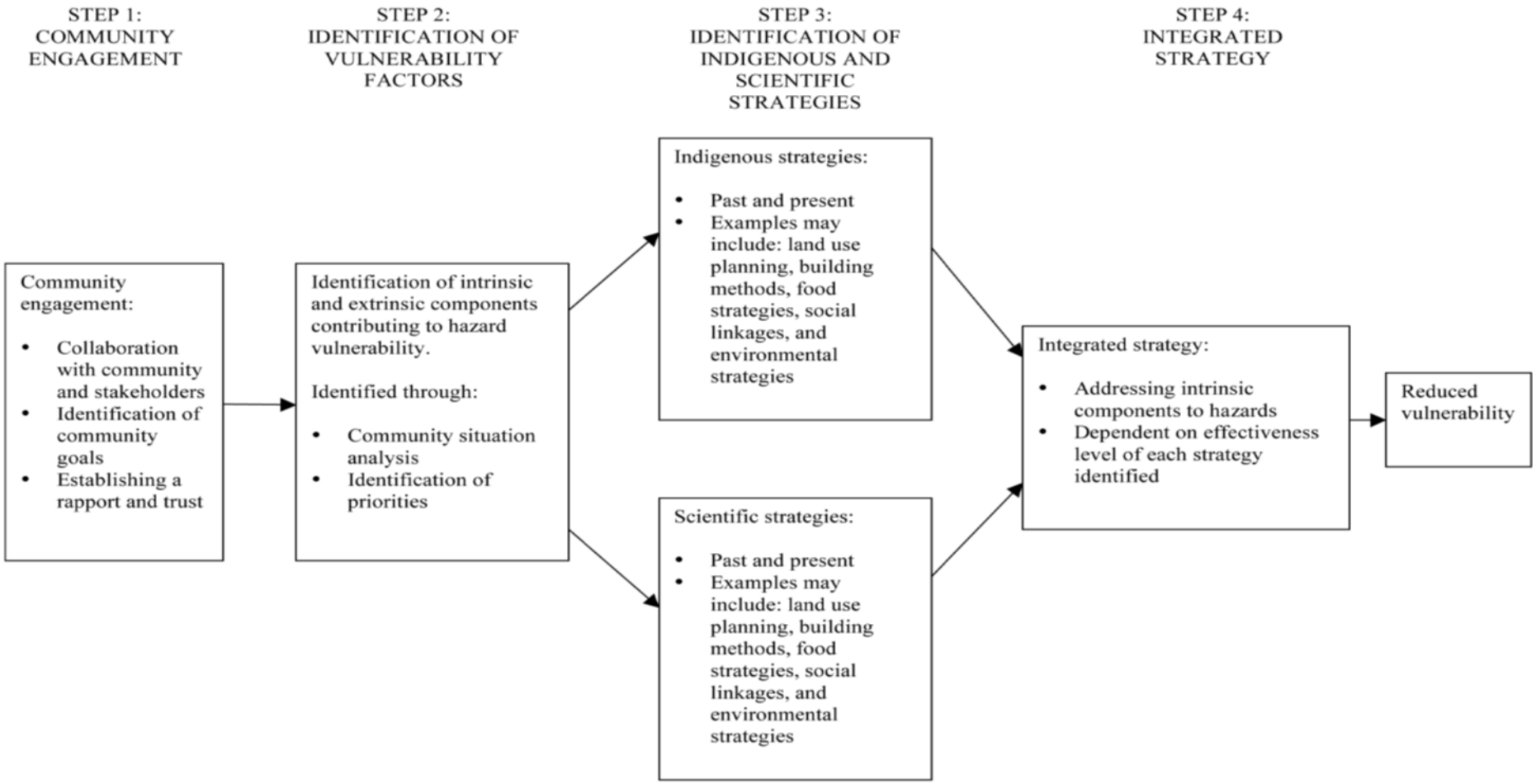


Figure 5.7: A four-step framework for integrating of indigenous knowledge system

***Source*:** Mercer *et al.*, (2010).

The step-by-step framework emphasises the vulnerability of small-scale farmers can reduce their vulnerability through a sequential process from community engagement then intrinsic and extrinsic identification of the causes of vulnerability. In step 3, the framework identifies both indigenous and scientific strategies to reduce the degree of vulnerability, and step number 4 shows the intended outcome of the integrated strategies of the two knowledge systems.

Debates about the incorporation of local knowledge in climate change and variability also come from an observation that small-scale farmers in rural communities are vulnerable to challenges of climate and weather hazards (Boko *et al*., 2007; Nyong *et al.,* 2007), yet they do not contribute much carbon dioxide emission which causes temperature increases (IUCN, 2008). The idea of climate governance should include all stakeholders from top to bottom and make sure that even the poor small-scale farmers are included (Chanza & de Wit 2016). This thesis proposes integrating a two-knowledge system to reduce the impacts of climate vulnerability (Mercer *et al*., 2010).

Several scholars view that IK has been the basis for survival for most rain-fed agriculturalists and their livelihood and therefore they are highly conscious of any environmental change and climate variability (King *et al*., 2008; Peloquin and Berkes, 2009; Turner & Clifton, 2009; and Green *et al*., 2010). Figure 5.8 shows the proposed framework for integrating Seasonal Climate forecasts into Indigenous Knowledge.

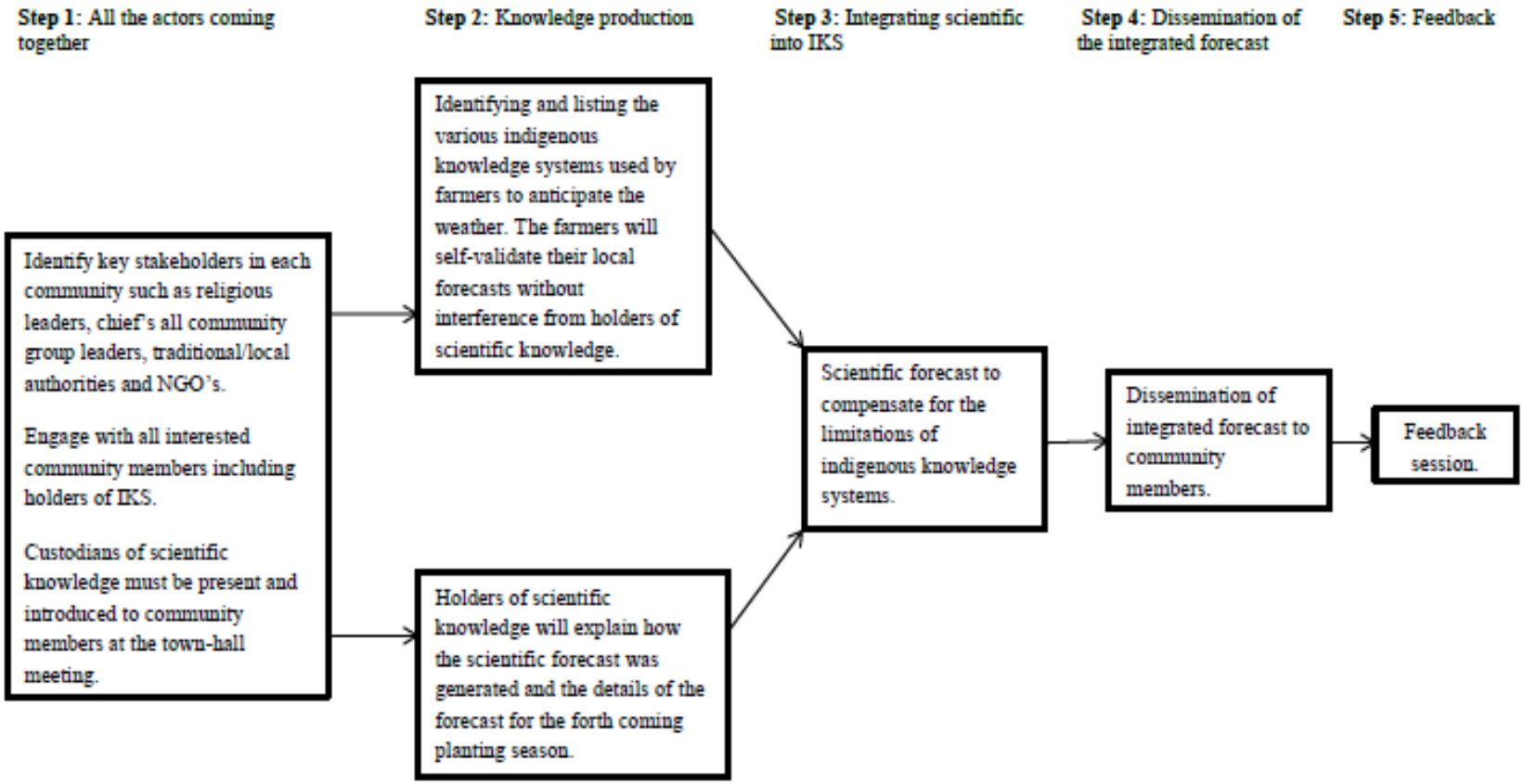


Figure 5.8: The proposed framework for integrating Seasonal Climate Forecast into indigenous knowledge systems

Source: Mercer *et al.*, (2010*).*

5.7 The wider implications of the empirical evidence

While scientific knowledge is becoming dominant in the contemporary search for knowledge to deal with climate change disaster-related events, this study revealed that for a successful climate change adaptation, the two knowledge systems must be integrated because they complement each other weaknesses. Climate variability is occurring at an alarming rate, to such an extent that the indigenous knowledge alone is becoming overwhelmed to give accurate climate forecasts (IPCC, 2014; Roncoli *et al.*, 2002). The results show that 61% of the small-scale farmers rely on indigenous knowledge systems creating what is called 'decision pathology' Wisner *et al.*, (1977) whereby the small-scale farmers' livelihoods are based on the information from indigenous knowledge (Ebhuoma *et al*., 2019).

This research has shown that Mapfungabutsi and Sengwa constituencies had low asset adaptability to climate variability because they are purely rural constituencies, unlike Gokwe Central, Sesame, and Kana constituencies which are peri-urban. Lack of financial assets was the main cause of vulnerability among small-scale farmers. Many farmers had adapted to many strategies like adopting drought-resistant crops for high temperatures and many proposed irrigation schemes as an adaptive strategy for shortages in rainfall. The whole district has an average vulnerability index of 3.04 with the highest value of 5 as highly adapted. About 96.7% of the interviewed people agreed that there was a general decrease in rainfall in the past 30 years. Several factors influencing the choice of adaptive strategies were identified in various constituencies. Several respondents also noted that they rely on IKS in the prediction of seasons than the scientific knowledge systems. Results in Table 4.15 revealed that 61% of respondents in Gokwe South rely on IKs compared to 39% who said were using SCs. A high percentage of 89% of the respondents knew about climate change and variability. Almost all (96.8%) of the participants perceived that the amount of rainfall received was decreasing over the past 30 years. About 88.88% of the respondents agreed that the temperature was increasing in the Gokwe South district. This indicates a high climate variability in the district. A shift in the onset of rainfall was acknowledged by 85.33% of the respondents. Most of the interviewed people (89.33%) were saying rainfall was starting much later than usual. One other phenomenon which was a measure of climate variability was the incidence of drought whereby 89.77% of the interviewees said that they were now experiencing frequent droughts in the recent past (See Table 4). The Government of Zimbabwe is trying to engage all stakeholders to embrace climate change adaptation strategies and achieve food security by the year 2030. In Zimbabwe, Climate Adaptation Policy is implemented through various strategies like the National Climate Change Response Strategy, the National Adaptation Plan, and the Low

Carbon Development Strategy. The search for a knowledge integration approach has been suggested by the application of the Multiple Evidence Base (MEB) as a practical starting point that integrates scientific weather forecasts and indigenous knowledge on weather forecasts.

Climate variability is a serious threat to livelihood and food security in Zimbabwe particularly to the rain-fed farmers. The Zimbabwe climate policy documents and institutional framework sought to create pathways to introduce climate-proof agricultural practices. As suggested by Zuka (2015), the success of climate adaptation strategies is dependent on the ability of the government to provide consistent and timeous funding to small-scale farmers. Research findings by Nyahunda & Tirivangasi (2019) in Bikita, noted that lack of institutional support has stifled the adaptation strategies and the level of vulnerability remains high impacting on food security. A similar research finding was noted in Chimanimani where institutional support was not sufficient to offset the impacts of climate variability which are visible in the district (Mutandwa *et al.*, 2019). The role of institutional support and policy documents play a key role in the climate adaptation process of small-scale farmers in rural communities.

Zimbabwe attempted to address the small-scale vulnerability, an assessment was done, and recommendations were made through pro-poor institutional policies to improve small-scale farmers' resilience and adaptation capacity. However, most of the institutional policies to assist small-scale farmers were stifled by several challenges, including corruption, and lack of funding to support climate change adaptation initiatives in rural areas. Various priorities are taking precedence over improving the small-scale farmers' adaptive initiatives. One challenge that militated against government efforts to effectively implement the institutional and policy frameworks was that most of the policies were highly politicised and as a result, some of the small-scale farmers from the opposition political parties did not benefit. The government had other priorities other than improving the resilience and adaptive capacity of small-scale farmers. (See Chapter 6). The role of government influence should not be underestimated in the success of climate change adaptation strategies (Shiferaw, 2014). Land acquisition and distribution also affected the decisions in adaptation strategies (Mandleni & Anim, 2011). The Land Reform Programme in Gokwe South affected the livelihoods of rural communities. It did not provide enough institutional support to the newly settled farmers (Chagutah, 2010; Muzari, *et al*., 2016). In Zimbabwe, the resettled farmers were given ninety-nine-year lease permits. Without the guarantee of private ownership of land, most of the resettled farmers were not able

to put the land into full production, hence food security in Zimbabwe was compromised (Chagutah, 2010).

Policymakers may use the results and implement policies that can improve climate-adaptive strategies and improve food security in rural areas. Several policy options were presented in Chapter 4 as identified by various stakeholders through interviews and questionnaires on their resilience to the impacts of climate change and variability. These recommendations should be implemented through government departments and rural institutions. While Zimbabwe has entered several regional and international platforms and conferences on climate variability, it is still facing a challenge to implement the policies that have been crafted to fight against the challenges of climate variability.

The crafting of Zimbabwe's revised NDC was informed by the National Development Strategy 1 (2021- 2025) which seeks to transform Zimbabwe into an upper-middle income economy by 2030 (GoZ, 2021). In this regard, Zimbabwe will pursue a holistic and balanced development trajectory, which seeks to balance national development, fulfilment of our multilateral international obligations, and sustainable development. The Zimbabwe National Development Strategy (2021-2025) framework, for example, captures "Environment Protection, Climate Resilience and Natural Resources Management" as a national priority to achieve sustainable socio-economic development (GoZ, 2021).

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter presents an introduction, conclusions of the thesis, and recommendations proposed by the authors, and it ends with the proposal of future research needs. The study aimed at investigating how small-scale farmers in the Gokwe South district use their asset portfolios to reduce the impacts of climate variability on their livelihoods. The chapter is divided into four sections where the first section is the introduction of the chapter, then the conclusion of the thesis, followed by the recommendations by the authors, and finally the future research needs. The second section focused on conclusions of the research findings based on empirical evidence and data analysis done in the preceding Chapter 5. The conclusions are important because they give the final answer to the aims and objectives of the study. The recommendations were based on key aspects debilitating small-scale farmers to achieve sustainable livelihoods and food security. The chapter concludes by outlining the future research studies which can enhance the understanding of climate change and variability discourses.

6.2 Conclusion

The research findings revealed that climate variability has caused many problems for small-scale farmers in the Gokwe South district. The quality and quality of asset portfolios are key resources affecting the level of vulnerability to climate variability. The asset mix was seen to be significant in reducing the vulnerability of small-scale farmers in Sengwa and Mapfungabutsi, the constituencies worst affected by climate variability due to poor asset endowment farmers in the Gokwe South district. The results have shown that the financial asset is affecting vulnerability most because it can be converted into other assets through buying. There is weak institutional intervention rendering many small-scale vulnerable to climate variability, the government is not fully supporting the small-scale farmers to increase their adaptive capacity and resilience. The climate-related problems in the Gokwe South district are attributed to climate change, which resulted in an agroecological shift exposing some farmers

to extreme climate conditions. Small-scale farmers are finding hope in Pfumvudza Agriculture which was introduced by the Government of Zimbabwe to buttress food insecurity and poverty among rural communities. The research findings also noted that the demographic and socio-economics factors are factors affecting the farmers' ability to adapt to impacts of climate variability most in district. The most preferred adaptation strategy in Gokwe South district was the multiple crop farming. Gokwe Centre has better assets and therefore it has a better climate variability adaptation, compared to the rest of the constituencies. Generally, the whole district has an asset vulnerability of 3.04.

A perfect asset mix of financial, physical, social, natural, and human assets in above-average proportions can reduce the vulnerability of small-scale farmers in Gokwe South and Zimbabwe as a whole. Adaptive capacity is inversely related to climate vulnerability. The FGD revealed that the top-down approach to the vulnerable communities did not yield the intended results hence there is a need for the bottom-up approach or mixing of the two approaches.

Besides the criticisms levelled against the use of indigenous knowledge systems by subsistence rain-fed farmers, many of them continue to use it as the basis of climate and weather forecasts put forward by (Kalanda, *et al.*, 2011; Nkomwa *et al.,* 2014). The research findings proved that the search for knowledge integration, basically the IKs and the SKs to fill the knowledge gap on the small scale to realize their full potential in reducing the impact of climate change variability and the vulnerability of farmers is long overdue. The need for knowledge integration should be an approach to solving problems of climate variability.

The findings from the research also noted that there is a relationship between climate variability and asset portfolios (Huq, 2007; Moser, 2008; Prowse & Scott; 2008). This study also revealed that several factors that contribute to limited adaptive capacity include: the low levels of investment in irrigation; weak early warning systems that disadvantage timely dissemination of early warning information; limited funding for research and development of drought-tolerant varieties; and lack of effective extension service provision, and limited adoption of climate-smart agricultural practices. As put by Padgham *et al.,* (2013) climate warning information can only be effective when it is timeously sent in an appropriate language that can be understood by the small-scale farmers in the region. Generation and dissemination of climate and weather information to small-scale farmers in the Gokwe South district has been cited as a prohibitive mechanism to proactive climate adaptation strategies (Hellmuth *et al*., 2007). The MEB

provided an option of a viable approach to reducing the degree of vulnerability due to climate variability because there have been frequent droughts and floods in the Gokwe South district, hence the MEB (Figure 5.5) can be used to reduce their vulnerability. The Zimbabwean government has fragmented climate variability policies that need to be integrated and well-coordinated to achieve sustainable climate adaptation strategies. Generally, there is a lack of inter-ministerial coordination on climate variability adaptation strategies.

Considering the above expositions and observations, small-scale farmers in the Gokwe South district are active victims of climate variability. They are drawing from their asset portfolios to reduce the impacts of climate variability. Both IKs and SKs are contributing to weather and climate forecasts. To improve the adaptive capacities of small-scale farmers in which the integration of the two knowledge systems is recommended and is expected to contribute positive results to the end-users.

This thesis has created a focal point for many stakeholders such as policymakers, academia, various practitioners, climate scientists, and small-scale farmers to fight against the negative impacts of climate variability and change. The findings also provided insight into the possibility of integrating indigenous knowledge and scientific knowledge to give unpolarised solutions to the problems created by climate variability, particularly for small-scale farmers.

This thesis has drawn much guideline from various models. The Vulnerability Matrix (Figure 2.3) was helpful in assessing the degree of vulnerability of the small-scale farmers in Gokwe South district. The equation by Pearson *et al*., (2008) was used to assess the significance of asset portfolios in Gokwe South district. The climate change vulnerability model by Isoard (2008) also gave an insight into how climate change and variability impacted the small-scale farmers in Gokwe South district. The Human Response Model by Smit *et al*, (1999) enabled the researcher to assess the types of adaptation in Gokwe South district. Turner's Vulnerability Framework by Turner et al., (2003) was used as a basis for analysing exposure, sensitivity, and adaptive capacity in Gokwe South district. The Sustainable Livelihood Framework which incorporated the asset portfolios to adapt to climate variability was highly applauded. However, the authors' contributions were that they were able to identify and analyse some of the asset portfolios that were not included in the models particularly the intangible assets used to improve the adaptive capacity. Also, the use of technology added a new dimension to the quest for the solutions of climate variability in Gokwe South district.

6.3 Recommendations

In view of the above observation, we recommended that the GoZ should involve the small-scale farmers from the local scale to the national. Therefore, we are recommending that the bottom-up and top-bottom approach should form the basis of climate variability adaptation in Gokwe South district. The implementation of the recommendations should be based on the geography of the area and the availability of assets to adapt to climate variability in district.

Climate variability adaptation can only yield positive results if the vulnerability of communal farmers can be understood in the context of asset availability and asset mix. In view of the above findings, the Government is recommended to undertake many initiatives and strengthen their policies and priorities towards the population who are vulnerable to the impacts of climate variability. The government of Zimbabwe and various departments have put in their weight to support climate adaptation strategies to ensure food security in the Gokwe South district.

The small-scale farmers who are seriously affected by climate variability are the ones who should manage its effects. Therefore, IK should be recorded so that it can be retrieved for future use. Since climate continues to change, there is also a need for a continuous monitoring of climate variables of the country and advice the small-scale farmers periodically so that they adapt to climate variability (See Figure 2.2 and Figure 2.3).

The GoZ is also recommended to strengthen strategies that consider both animal and crop production. Due to climate variability, small-scale farmers are recommended to strengthen their capacity for drought-resistant crops and animals. The government should also address constraints and obstacles and ensure that they promote food security and poverty alleviation. The socio-economic, environmental, and political barriers should be addressed. Generally, there is a need to adopt conservation and smart agriculture, to make sure the country does not experience food insecurity. The research findings noted that the small-scale farmers in the Gokwe South district have two options “to adapt or die” due to the impacts of climate variability.

6.3.1 Public awareness and communication

Climate change and variability information should be ubiquitous to all stakeholders, particularly small-scale farmers in rural areas. This thesis recommends that the government improve the provision of climate extension services, particularly to small-scale farmers with climate-sensitive livelihoods. It also recommends that the agro-meteorological information should reach the small-scale farmers in a manner that is well-understood even by women and other vulnerable communities. Media practitioners should make sure climate information is disseminated to rural communities in a manner that is understandable to the public. The GoZ should also enhance early warning and climate-related disaster risk reduction systems (including information management systems), (GoZ, 2021).

6.3.2 Use of indigenous knowledge systems

IKS has been used in Low-Income Countries to determine the agricultural calendar for small-scale farmers (Eakin, 1999; Nyong *et al*., 2007; Kolawole, 2012; Al Mamun *et al*., 2014). The IKS of small-scale farmers in Low-Income Countries has become increasingly unreliable (Roncoli *et al*., 2002). Zimbabwe acknowledges the utility of IKs in complementing scientific knowledge on climate variability. IK is facing a serious challenge in that it is lost because it is undocumented, therefore it should be stored in databases. A database for IKs should be established, and there is a need to merge it with scientific knowledge and include it in the national policies for retrieval and use by small-scale farmers. Improving and increasing indigenous knowledge can bring a positive change to agricultural output both in crop and animal production.

6.3.3 Financial resource allocation, mobilisation, and management

The government needs to make sure that climate funding is consistent and accessible to several small-scale farmers. Given this paucity of funding, this thesis recommends the government should prioritise climate change programmes and provided sufficient funding. Resources mobilised for climate change adaptation programmes should be closely monitored because there is a tendency for misappropriation and embezzlement of funds. The money budgeted for agricultural development and climate change adaptation is diverted before it reaches the

intended recipients. The government is recommended to make sure that the money and other resources are used in the manner budgeted for. The small-scale farmers also have a tendency of diverting the borrowed money to various things such as school fees and other priorities. Unequitable distribution is another challenge. Members of the opposition political parties are omitted from such benefits, hence it is difficult to fully implement climate change adaptation strategies in areas like Gokwe South district which is politically divided.

6.3.4 Strengthen climate governance, and resilience

It is recommended that the government of Zimbabwe have a comprehensive and inclusive climate governance approach so that it will be able to decide, manage, implement, and monitor climate policies and measures to achieve sustainable climate change adaptation. Climate governance can be applied through different concepts such as multilevel, participatory, adaptive, and flexible governance. Multilevel governance involves the relationships of all institutions in the country from the local past regional to national levels. In this climate adaptation governance, information can flow from top to bottom and vice-versa. This study also noted that participatory climate governance is important because it allows direct public engagement in decision making such as focus group discussions, involvement in any voting process, and budgeting. Small-scale farmers should be involved actively in climate governance programmes. In support of the above climate governance. It is recommended that the government of Zimbabwe to practise flexible climate governance in which social learning and rapid feedback for all stakeholders in planning through experimental and management processes (IPCC, 2019). Bottom-up strategies should be enforced to achieve climate adaptation objectives and hence reduce climate change vulnerability and improve the resilience of rural farmers. The promotion of private-public participation in climate change is an encouragement for all stakeholders to achieve a climate-resilient country. The government should work towards achieving global emission targets to reduce the impacts of global warming and climate change.

6.3.5 Role of gender in climate change adaptation

In most parts of the SSA, women are regarded as environmental managers, for they are mainly involved in fetching firewood, fetching water, and weeding crops. Given such roles, women

should be actively involved in climate change-related activities. Due to gender roles in Zimbabwe, female small-scale farmers are usually excluded from climate change programmes, and they have limited access to extension services hence they are vulnerable to climate change and variability. Women are not much involved in many climate-initiative programmes, they have limited access to resources and climate (Mehar *et al*., 2016). There are gender inequalities in terms of exposure, access to resources, vulnerability, opportunities, and capabilities to climate change information (Afriyie *et al*., 2017; Madhuri, 2016). Climate adaptation policies and strategies in Zimbabwe should consider gender roles at all levels of governance Chagutah, (2010). In Zimbabwe, due to cultural gender role, the degradation of forests, watersheds, and agricultural lands place enormous responsibility of adaptation on women under conditions of climate change. The operational policy frameworks for climate change in Zimbabwe are gender-sensitive (Chagutah, 2010). Both males and females are carriers, custodians, and transmitters of climate information. Therefore, processes and systems that formulate plans, and strategies must be gender- sensitive and gender- responsive.

6.3.6 Exploring adaptation strategies to reduce the impacts of climate variability

Several authors testified that social, economic, land tenure, the geography of the area and institutional support, influence the choice of adaptive strategy against the challenges of climate change (Deressa *et al*., 2009; Bryan *et al.,* 2009; Below *et al.*, 2012). The government should be doing enough to realise its full potential in climate adaptation. The use of appropriate technology, weather forecast information, capacity building, infrastructural development, education and training of the small-scale farmers, and appropriate crop varieties for a specific agroecological regions should be effectively implemented in Zimbabwe. To facilitate successful adaptations and resilient human settlements, it is necessary to consider the differences in the vulnerability of various groups in rural settlements. There is a need to integrate adaptation into human development programmes and capacity building for small-scale farmers' development of agricultural infrastructure such as roads, earth dams, and granaries, with a particular focus on the poor and improving living conditions for all. Agricultural extension services should be readily available in a language that small-scale farmers can understand.

6.4 Future Research Needs

Climate variability has affected various sectors of the economy and it has left an indelible mark that future generations will have challenges to erase. One potential gap for future research needs is to explore the extent to which climate education is implemented in primary and secondary schools and how best IK can be included in the educational curriculum. Future research should also focus on identifying IKs erosion in communal areas and finding a means to document and store indigenous knowledge systems, in a retrievable database. An assessment of the relationship between climate adaptation, vulnerability thresholds and coping range needs to be explored in the future to better equip small-scale farmers for climate change risks.

There should be an attempt to quantify the indigenous knowledge indicators and systems for assessing climate change and variability that needs further exploration. The use of Geographical Information Systems (GIS) in indigenous knowledge systems should be attempted to improve its applicability in various parts of the globe. One area that needs further research is the impact of climate change on the tourism industry. Climate change may bring positive and negative impacts to the tourism industry in Zimbabwe. Some of the tourist destinations may have been negatively affected.

One aspect to be investigated for future research is climate change and its impact on migration. Most Zimbabweans left the country because of the frequent droughts and floods such as Cyclone Idai which occurred in 2019 and swept across Mozambique and the eastern part of Zimbabwe. Another area of research needs is the impact of climate change on groundwater in the drainage basins of Zimbabwe. Another area of interest to be investigated in the realm of climate change is the impact of climate change on the generation of electricity in the southern part of Africa since most of the hydrological regimes of the main rivers' discharge like the Zambezi River have been greatly affected. Future studies should also focus on gender and climate variability and change. From this study, it has been noted that the role of women in climate variability and change is underscored. The integration of women in climate discourses from national to international forums will probably bring a positive change to the challenges orchestrated by climate variability since women in rural areas are involved in agricultural activities.

REFERENCES

Accra, (2011). The *ACCRA Local Adaptive Capacity Framework* (Uganda, Mozambique, and Ethiopia): Retrieved from: http://community.eldis.org/accra/ (Accessed on 12/07/2020).

Adekunle, A. (2015). *Agricultural Mechanisation*. Background paper. Feed African Institute for Agrarian Studies Baseline Surve. Inter-district household and whole farm survey database. Harare: African Institute for Agrarian Studies (AIAS), Harare.

Adesoji, S. A., & Ayinde, J. O. (2013). Ethno-practices and adaptation strategies for the mitigation of climate change by arable crop farmers in Osun State: Implications for extension policy formulation in Nigeria. *Journal of Agricultural and Food Information,* 14 (1), pp. 66-76.

Adger, W. N., & Kelly, P. M. (1999). Social vulnerability to climate change and the architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change,* 4 (3), pp. 253-266.

Agoumi, A. (2003). *Vulnerability of North African countries to climatic changes: Adaptation and implementation strategies for climatic change*. IISD/Climate Change Knowledge Network. Retrieved from http://www.cckn.net//pdf/north_africa.pdf (Accessed on 16/07/2020).

Aguado, E. & Burt, J. E. (2010). *Understanding Weather and Climate*. New York: Prentice Hall.

Ajani, E. N., Mgbenka, R. N., & Okeke, M. N., (2013). Use of indigenous knowledge as a strategy for climate change adaptation among farmers in sub-Sahara Africa: policy implications, *Asian Journal of Agricultural Extension, Economics, and Sociology,* 2 (1), pp. 23-40.

Al Mamun, M. A., Shultana, R., Rana, M. M., & Mridha, A. J., (2014). Climate change adaptation strategies through indigenous knowledge system: aspect on agro-crop production in the flood-prone areas of Bangladesh. *Asian Journal of Agriculture and Rural Development*, 4, pp. 42–58.

Ali, F., Thaver, I., & Khan, S. A. (2014). Assessment of dietary diversity and nutritional status of pregnant women in Islamabad, Pakistan. *Journal of Ayub Medical College Abbottabad*, 26 (4), pp. 506–509.

Alvesson, M. (2011). Rethinking Interviews: New Metaphors for Interviews. Interpreting Interviews. In, Alvesson M (control.) *Research Methods*. Thousand Oaks, CA, SAGE.

Antwi-Agyei, P., Stringer, L. C., & Dougill, A. J. (2014). Livelihood adaptations to climate variability: insights from farming households in Ghana., *The Journal of Regional and Environmental Change* , 14, pp. 1615-1626.

Antwi-Agyei, P., Dougill, A. J., & Stringer, L. C. (2015). Barriers to climate change adaptation: Evidence from northeast Ghana in the context of a systematic literature review. *Journal of Climate and Development*, 7 (4), pp. 297–309.

Anyoha, N. O., Nnadi, F. N., Chikaire, J., Echetama, J. A., Utazi, C. O., & Ihenacho, R. A. farmers in Umuahia South Area of Abia state, Nigeria. *Net Journal of Agricultural Science*, 1 (2), pp. 42–47.

Appiah-Opoku, S. (2005). *The Need for Indigenous Knowledge in Environmental Impact Assessment: The Case of Ghana. African Studies*, 74. New York: Edwin Mellen Press.

Arbuckle, Jr, J. G., Morton, L. W., & Hobbs, J. (2013). Farmer beliefs and concerns about climate change and attitudes toward adaptation and mitigation: evidence from Iowa. *Journal of Climatic Change*, 118 (3–4), pp. 551–563.

Asfaw, A., & Admassie, A. (2004). The role of education on the adoption of chemical fertiliser under different socio-economic environments in Ethiopia. *Journal of Agricultural Economics*, 30 (3), pp. 215–228.

Ashley, C., & Carney, D. (1999). *Sustainable Livelihoods: Lessons from Early Experience*. Department for International Development, Printed by Russell Press Ltd., Nottingham London.

Asian Coalition for Housing Rights (ACHR). (2005). Tsunami: How Asia's precarious coastal settlements are coping after the tsunami, housing by people in Asia. *Housing by people in Asia*, No. 16, August, ACHR, Bangkok.

Asif, M. (2013). Methodological pluralism concerning recent literature. *European Journal of Research in Social Sciences,* (1), pp. 24–37.

Balama, C., Augustino, S., Eriksen, S., & Makonda, F. B. S. (2016). Forest adjacent households' voices on their perceptions and adaptation strategies to climate change in Kilombero District, Tanzania. *Springer Plus*, 5 (1), pp. 1-21.

Balew, S., Agwata, J., & Anyango, S. (2014). Determinants of adoption choices of climate change adaptation strategies in crop production by small-scale farmers in some regions of central Ethiopia. *Journal of Natural Sciences Research*, 4 (4), pp. 78–93.

Bandara, J.S., & Cai, Y. (2014). The impact of climate change on food crop productivity, food prices and food security in South Asia. *Economic Analysis and Policy,* (44), pp. 451–465.

Banerjee, A., Duflo, E., Chattopadhyay, R., & Shapiro, J. (2007). *Targeting Efficiency: How well can we identify the poor?* Working Paper Series 21. Institute for Financial Management and Research Centre for Micro Finance Retrieved from http://povertyaction.org/sites/default/files/89 Duflo Banerjee Targeting Efficiency. (Accessed on 16/08/2020).

Baumann, P. (2000). *Sustainable livelihoods and political capital: Arguments and evidence from decentralisation and natural resource management in India:* Working Paper 136. London, Overseas Development Institute.

Baumann, P., & Sinha, S. (2009). *Linking development with democratic processes in India: political capital and sustainable livelihoods analysis. natural resource perspectives* No. 68*:* Overseas Development Institute, London.

Bebbington, A. (1999). Capitals and capabilities: a framework for analysing peasant viability, rural livelihoods, and poverty. *World Development,* 27 (12), pp. 2021-44.

Beddington, M., Asaduzzaman, C., Nguyen van B., & Wakhungu. (2012). The role of scientists in tackling food insecurity and climate change. *Agriculture and Food Security* **1**, p. 10.

Bell, J. (2013). *Doing Your Research Methods.* Buckingham. Open University Press

Béné, C., Cannon, T., Davies, M., Newsham, A., & Tanner, T. (2014). *Social Protection and Climate Change,* (No. 16). Paris, OECD Publishing.

Berg, B. L. (1995). *Qualitative Research Methods for the Social Sciences*. 2nd Edition. Allyn and Bacon. USA.

Berkes, E. (1994) Co-management: bridging the two solitudes. *Northern Perspectives*, 22, pp. 18-20.

Berkes, E., & Henley, T. (1997). Co-management and traditional knowledge: threat or opportunity. *Policy Options,* 18, pp. 29-31.

Berneshawi, S. (1997). Resource management and the Mi'lkmaq nation. *Canadian Journal of Native Studies,* 17, pp. 115-148.

Bhavnani, A., Chiu, R.W.W., Janakiram, S., Silarszky, P. & Bhatia, D. (2008). *The role of mobile phones in sustainable rural poverty reduction.* Washington, DC: ICT Policy Division, Global Information and Communications Department (GICT), World Bank.

Biggs, E. M., Tompkins, E. L., Allen, J., Moon, C., & Allen, R. (2013). Agricultural adaptation to climate change: observations from the Mid-Hills of Nepal. *Climate and Development*, 5 (2), pp. 165–173.

Birkmann, J. (2006). Measuring vulnerability to promote disaster-resilient societies: conceptual frameworks and definitions. In: BIRKMAN, J. (ed.). *Measuring Vulnerability to*

Natural Hazards: Towards Disaster Resilient Societies. United Nations University Press, Tokyo. pp. 9-54.

Blandford, A. (2013). Semi-structured qualitative studies. In: Soegaard, Mads and Dam, Rikke Friis (eds). *The Encyclopedia of Human-Computer Interaction,* (2nd ed). Aarhus, Denmark. Available online at http://www.interactiondesign.org/encyclopedia/semi-structured_qualitative studies.

Boer, G. J., Stouffer, R. J., Dix, M., Noda, A., Senior, C. A., Raper, S., & Yap, K. S. (2001). Projections of Future Climate Change. In J.-W. Kim, J. Stone (Eds.), *Climate Change 2001*: *The Scientific Basis*. Cambridge: Cambridge University Press, UK

Bohensky E.L., & Maru, Y. (2011). Indigenous knowledge, science, and resilience: What have we learned from a decade of international literature on integration? *Ecology and Society,* 16 (4), pp. 6.

Bohle, H. G, Downing, T. E., & Watts, M. J. (1994). Climate change and social vulnerability: toward a sociology and geography of food insecurity. *Journal of Global Environmental Change,* 4 (1), pp. 37-48.

Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R., & Yanda, P. (2007). 'Africa'. In. Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. and Hanson, C.E. (eds.), *Climate Change (2007)*: *Impacts, Adaptation and Vulnerability*. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, pp. 433–467.

Bola, G., Mabiza, C., Goldin, J., Kujinga, K., Nhapi, I., Makurira, H., & Mashauri, D. (2014). Coping with droughts and floods: a case study of Kanyemba, Mbire District, Zimbabwe. *Journal of Physics and Chemistry of the Earth, Parts A/B/C*, pp. 67–69, pp. 180–186.

Bourke, B. (2014). Positionality: reflecting on the research process. *The Qualitative Report,* 19 (33), pp. 1-9.

Bowling, A. (2002). *Research Methods in Health: Investigating Health and Health Services* (2nd ed). Buckingham: Open University Press.

Boyd, H. K., Westfall, R., & Stasch, S. F. (1981). *Marketing Research: Text and Cases*. Richard d Irwin; 7th edition, USA.

Brazier, A. (2017). *Climate Change in Zimbabwe*: *A Guide for Planners and Decision-Makers*; 2nd Edition, Konrad Ademar Stiftung. Alexandra Park, Harare, Zimbabwe.

Briggs, J., & Moyo, B. (2012). The resilience of indigenous knowledge in small-scale African agriculture. *Scottish Geographical Journal,* 128 (1), pp. 64-80.

Brooks, N. (2003). *Vulnerability, risk, and adaptation: a conceptual framework*. Tyndall Centre for Climate Change Research Working Paper, 38, pp.1-16.

Brown, K. (2003). Three challenges for real people-centred conservation. *Journal of Global Ecology and Biogeography*, 12, pp. 89-92.

Brown, K., & Westaway, E. (2011). Agency, capacity, and resilience to environmental change: lessons from human development, well-being, and disasters. *Annual Review of Environment and Resources*, 36, pp. 321-342.

Brüntru, M., & Tsegai, D. (2017). *Drought adaptation and resilience in developing countries, in promoting food security in rural Sub-Saharan Africa*; German Development Institute , Briefing Paper 23/2017, United Nations.

Bryan, E., Deressa T. T., Gbetibouo & Ringler, C. (2009). Adaptation to Climate Change in Ethiopia and South Africa: options and constraints. *Environmental Science Policy,* 12 (4), pp. 413-426.

Bryman, A. (2008). *Social Research Methods*. New York: Oxford University Press.

Bryant, C. R., Smit, B., Brklacich, M., Johnston, T. R., Smithers, J., Chiotti, Q., & Singh, B. (2000). Adaptation in Canadian agriculture to climatic variability and change. *Journal of Climatic Change*, 45 (1), pp. 181–201.

Burns, N., & Grove, S. K. (2003). *Understanding Nursing Research*. 3rd Ed. Philadelphia, W.B. Saunders Company, USA.

Butt, T. A., McCarl, B. A., & Kergna, A. O. (2006). Policies for reducing agricultural sector vulnerability to climate change in Mali. *Journal of Climate Policy*, 5 (6), pp. 583–598.

Bwalya, M. (2013). *Comprehensive Africa Agriculture Development Programme (*CAAD*)*, New Partnership for Africa's Development (NEPAD) , Midrand, South Africa

Cabrera, V. E., Letson, D., & Podestá, G. (2007). The value of the climate information when farm programs matter. *Journal of Agricultural Systems,* 93, pp. 25-42.

Care, (2010). *Toolkit for Integrating Climate Change Adaptation into Development Projects* – Digital Toolkit – Version 1.0. CAE International Institute for Sustainable Development (IISD).

Carling, J., Erdal, M. B., & Ezzati, R. (2013). Beyond the insider-outsider divide in migration research. *Journal of Migration Studies*, 2 (1), pp. 36-54.

Carney, D., Drinkwater, M., Rusinow, T., Neefjes, K., Wanmali, S., & Singh, N. (1999). *Livelihoods approach compared:* A brief comparison of the livelihoods approaches of

the UK Department for International Development (DFID), CARE, Oxfam, and the United Nations Development Programme (UNDP), November 1999. London: Department for International Development.

Carr, L. T. (1994). The strengths and weaknesses of quantitative and qualitative research: what method for nursing. *Journal of Advanced Nursing*, 20 (4), pp. 716-721.

Carr, E. R. & Kettle N. P. (2009). The challenge of quantifying susceptibility to drought-related crisis. *Journal of Regional Environmental Change,* 9 (2), pp. 131–136.

Chagonda, I., Mugabe, F. T., Munodawafa, A., Mubaya, C. P., Masere, P., & Murewi, C. (2015). Engaging smallholder farmers with seasonal climate forecasts for sustainable crop production in semi-arid areas of Zimbabwe. *African Journal of Agricultural Research,* 10 (7), pp. 668-676.

Chagutah, T. (2010). *Climate Change Vulnerability and Preparedness in Southern Africa*: *Zimbabwe Country Report,* Heinrich Boell Stiftung, Cape Town.

Chambers, R., & Conway, G. (1992). *Sustainable rural livelihoods. practical concepts for 21st Century*. Discussion Paper 296. Brighton, England: Institute of Development Studies.

Chang'a, L. B., Yanda, P. Z., & Ngana, J. (2010). Indigenous knowledge in seasonal rainfall prediction in Tanzania: A case of the South-western Highland of Tanzania. *Journal of Geography and Regional Planning,* 3 (4), pp. 66-72.

Chanza, N. (2014). *Indigenous Knowledge and Climate Change*: *Insights from Muzarabani, Zimbabwe.* Nelson Mandela Metropolitan University, Port Elizabeth, South Africa.

Chanza, N. (2015). *Indigenous knowledge practices related to climate change: case of Muzarabani, Zimbabwe,* Unpublished PhD thesis, Nelson Mandela Metropolitan University, South Africa.

Chanza, N., & de Wit, A. (2015). Rediscovering indigenous climate knowledge for better responses to climate change: insights from Muzarabani. *International Journal of Climate Change: Impacts and Responses,* 6, pp. 19–35.

Chanza, N., & de Wit, A. (2016). Enhancing climate governance through indigenous knowledge: case in sustainability science. *South African Journal of Science,* 112, pp. 35–41.

Chazovachii, B. (2016). *Conditions Characterizing the Sustainability of Smallholder Irrigation Schemes: The Case of Bikita District Zimbabwe*. PhD thesis, University of The Free State, South Africa.

Chifamba, E. (2012). Climate Hazard Management to Promote Sustainable Land Management in Dry Region of Gokwe, Zimbabwe. *Journal of Environmental Science and Water Resources*, 1 (7), pp. 169-177.

Chirimuuta, C., & Mapolisa, T. (2011). Centring the peripheries' systems: Zimbabwean indigenous knowledge systems for food security. *Zimbabwe International Journal of Open & Distance Learning*, 1, pp. 52–56.

Choi, H. S., Schneider, U. A., Rasche, L., Cui, J., Schmid, E., & Held, H., (2015). Potential effects of perfect seasonal climate forecasting on agricultural markets, welfare, and land use: A case study of Spain. *Journal of Agricultural Systems*, 133, pp. 177–189.

Clapp, R. A. J. (1988). Representing Reciprocity, Reproducing Domination: Ideology and labour process in Latin America Contract farming. *The Journal of Peasant Studies,*16 (1) , pp. 5-39.

Clarke, R. (Ed). (1986). *The Handbook of Ecological Monitoring*. Clarendon Press, Oxford, pp. 298.

Clements, R., Haggar, J., Quezada, A., & Torres, J. (2011). *Technologies for Climate Change Adaptation: Agriculture Sector.* United Nations Environment Programme Climate Change Management in Africa, CTA, Wageningen, The Netherlands.

Conway, D., & Schipper, E. L. F. (2011). Adaptation to climate change in Africa: challenges and opportunities identified from Ethiopia. *Global Environmental Change,* 21, pp. 227–237.

Conway, G. (2011). *On being a smallholder. conference on new directions for smallholder agriculture*, pp. 24–25. Rome, Italy.

Cooper, P. J. M., Dimes, J., Rao, K. P. C., Shapiro, B., Shiferaw, B., & Twomlow, S. (2008). Coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Africa: an essential first step in adapting to future climate change? *Agriculture, Ecosystems and Environment,* 126, pp. 24–35.

Crang, M. (2002). Qualitative methods: the new orthodoxy? *Journal of Progress in Human Geography*, 26 (5), pp. 647-655.

Crawford, 1. M. (1997). *Marketing Research and Information Systems*. Food and Agriculture Organization of the United Nations, Rome.

Creswell, J. W. (2002). *Educational research: Planning, conducting, and evaluating quantitative and qualitative approaches to research*, Upper Saddle River, NJ, Merrill/Pearson Education.

Creswell, J. W. (2008). *Research Design: Qualitative, Quantitative, and Mixed Methods approach* Los Angeles, CA.; London, Sage.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approach,* . doi: 10.1016/j.math.2010.09.003. (Accessed on 14/04/2021).

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approach - 4th ed*., SAGE Publication, Inc.

Croppenstedt, A., Demeke, M., & Meschi, M. M. (2003). Technology adoption in the presence of constraints: the case of fertilizer demand in Ethiopia. *Review of Development Economics*, 7 (1), pp. 58–70.

Central Statistics Office (1985). *Statistical Yearbook of Zimbabwe 1985*. Central Statistics Office, Harare, Zimbabwe

Curry, L. A., Nembhard, I. M., & Bradley, E. H. (2009). Qualitative and mixed methods provide unique contributions to outcomes research. *Circulation*, 119 (10), pp. 1442-1452.

Debela, N., Mohammed, C., Bridle, K.; Corkrey, R., & McNeil, D. (2015). Perception of climate change and its impact by smallholders in pastoral/ agro-pastoral systems of Borana, South Ethiopia. *Springer Plus* 4 (1), DOI 10.1186/s40064-015-1012-9

Deckens, J. (2007). *Local Knowledge for Disaster Preparedness: A Literature Review*. International Centre for Integrated Mountain Development, International Centre for Integrated Mountain Development (ICIMOD), Nepal. DOI: 10.53055/ICIMOD.474 Kathmandu. Nepal

Deresa, T. T., Hassan, R. M., Ringler, C., Alemu, T., & Yesuf. M. (2009). Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change*, 19, pp. 248-255.

Deressa, T. T., Hassan, R. M., & Ringler, C. (2011). Perception of and adaptation to climate change by farmers in the Nile basin of Ethiopia. *Journal of Agricultural Science*, 149, pp. 23–31.

Deressa, T., Hassan, R. M., Alemu, T., Yesuf, M., & Ringler, C. (2008). *Analyzing the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia.* International Food Policy Research Institute, Series Number 798.

Deressa, T. T., Hassan, R. M., & Ringler, C. (2010). Perception of and adaptation to climate change by farmers in the Nile Basin of Ethiopia. *The Journal of Agricultural Science*, 149 (1), pp. 23-31.

Devereux, S. (2010). *Building Social Protection Systems in Southern Africa. background paper for the European report on development.* European University Institute

DeWalt, B. R. (1994). Using indigenous knowledge to improve agriculture and natural resource management. *Human Organizations,* 53, pp.123-130.

Department for International Development (DFID). (1999). *Sustainable livelihoods guidance sheets:* London, UK. Context 26. http://www.eldis.org/vfle/upload/1/document/0901/section2.pdf%3E

Department for International Development (DFID). (2000). *Sustainable livelihoods guidance sheet. Department for International Development.* Discussion Paper 296. Brighton: IDS.

Dixon, R. K., Smith, J., & Guill, S. (2003). Life on the edge: Vulnerability and adaptation of African ecosystems to global climate change. *Mitigation and Adaptation Strategies for Global Change*, 8, pp. 93-113.

Dodman, D., & Mitlin, D. (2015). The national and local politics of climate change adaptation. *Climate and Development*, 7 (3), pp. 223-234.

Domfeh, K. A. (2007). Indigenous knowledge systems and the need for policy and institutional reforms, tribes and tribals, indigenous knowledge systems and sustainable development: *Relevance for Africa*, 1 (5), pp. 41–52.

Dressa, T., Hassan, R. M., Yesuf, M., Alemu, T., & Ringler, C. (2008). *Analyzing the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia*. IFPRI Discussion Paper 00798. International Food Research Policy Institute.

Dube, K., & Nhamo, G. (2019). Climate change and the aviation sector: a focus on the Victoria Falls tourism route. *Journal of Environmental Development Volume, 29,* pp. 5-15.

Dube, T. & Phiri, K. (2013). Rural livelihoods under stress: The impact of climate change on livelihoods in Southwestern Zimbabwe, *American International Journal of Contemporary Research,* 3 (5), pp. 11–25.

Du toit, A. (2005). *Poverty measurement blues: some reflections on the space for understanding chronic and structural poverty in South Africa. Manchester:* Chronic Poverty Research Centre Background Paper 3. http://ssrn.com/abstract=1754544 (Accessed on 16/04/2021)

Eakin, H., & Luers, A. L. (2006). Assessing the vulnerability of social-environmental systems. *Annual Review of Environment and Resources,* 31, pp. 365-394.

Ebhuoma, E., & Simatele, D. (2017). Defying the odds: Climate variability, asset adaptation and food security nexus in the Delta State of Nigeria. *International Journal of Disaster Risk Reduction*, 21, pp. 231–242.

Ebi, K., & Schmier, J. (2005). A stitch in time: Improving public health early warning systems for extreme weather events. *Epidemiologic Review*, 27, pp. 115-121.

Ellen, R., & Harris, H. (2000). Introduction. In. Ellen, R., Parkes, P., & Bicker A. (eds.), *Indigenous Environmental Knowledge and its Transformations*. Harwood Academic Publishers, Amsterdam, the Netherlands.

Ellis, F. (2000). The determinants of rural livelihood diversification in developing countries, *Journal of Agricultural Economics*, 51 (2), pp. 289-302.

Engle, N. L. (2011). Adaptive capacity and its assessment. *Journal of Global Environmental Change*, 21, pp. 647–656.

Eriksson, P., & Kovalainen, A. (2015*). Qualitative Methods in Business Research: A Practical Guide to Social Research*. London, UK, Sage.

Esham, M., & Garforth, C. (2013). Agricultural adaptation to climate change: insights from a farming community in Sri Lanka. *Mitigation and Adaptation Strategies for Global Change*, 18 (5), pp. 535–549.

Esterhuizen, D. (2017). *Cotton Production and Consumption in Zimbabwe*, *Gain Report* Global Agricultural Network, USA Government.

Fankhauser, S., Smith, J. B., Tol, R. S. J. (1999). Weathering climate change: some simple rules to guide adaptation decisions. *Journal of Ecological Economics*, 30, pp. 67–78.

Feresu, S. (2011). *Moving Zimbabwe Forward: A Based Policy Dialogue Initiative*; Pathways Out of Poverty for Zimbabwe, Holiday Inn Harare, Institute of Environmental Studies. University of Zimbabwe.

Flavier, J. M., Jesus, A., de Navarro, C. S., & Warren, D. M. (1995). The regional program for the promotion of indigenous knowledge in Asia. In D. M. Warren, L. J. Slikkerveer, & D. Brokensha (Eds.), *The cultural dimension of development: Indigenous knowledge systems*, pp.479-487. IT Publications. London, UK.

Flickers, S., Travers, R., Guta, A., McDonald, S., & Meagher, A. (2007). Ethical dilemmas in community-based participatory research: recommendations for institutional review boards. *Journal of Urban Health*, 84 (4), pp. 478-493.

Food and Agriculture Organization of the United Nations, (2004). *Drought impact mitigation and prevention in the Limpopo River Basin: A situation analysis*. *Land and Water* Discussion Paper 4, Food and Agriculture Organization of the United Nations, Rome.

Food and Agriculture Organisation, (2008). *Climate change and food security: A framework document*. United Nations, Rome, Italy

Food Agricultural Organisation, (2009). *Analysis of Livelihood Assets. Integrated Food Security Phase Classification.* FAO. Rome, Italy

Food Agricultural Organisation (2020). *The state of food security and nutrition in the world. transforming food systems for affordable healthy diets.* FAO. Rome. http://www.fao.org/ca9692en/ca9692en.pdf: (Accessed on 22/03/2021).

Ford Foundation, (2004). *Building Assets to Reduce Poverty and Injustice.* Ford Foundation, New York.

Fosu-Mensah, B. Y., Vlek, P. L. G., & MacCarthy, D. (2012). Farmers' perception and adaptation to climate change: A case study of Sekyedumase district in Ghana. *Journal of Environment, Development and Sustainability, Springer,* 14 (4), pp. 495-505.

Franzel, S. (1999). Socioeconomic factors affecting the adoption potential of improved tree fallows in Africa. *Journal of Agroforestry Systems*, 47 (1–3), pp. 305–321.

Fraser, E. D. G., Dougill, J. J., Wabee, W. R., Meed, M. & Mcalpine, P. (2006). Bottom-up and top-down: Analysis of participatory processes for sustainability indicator identification as a pathway to community empowerment and sustainable environmental management. *Journal of Environmental Management,* 78**,** pp**.** 114-127.

Frimpong, H. N. (2013). Indigenous knowledge and climate adaptation policy in northern Ghana, Backgrounder from micro-level data. *Global Environmental Change*, 21 (4), pp. 1245–1261.

Gadgil, M., Berkes, F., & Folke, C. (1993). Indigenous knowledge for biodiversity conservation. *Ambio* (22:2-3), pp. 151-156.

Gaillard, J.C., & Mercer, J. (2012). From knowledge to action: Bridging gaps in disaster risk reduction. *Progress in Human Geography,* 37 (1), pp. 93-114.

Gbetibouo, G. A. (2009). *Understanding farmers' perceptions and adaptations to climate change and variability: the case of Limpopo Basin, South Africa.* IFPRI Discussion Paper 00849. International Food Policy Research Institute. Washington, D.C.

Gegeo, D. W. (2000). Indigenous knowledge and empowerment: Rural development examined from within. In D. L. Hanlon & G. M. White (Eds.). *Voyaging Through the Contemporary Pacific*. Lanham, MD: Rowman & Littlefield.

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: Interviews and focus groups. *British Dental Journal*, 204 (6), pp. 291-295.

Glantz, M. H. (2003). *Climate Affairs: A Primer*. Washington: Island Press.

Glantz, M. H. (2005). *Usable science 9: El Niño early warning for sustainable development in Pacific Rim countries and islands*. Report of a workshop held September 13-16,2004 in the Galapagos Islands, Ecuador. Boulder, ISSE/NCAR, 2005.

Goddard, L., Aitchellouche, Y., Baethgen, W., Dettinger, M., Graham, R., Hayman, P., & Conrad, E. (2010). Providing Seasonal-to-interannual Climate Information for Risk Management and Decision-making. *Procedia Environmental Sciences,* 1, pp. 81-101.

Goklany, I. M. (1995). Strategies to enhance adaptability: technological change, sustainable growth, and free trade. *Climatic Change*, 30, pp. 427–449.

Gong, X. A., Barnston, G., & Ward, M. N. (2003). The effect of spatial aggregation on the skill of seasonal rainfall forecasts. *Journal of Climate,* 16, pp. 30-59.

Government of Zimbabwe, (1998). *Zimbabwe Initial National Communication to the United Nations Framework Convention on Climate Change.* Ministry of Mines, Environment and Tourism, Harare: Government of Zimbabwe.

Government of Zimbabwe (GoZ), (2006). *Zimbabwe 2003 Poverty Assessment Study Survey Summary (PASS) Report*, Ministry of Public Service, Labour and Social Welfare, July 2006, Harare, Zimbabwe.

Government of Zimbabwe, (GoZ), and United Nations (2013). *Zimbabwe National Contigency Plan,* (December 2012), pp. 1–31.

Government of Zimbabwe, (2014). *National Climate Change Response Strategy*. Harare: Government of Zimbabwe. [www.ies.ac.zw/downloads/draftstrategy.pdf] (Accessed on 15/08/2019)

Government of Zimbabwe, (2016). *Zimbabwe Climate Policy*, Harare Zimbabwe

Government of Zimbabwe, (2018). *National Agriculture Policy Framework (2018-2030*), *First Draft;* Harare Zimbabwe.

Government of Zimbabwe, (2020). *Towards a Prosperous and Empowered Upper Middle-Income Society by 2030.* National Development Strategy 1 Harare, Zimbabwe.

Government of Zimbabwe, (2021). *Zimbabwe Revised Nationally Determined Contribution*, Harare, Zimbabwe

Green, D., Billy, J., & Tapim, A. (2010). Indigenous Australians' knowledge of weather and climate. *Climatic Change,* 100, pp. 337–354.

Grothmann T., & Patt A. (2005). Adaptive capacity and human cognition: the process of individual adaptation to climate change. *Journal of Global Environmental Change,* 15 (3), pp. 199-213.

Grothmann, T., & Reusswig, F. (2006). People at risk of flooding: why some residents take precautionary action while others do not. *Journal of Natural Hazards,* 38 (1), pp. 101–120.

Gukurume, S. (2012). Interrogating foreign aid and the sustainable development in African countries: a Zimbabwean experience of the debt trap and service delivery. *International Journal of Politics and Good Governance,* 3 (3.4), pp. 1–20.

Gukurume, S. (2013). Climate change, variability, and sustainable agriculture in Zimbabwe's rural communities. *Russian Journal of Agricultural Socio-Economic Sciences,* 14 (2), pp. 89-100.

Gupta, J., & Hisschemöller, M. (1997). Issue linkage as a global strategy toward sustainable development: a comparative case study of climate change. *International Environmental Affairs,* 9 (4), pp. 289–308.

Gwimbi, P., & Mundonga, T. (2010). Impact of climate change on cotton production under rainfed conditions: case of Gokwe. *Journal of Sustainable Development in Africa*, 12, 8, pp. 2010.

Gwimbi, P. (2009a). Linking rural community livelihoods to resilience building in flood risk reduction in Zimbabwe. *Journal of Disaster Risk Studies,* 2 (1), pp. 71-79.

Gwimbi, P. (2009b). Cotton farmers' vulnerability to climate change in Gokwe District (Zimbabwe): impact and influencing Factors. *Journal of Disaster Risk Studies,* 2 (2), pp. 81-92.

Hahn, M. B., Riederer, A. M., & Foster, S. O. (2009b). The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change: a case study in Mozambique. *Global Environmental Change*, 19 (1), pp. 74-88.

Hallegatte, S., Bangalore, M., Bonzanigo, L., Fay, M., Kane, T., Narloch, U., Rozenberg, J., Treguer, D., & Vogt-Schilb, A. (2015). *Shock waves: managing the impacts of climate change on poverty*. The World Bank. Washington DC, USA

Hammer, G. L., Hansen, J., Phillips, J. G., Mjelde, J. W., Hill, H. S. J., Love, A., & Potgieter, A. (2001). Advances in the application of climate prediction in agriculture. *Agricultural Systems,* 70, pp. 515-553.

Hansen, J. W. (2002). Realizing the potential benefits of climate prediction to agriculture: issues, approaches, challenges. *Agricultural Systems,* 74, p. 309.

Hansen, J. W., Mishra, A., Rao, K. P. C., Indeje, M., & Ngugi, R. K. (2009). The potential value of GCM-based seasonal rainfall forecasts for maize management in semi-arid Kenya. *Agricultural Systems,* 101, 80-90.

Hansen, J.W., Mason, S.J., Sun, L., & Tall, A. (2011). Review of seasonal climate forecasting for agriculture in sub-Saharan Africa. *Journal of Experimental Agriculture,* 47, 205–240.

Hassan, R., & Nhemachena, C. (2008). Determinants of African farmers' strategies for adapting to climate change: multinomial choice analysis. *African Journal of Agricultural and Resource Economics*, 2 (1), pp. 83–104.

Hebb, A., Mortsch, L. (2007). *Floods: Mapping vulnerability in the Upper Thames watershed under a Changing Climate*. CFCAS Project Report XI. Adaptation and Impacts Research Division, Environment Canada, University of Waterloo, Waterloo, Ontario. P. 53.

Hellmuth, M. E., Moorhead, A., Thomson, M. C., & Williams, J., (eds.) (2007). *Climate Risk Management in Africa: Learning from Practice*. International Research Institute for Climate and Society (IRI). New York: Columbia University

Hewitt, K. (2012). Culture, hazard and disaster, in Wisner B., Gaillard J.C. & Kelman I (eds.), *Handbook of Hazards and Disaster Risk Reduction (1STed*), pp. 85–96, Routledge, Abingdon, Oxfordshire.

Hinkel, K. M., B.M., Jones, W.R. Eisner, C.J. Cuomo, R.A. Beck, & R. Frohn. (2007). Methods to assess natural and anthropogenic thaw lake drainage on the western Arctic coastal plain of northern Alaska. *Journal of Geophysical Research: Earth Surface*,112 (2), p. 9.

Hisali, E., Birungi, P., & Buyinza, F. (2011). Adaptation to climate change in Uganda: evidence from micro level data. *Global Environmental Change*, 21 (4), 1245-1261.

Hiwasaki, L., Luna, E., Syamsidik & Shaw, R., (2014). *Local and indigenous knowledge for community resilience: Hydro-meteorological disaster risk reduction and climate change adaptation in coastal and small inland communities,* UNESCO, Jakarta.

Le Dang, H., Li, E., Nuberg, I., & Bruwer, J. (2019). Factors influencing the adaptation of farmers in response to climate change: a review. *Journal of Climate and Development*, 11 (9), pp. 765-774.

Hove, J. (2014). *The role of contract farming on cotton production and peasantry livelihoods*: *the case of Jiri communal lands of Gokwe South in Zimbabwe* MA Thesis, Midlands State University, Zimbabwe.

Howard, A., & Widdowson, F. (1997). Traditional knowledge advocates weave a tangled web. *Policy Options,* 18, pp. 46-48.

Iofrida, N., Luca, A. I. D., Strano, A., & Gulisano, G. (2016). Can social research paradigms justify the diversity of approaches to social life cycle assessments? *International Journal of Life Cycle Assessments,* 1 (1), pp. 1-17.

IIED, (2012). *Climate change impacts, vulnerability and adaptation in Zimbabwe, climate change.* Working Paper Series No. 3, December 2012. International Institute for Environment and Development, London, UK. http://pubs.iied.org/10034IIED.html (Accessed on 12/06/2021).

Hulme, M. (2001). Climatic perspectives on Sahelian desiccation: 1973-1998. *Journal of Global Environmental Change,* 11 (1), pp. 19-29.

Innocent, K. (2018). *Getting Zimbabwe's agriculture moving again*: *The beckoning of new era* Published on Africa Can End Poverty: world bank org.

Intergovernmental Panel on Climate Change, (2001a). *Impact, Adaptation, and Vulnerability. Contribution of working group II to the third assessment report of the intergovernmental panel on climate change.* Cambridge, United Kingdom.

Intergovernmental Panel on Climate Change, (2001b). *Climate Change*. *A Synthesis Report. A Contribution of Working Groups I, II and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* In: eds. R.T. Watson & Core Writing Team. Cambridge & New York: Cambridge University Press.

Intergovernmental Panel on Climate Change, (2001c). *Adaptation to Climate Change in the Context of Sustainable Development and Equity*. In B. Smit & O. Pilifosova (eds.), *Climate Change* (2001*): Impacts, Adaptation and Vulnerability* , pp. 879-902. Cambridge: Cambridge University Press.

International Institute for Sustainable Development (IISD). (2003). *Livelihoods and climate change: Combining disaster risk reduction, natural resource management and climate change adaptation in a new approach to the reduction of vulnerability and poverty*. International Institute for Sustainable Development. Available at: http://www.iisd.org/pdf/2003/natres_livelihoods_cc.pdf (Accessed; 20/10/2020).

Intergovernmental Panel on Climate Change, (2007). *Climate Change*: *Synthesis Report*. *Contributions of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC, Geneva.

Intergovernmental Panel on Climate Change, (2007). *Climate Change*: *Impacts, Adaptation and Vulnerability*. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Glossary, pp. 869–883. M.L.

Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linder & C.E. Hanson (eds). Cambridge, UK, Cambridge University Press.

Intergovernmental Panel on Climate Change, (2012). Summary for policymakers. In: Managing the risks of extreme events and disasters to advance climate change adaptation. Field CB, Barros V, Stocker TF, Qin D, Dokken DJ, Ebi KL, Mastrandrea MD, Mach KJ, Plattner GK, Allen SK, Tignor M, & Midgley PM (eds.). *A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change.* Pp.1-19. Cambridge University Press, Cambridge, UK, and New York, NY, USA.

Intergovernmental Panel for Climate Change, (2012). Summary for policymakers, in C.B. Field, Barros, V., & Stoker, T., (eds.), *Managing the risks of extreme events and disasters to advance climate change adaptation*, pp. 555–564, *A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*, pp. 555-564 Cambridge University Press, Cambridge.

Inter-governmental Panel on Climate Change, (IPCC). (2014). *Climate Change: Impacts, Adaptation, and Vulnerability.* Part A: Global and sectoral aspects. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, & L. L. White (eds.*), Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change,* pp. 113. Cambridge and New York, NY: Cambridge University Press.

Intergovernmental Panel on Climate Change, (IPCC). (2014). *Rural areas.* Intergovernmental Panel on Climate Change. https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap9_FINAL.pdf (Accessed 25/8/2020).

Intergovernmental Panel on Climate Change, (2019). Annexe I: Glossary, *IPCC Special Report on Climate Change and Land,* https://www.ipcc.ch/srccl/:(Accessed on 29/9/2022).

International Union for Conservation of Nature, (IUCN). (2008). *Indigenous and traditional peoples and climate change*. Issues Paper, March 2008. http:// cmsdata.iucn.org/downloads/indigenous peoples climate change. (Accessed 23/02/22).

Isoard, S., Grothmann, T., & Zebisch, M. (2008). *Climate change impacts, vulnerability, and adaptation: theory and concepts in the European Alps,* Vienna.

Jain, P. (2014). Indigenous Knowledge Management in Botswana Using ICT Applications. *Journal of Information Knowledge Management Studies from Developing and Emerging Economies,*43 (4), pp. 167-191.

Jamieson, D. (2005). *Adaptation, Mitigation, and Justice Perspectives on Climate Change: Science, Economics, Politics, Ethics*, 5, pp, 217-248. JAI Press, Emerald Group Publishing Limited. Bingley, UK

Jick, T. D. (1979). Mixing qualitative and quantitative methods: triangulation in action. *Administrative Science Quarterly*, 24, (4), pp. 602-611.

Jimat, (2008). Coping with Drought and Climate Change Project: *Baseline Study. Final Report to EMA and UNDP*. Harare: JIMAT Development Consultants.

Jiri, O. Paramu, L. Mafongoya, Mubaya, C., & Mafongoya, O. (2016). Seasonal climate prediction and adaptation using indigenous knowledge systems in agriculture systems in Southern Africa. *Journal of Agricultural Science*, 8 (5), pp. 2016.

Jiri, O. Mafongoya, P., & Chivenge, P., (2015). Smallholder farmer perceptions on climate change and variability: a predisposition for their subsequent adaptation strategies. *Journal of Earth Science and Climate Change*, 6 (5) , pp. 1-7.

Jupp, V., (2006). *The SAGE Dictionary of Social Research Methods*, London, Thousand Oaks, Sage Publications. New Delhi

Johnson, J. M, (2001). In-depth Interviewing. *Handbook of Interview Research*. Gubrium JF and Holstein JA (control.). SAGE, Thousand Oaks, CA.

Kalawole, O. D., Wolski, P., Ngwenya, B., & Mmopelwa, G. (2014). Ethno-meteorology scientific weather forecasting: small farmers and scientists' perspective on climate variability in the Okavango Delta, Botswana. *Climate risk management*, 4 (5), pp. 43-58.

Joshua, K. M., Ngongondo, C., Chipeta, L., Mpembeka, F. (2011). Integrating indigenous knowledge with conventional science: Enhancing localised climate and weather forecasts in Nessa, Mulanje, Malawi. *Physics and Chemistry of the Earth*, Parts A/B/C, 36, pp. 996–1003.

Kelkar, M. (2007). Local knowledge and natural resources management: a gender perspective. *Indian Journal of Gender Studies*, 14 (2), pp. 295 -306.

Kelly, P. M., & Adger W. N., (2000). Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climate Change*, 47 (4), pp. 325–352.

King, D. N. T., Skipper, A., & Tawhai, W. B. (2008). Maori environmental knowledge of local weather and climate change in Aotearoa – New Zealand. *Climatic Change*, 90, pp. 385–409.

Klopper, E., Vogel, C. H., & Landman, W. A. (2006). Seasonal climate forecasts, potential agricultural-risk management tools? *Climatic Change*, 76, pp, 73–90.

Knowler, D., & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: a review and synthesis of recent research. *Food Policy*, 32 (1), pp. 25–48.

Kollmair, M. & Gamper, St. (2002). The Sustainable livelihood approaches. *Input paper for the integrated training course of NCCR North-South.* Development Study Group. (9. - 20. September 2002). The University of Zurich.

Komba, C. & Muchapondwa, E. (2015). *Adaptation to climate change by smallholder farmers in Tanzania.* Discussion Paper Series, Environment for Development (EfD) 15-12. https://www.jstor.org/stable/resrep15022 (Accessed: 07-05-2020), 21:34 UTC).

Korovkin, T. (1992). Peasants grapes and corporation: the growth of contract farming in a Chilean community. *The Journal of Peasant Studies*, 19 (2), pp. 228-254.

Kothari, C. R. (2004). *Research Methodology: Methods and Techniques*. New Age International Publishers, New Delhi

Kristjanson, P., Neufeldt, H., Gassner, A., Mango, J., Kyazze, F. B., Desta, S., Sayula, G., Thiede, B., Förch, W., & Thornton, P. K. (2012). Are food-insecure smallholder households making changes in their farming practices? Evidence from East Africa. *Food Security*, 4, pp. 381-397.

Lacey, A., & Luff, D. (2009). *Qualitative Data Analysis*. National Institute of Health Research, The NIHR Research Design Service for Yorkshire & the Humber. http://www.rds-eastmidlands.nihr.ac.uk (Accessed on 14/07/2020).

Lavoie, L., Marquis, D. & Laurin, P. (2005). La recherche-action, *Théorie et pratique*. Presses de l'Université du Québec, Ste Foy, Canada, 229.

Laws, G. (1994). Oppression, knowledge, and the built environment, *Political Geography*, 13 (1), pp. 7–32.

Lewin, K. (1946). Action research and minority problems. *Journal of Social Issues*, 2 (4), pp. 34–46.

Lesolle, D. (2012). SADC Policy Paper on Climate Change: *Assessing the policy options for SADC Member States.* Botswana , SADC.

Li, C., Tang, Y., Luo, H., Di, B., & Zhang, L. (2013). Local farmers' perceptions of climate change and local adaptive strategies: a case study from the Middle Yarlung Zangbo River Valley, Tibet, *China. Journal of Environmental Management*, 52, pp. 894-906.

Little, P., & Watts, M., (eds). (1994). Living Under Contract: *Contract Farming and Agrarian Transformation in Sub-Saharan Africa, Madison*: University of Wisconsin Press.

Lobell, D. B., Burke, M. B., Tebaldi, C., Mastrandrea, M. D., & Falcon, W. P. (2008). Prioritizing climate change adaptation needs for food security in 2030. *Journal of Science*, 31, pp. 607-610.

Lucas, P.L., & Hilderink, H. B. M. (2004). *The vulnerability concept and its application to food security*. Report 550015004/2004. Netherlands: National Institute for Public Health and the Environment (RIVM). http://www.rivm.nl/ieweb (Accessed on 12/09/2020).

Luers, A. L., & Moser, S. C. (2006). Preparing for the impacts of climate change in California: *Advancing the debate on adaptation*. Report prepared for the California Energy Commission, Public Interest Energy Research Program and the California Environmental Protection Agency, Sacramento, CA, CEC-500-2005-198-SF.

Lutgens, F. K., & Tarbuck, E. J. (2010). *The Atmosphere: An Introduction to Meteorology*. New York: Prentice Hall.

Lwoga, E. T., Ngulube, P., & Stillwell, C. (2010). Understanding indigenous knowledge: Bridging the knowledge gap through a knowledge creation model for agricultural development August 2010. *SA Journal of Information Management,* 12 (1), pp. 436-444 DOI: 10.4102/sajim. v12i1.436

Maarleveld, M., & Dangbégnon, C. (1999). Managing natural resources: a social learning perspective. *Agriculture and Human Values,* 16, pp. 267–280.

Mack, L. (2010). The philosophical underpinnings of educational research. *Polyglossia,*19, pp. 5 – 11.

Macharia, P., Thuranira, E., Nganga, L., Lugadiru, J., & Wakori, S. (2012). Perceptions and adaptation to climate change and variability by immigrant farmers in semi-arid regions of Kenya. *African Crop Science Journal*, 20 (2), pp. 287-296.

Maconachie, R. (2012). Reconciling the mismatch: evaluating competing knowledge claims over soil fertility in Kano, Nigeria. *Journal of Cleaner Production,* 31, pp. 62-72.

Maddison, D. (2006). *The perception of and adaptation to climate change in Africa*. CEEPA. Discussion Paper No. 10, Centre for Environmental Economics and Policy in Africa, University of Pretoria, Pretoria, South Africa.

Madhuri, P. (2016). The impact of flooding in Bihar, India on women: A qualitative study. *Asian Women*, 32 (1), pp. 31–52.

Madzwamuse, M. (2010). Climate Governance in Africa*: Adaptation strategies and Institutions*, Heinrich Boll Stiftung, Unity Press , Cape Town, South Africa.

Magadza, C. H. D. (2000). Climate change impacts and human settlements in Africa: prospects for adaptation. *Journal of Environmental Monitoring and Assessment*, 61 (1), pp. 193–205.

Makwara, E. C. (2013). Indigenous knowledge systems and modern weather forecasting: exploring the linkages. *Journal of Agriculture and Sustainability*, 2 (1), pp. 98-141.

Mandleni, B., & Anim, F. D. K. (2011). *Climate change awareness and decision on adaptation measures by livestock farmers*. 85th Annual Conference of the Agricultural Economics Society. Warwick University, pp. 18–20. DOI: 10.22004/ag.econ.108794

Mahoo, H., Mbungu , W., Yonah I., Recha, Radeny, M., Kimeli., P., & Kinyangi J. (2015). *Integrating Indigenous knowledge and Scientific weather forecast for climate risk management for Lushoto district, Tanzania,* Working Paper no. 103. Copenhagen, Denmark, https://hdl.handle.net/10568/56996

Mashizha, T. M., Ncube, C., Dzvimbo, M. A. & Monga, M. (2017). Examining the impact of climate change on rural livelihoods and food security: evidence from Sanyati District in Mashonaland West, Zimbabwe. *Journal of Asian and African Social Science and Humanities* 3 (2), pp. 56–68.

Mashoko, E., Muchenje, V., Ndlovu, T., Mapiye, C., Chimonyo, M., & Musemwa, L. (2007). Beef cattle production in a peri-urban area of Zimbabwe. *Journal of Sustainable Development in Africa*, 9, pp. 121-132.

Masipa, T. S. (2017). 'The impact of climate change on food security in South Africa: Current realities and challenges ahead', Jàmbá: *Journal of Disaster Risk Studies*, 9 (1), pp. 411.

Mashizha, T. M., Ncube, C., Dzvimbo, M. A., & Monga, M. (2017). Examining the impact of climate change on rural livelihoods and food security: evidence from Sanyati District in Mashonaland West, Zimbabwe. *Journal of Asian and African Social Science and Humanities,* 3 (2), pp. 56–68.

Mawere, M., & Awuanh-Nymekye, S. (2015). *Harnessing Cultural Capital for Sustainability*: *A Pan Africanist Perspective*. Langaa RPCIG Research and Publishing Common Initiative Group, Mankon, Cameroon.

Mayring, P. (2000). Qualitative content analysis. Forum: *Qualitative Social Research,* 1 (2) https://doi.org/10.17169/fqs-1.2.1089. (Accessed on 18/05/2020).

Mberego, S., & Sanga-Ngoie, K. (2012). Using locally captured climatic information for guiding local-level agriculturalists in Africa: a case study of Makonde district in Zimbabwe. *Journal of Land Use Science,* 9 (2), pp. 178-194.

McCormick, O. (2015), *Awareness Session IFRC Livelihoods Resource Centre*; Spanish Red Cross (SRC), Madrid, Spain. : www.livelihoodscentre.org, (Accessed on 28/11/2021)

McIntosh, P. C., Pook, M. J., Risbey, J. S., Lisson, S. N., & Rebbeck, M. (2007). Seasonal climate forecasts for agriculture: Towards better understanding and value. *Field Crops Research* , 104 (1-3), pp.130-138.

Mehar, M., Mittal, S., & Prasad, N. (2016). Farmers coping strategies for climate shock: is it differentiated by gender? *Journal of Rural Studies,* 44, pp. 123–131.

Mehrad, A., Tahriri, M., (2019). Comparison between qualitative and quantitative research approaches, social sciences. *International Journal for Research in Educational Studies Sciences*, 5 (7), pp. 2208-2115.

Mendelsohn, R. (2008). The impact of climate change on agriculture in developing countries. *Journal of Natural Resources Policy Research*, 1 (1), pp. 5-19.

Mercer, J. (2012). Knowledge and disaster risk reduction, in Wisner B., Gaillard J.C. & Kelman I. (eds.), *Handbook of Hazards and Disaster Risk Reduction*, pp. 97–108. Routledge, Abingdon, Oxfordshire.

Mercer, J., Kelman, I., Taranis, L., Suchet-Pearson, S. (2010). Framework for integrating indigenous and scientific knowledge for disaster risk reduction. *Disasters* 34, pp. 214–239.

Mettrick, H. (1993). *Development-Oriented Research in Agriculture:* an ICRA textbook. Wageningen: The International Centre for Development-Oriented Research in Agriculture (ICRA).

Mhita, M.S. (2006). Training manual of indigenous knowledge for nature and environmental conservation, agriculture, food security and disaster management in Tanzania: *Journal of Geographical and Regional Planning*, 3, pp. 66-72.

Minhat, H.S. (2015). An overview of the methods of interviews in qualitative research. *International Journal of Public Health and Clinical Sciences.* 2 (1), pp. 210-214.

Mkodzongi, G., & Lawrence, P. (2019). The fast-track land reform and agrarian change in Zimbabwe. *Review of African Political Economy,* 46 (159), pp. 1-13.

Moonga, E., & Chitambo, H. (2010). The role of indigenous knowledge and biodiversity in livestock disease management under climate change, development in a semi-arid Region.: *Climate, Sustainability and Development in Semi-arid Regions* 2nd

International Conference August 16 - 20, 2010, Fortaleza - Ceará, Brazil Retrieved from http://africanclimate.net/en/cases/country-pilot-partnership-programme-adapting-climate-change-livestock-indigenous-knowledge (Accessed on 25/10/2021).

Moser, C. (2011). A conceptual and operational framework for pro-poor asset adaptation to urban climate change. *In Cities and Climate Change*: *Responding to an Urgent Agenda.* (1st ed), World Bank Publications. Washington DC.

Moser, S., & Ekstrom, J. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences,* 107 (51), pp. 22026-22031.

Moser, C., Stein, A. (2011). The importance of assets in current development debates: *Millennium development goals, social protection, and climate change.* Working Paper 7: http://www.seed.manchester.ac.uk/medialibrary/gurc/working_papers/GURC_ pdf (Accessed on 28/8/2020).

Moser, C., & Satterthwaite, D. (2008). *Towards Pro-poor Adaptation to Climate Change in the Urban Centres of Low-and Middle-income Countries,* Human Settlements Discussion Paper 3 Series, Climate Change and Cities, IIED, London.

Moser, C., Sparr, P., & Pickett, J. (2007). Cutting-edge development issues for INGOs: *Applications of an asset accumulation approach.* Asset debate Paper Number 1. Washington, DC: The Brookings Institution

Moyo, S. (2004). Overall Impacts of the Fast Track Land Reform Program. *Prepared for the review of the Zimbabwean agricultural sector following the implementation of the Land Reform Project.* African Institute of Agrarian Studies, Harare.

Mtisi, S. (2010). LEAPS and Climate Change: *Opportunities for Industry.* Zimbabwe (Presentation), Environmental Lawyers Association https://zela.org/publications/climate-change/

Moyo, S. (2011). The fast-track land reform and agrarian change in Zimbabwe. *Journal Review of African Political Economy,* 46 (159), pp. 1-13.

Mubaya, C. P., Njuki, J., Mutsvangwa, E. P., Mugabe, F. T., & Nanja, D. (2012). Climate variability and change or multiple stressors? farmer perceptions regarding threats to livelihoods in Zimbabwe and Zambia. *Journal of Environmental Management*. 102, pp. 9–17.

Mubaya, C. P., & Mafongoya, P. (2017). Local-level climate change adaptation decision-making and livelihoods in semi-arid areas in Zimbabwe. *Journal of Environment Development and Sustainability,* 19 (6), pp. 2377–2403.

Mudzonga, E., & Chigwada, T. (2009). *Agriculture future scenarios for southern Africa: A case study of Zimbabwe's food security.* International Institute for Southern Development. Manitoba. Available at: http://www.iisd.org/tkn/pdf/ag scenarios_africa_zimbabwe.pdf. (Accessed on 23/04/2020).

Mugambiwa, S. S., & Tirivangasi, H. M. (2017). Climate change: A threat towards achieving Sustainable Development Goal number two (end hunger, achieve food security and improved nutrition and promote sustainable agriculture) in South Africa, Jàmbá: *Journal of Disaster Risk Studies,* 9 (1), p. 350.

Mugambiwa, S. S. (2018). Adaptation measures to sustain indigenous practices and the use of indigenous knowledge systems to adapt to climate change in Mutoko rural district of Zimbabwe,' Jàmbá. *Journal of Disaster Risk Studies,* 10 (1), p. 388.

Mukheibir, P., & Ziervogel, G. (2007). Developing a Municipal Adaptation Plan (MAP) for climate change: the city of Cape Town. *Environment and Urbanization,* 19, pp. 143-158.

Munyua, H. (2000). *Information and communication technologies for rural development and food security: Lessons from field experiences in developing countries.* Rome: Sustainable Development, Food and Agriculture Organization of the United Nations. www.fao.org/sd/CDdirect/CDre0055b.htm

Murombo, T., Dhliwayo, M., Dhlakhama., T. (eds), (2019). *Climate Change Law in Zimbabwe: Concepts and Insights;* The Konrad Adenauer Foundation, Harare, Zimbabwe .

Mutasa, M. (2015). Knowledge apartheid in disaster risk management discourse: Is marrying indigenous and scientific knowledge the missing link?', *Jàmbá Journal of Disaster Risk Studies* 7 (1), Art. #150, pp. 10 .

Mutasa, M. (2011). Climate Change Vulnerability and Adaptation in Failing States: *Zimbabwe's Drought Struggle*. Paper prepared for the Initiative on Climate Adaptation Research and Understanding through the Social Sciences (ICARUS-2) Marginal Peoples and Environments. University of Michigan.

Mutandwa, E., Hanyani-Mlambo, B., Manzvera, J. (2019). Exploring the link between climate change perceptions and adaptation strategies among smallholder farmers in the Chimanimani district of Zimbabwe. *International Journal Social Economics,* 4 (4), pp. 6–9.

Muzawazi, H. D., Terblanche, S. E., & Madakadze, C. (2017). Community gardens as a strategy for coping with climate shocks in Bikita District, Masvingo, Zimbabwe. *South African Journal of Agricultural Extension,* 45 (1), pp. 102-117.

Mwaura, P. (2008). *Indigenous Knowledge in Disaster Management in Africa*. United Nations Environment Programme, Nairobi.

Nangombe, S. S. (2015). *Drought Conditions and Management Strategies in Zimbabwe*. In Proceedings of the Regional Workshops on Capacity Development to Support National Drought Management Policies for Eastern and Southern Africa and the Near East and North Africa Regions, pp. 84-89.

Ndambiri, H., Ritho, C., Mbogoh, S., Nganga, S., & Muiruri, E. (2012). Assessment of farmer's adaptation to effects of climate change in Kenya. *Journal of Economic and Sustainable Development*: 3 (12), pp. 52.

Ndebele-Murisa, M., & Mubaya, C. (2015). Climate Change: Impact on Agriculture, Livelihood Options and Adaptation Strategies for Smallholder Farmers in Zimbabwe. *Beyond the Crises*: *Zimbabwe's prospects for transformation*. Weaver Press, Avondale, pp. 155–198.

Ndungu, C., & Bhardwaj, S. (2015). Assessment of People's Perceptions and Adaptation to Climate Change and Variability in Mid-Hills of Himachal Pradesh, India. *International Journal of Current Microbiology and Applied Sciences,* 4 (8), pp. 47-60.

Newton, A. C., Johnson, S.N., & P. J. Gregory (2010). *Implications of climate change for diseases, crop yields and food security.* A paper presented in BGRI 2010 Technical Workshop, 30-31- May 2010, St Petersburg, Russia.

Ngulube, P., Masuku, M., & Sigauke, D. T. (2011). The role of archives in preserving indigenous knowledge systems in Zimbabwe: is (re)inventing themselves the answer?'. *ESARBICA Journal* 30, pp. 261–278.

Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014). Africa. In: Barros, V. R., Field, C. B., Dokken, D. J., Mastrandrea, M. D., Mach, K. J., Bilir, T. E., Chatterjee, M., Ebi, K. L., Estrada, Y. O., Genova, R. C., Girma, B., Kissel, E. S., Levy, Amaccracken, S., Mastrandrea, P. R. & White, L. L. (eds.) Climate Change (2014). *Impacts, Adaptation, and Vulnerability*. *Part B: Regional Aspects*. *Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Nicholson, S. E. (2001). Climatic and environmental change in Africa during the last two centuries. *Climate Research,* 17 (2), pp. 123-144.

Nhemachena, C., & Hassan, R. (2007). *Micro-level analysis of farmers' adaption to climate change in Southern Africa.* In International Food Policy Research Institute (IFPRI),

Discussion paper 00714. Retrieved from http://books.google.com.au/ (Accessed on 20/10/2020).

Nhundu, K., Gwata, C & Mushunje, A. (2010). Impacts of Zimbabwe European Union micro-project programme (Zim/Eu MPP) in funding smallholder irrigation projects on food security and income levels: a case study of Mopane irrigation 112 scheme in Zvishavane, Midlands Province, Zimbabwe. *African Journal of Agricultural Research*, 4 (9), pp. 001-013.

Nkomwa, E. C., Joshua, M. K., Ngongondo, C., Monjerezi, M., & Chipungu, F. (2014). Assessing indigenous knowledge systems and climate change adaptation strategies in agriculture: a case study of Chagaka Village, Chikhwawa, Southern Malawi. *Physics and Chemistry of the Earth*, Parts A/B/C, pp. 67–69, pp. 164–172.

Nunes, A. R. (2014). *Taking it to the extremes: understanding the role of assets in older people's vulnerability, resilience, and adaptation to extreme temperatures*. Unpublished Ph.D thesis. The University of East Anglia.

Nyahunda, L., & Tirivangasi, H. M. (2019). Challenges faced by rural people in mitigating the effects of climate change in the Mazungunye communal lands, Zimbabwe. *Journal of Disaster Risk Studies,* 11 (1), pp. 1–9.

Nygren, A. (1999). Local knowledge in the environment-development discourse: From dichotomies to situated knowledge. *Critique of Anthropology,* 19 (3), pp. 267–288.

Nyong, A. (2005). Impacts of climate change in the tropics: *the African experience*. *A keynote presentation to a symposium on, Avoiding dangerous climate change*. Meteorological Office, Exeter, UK. www.stabilisation2005.com

O'Brien, K., & Selboe, E. (2015). *The Adaptive Challenge of Climate Change.* Publisher: Cambridge University Press

O'Brien, K. L., Leichenko, R. M., Kelkar, U., Venema, H. M., Aandahl, G., Tompkins, H., Javed, A., Bhadwal, S., Barg, S., Nygaard, L., West, J. (2004). Mapping vulnerability to multiple stressors: climate change and globalisation in India. *Journal of Global Environmental Change*, 14, pp. 303–31.

Ofoegbu, C., Chirwa, P., Francis, J. & Babalola, F. (2015). Understanding forest-based livelihood practices as a climate change mitigation and adaptation option in Vhembe Districts of South Africa, *in XIV World Forestry Congress*, Durban, South Africa, September 07–11, pp. 1–11. DOI: 10.13140/RG.2.1.2040.9363 (Accessed on 12/06/2020).

Okonya, S. J., Syndikus, K., & Kroschel, J. (2013). Farmers' Perception of and coping strategies to climate change: evidence from six agro-ecological zones of Uganda. *Journal of Agricultural Science*, 5 (8), pp. 252-263.

O'Riordan, T., & A. Jordan (1999). Institutions, climate change and cultural theory: towards a common analytical framework. *Global Environmental Change*, 9, pp. 81–93.

Orlove, B., Roncoli, C., Kabugo, M., & Majugu, A. (2010). Indigenous climate knowledge in southern Uganda: the multiple components of dynamic regional systems. *Journal of Climatic Change*, 100, pp. 243-265.

Osbahr, H., Boyd, E., & Ericksen, P. E. (2007). *Resilience, Realities and Research in African Environments. Report of Workshop of 18 June 2007*. Centre for the Environment, University of Oxford, Oxford, UK.

Owuor, B., Eriksen, S., & Mauta, W. (2005). Adapting to climate change in a dryland mountain environment in Kenya. *Mountain Research and Development*, 25 (4), pp. 310-315.

Ozor, N., & Cynthia, N. (2010). Difficulties in adaptation to climate change by farmers in Enugu state. Nigeria. *Journal of Agricultural Extension*, 14 (2), pp.106–122.

Padgham, J., Divissicher, T. Chuluun., Mtilatila, L., Kaimila, E., Mansigh, L., Agyemang-Yeboah., F.K. (2013). Building shared understating and capacity for action. Insights climate risk communication, from India, Ghana, Malawi, and Mongolia. *International Journal of Communication*, 7, pp. 970-983

Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods*. SAGE Publications.

Paddy, P. (2020). WholeEarthEducation.com: (Accessed on 2/11/2022).

Parahoo, K. (2006). *Nursing Research: Principles, Process and Issues,* (2nd edn). Palgrave, Basingstoke.

Parliament of Zimbabwe Report (2017). *The National Assembly 30th November 2017*, Harare Zimbabwe.

Patnaik, U., & Narayanan, K. (2005). Vulnerability and climate change: *An analysis of the eastern coastal districts of India.* Paper presented at the Human Security and Climate Change International Workshop, June 21–23, Asker, Norway.

Pearson, L., & Langridge, J. (2008). Climate change vulnerability assessment*: Review of agricultural productivity.* CSIRO Climate Adaptation Flagship Working Paper No.1. Web-ref http://www.csiro.au/resources/CAF-Working-Papers

Peloquin, C., & Berkes, F. (2009). Local knowledge, subsistence harvests, and social-ecological complexity in James Bay. *Human Ecology*, 37, pp. 533–545.

Perez, C., Jones, E. M., Kristjanson, P., Cramer, L., Thornton, P.K., Förch, W., & Barahona, C. (2015). How resilient are farming households and communities to a changing climate in Africa? A gender-based perspective. *Journal of Global Environmental Change,* 34, pp. 95–107.

Phillips, J. G., Hansen, J. W., Cunha, G. R., Haas, J. C., & Berlato, M. A. (2001). Forecast applications in agriculture: approaches, issues, and challenges. *Applications of climate forecasting for better decision-making processes in agriculture,* pp. 167–180. International Research Institute for Climate Prediction Palisades, New York 10964.

Polit, D. F. & Beck, C. T. (2004). *Nursing Research: Principles and Methods.* 7th Edition, Lippincott Williams & Wilkins, Philadelphia Potential Contributions of Agroforestry in Western Kenya, Harvard University.

Preston, B., & Stafford-Smith, M. (2009). *Framing vulnerability and adaptive capacity assessment:* A discussion paper. Canberra: https://doi.org/10.4225/08/5856d18fed8b0 (Accessed on 15/06/ 2020)

Pretty, J., & Buck, L.E. (2002). Social Capital and Social Learning in the Process of Natural Resource Management. In: C.B. Barrett, F. Place and A.A. Aboud (eds.), *Natural Resources Management in African Agriculture*. Nairobi: ICRAF and CABI Publishing.

Puri, S. K., (2007). Integrating Scientific with Indigenous knowledge: Constructing Knowledge Alliances for land Management in India. *MIS Quarterly,* 31 (2), pp. 355-379.

Randall, W.S., Gravier, M., & Prybutok, V. R. (2011). Connection, trust, and commitment: dimensions of co-creation? *Journal of Strategic Marketing,* 19 (1), pp. 3-24.

Randy, C., & McKenzie, J. F. (2011). *Health Promotion and Education Research Method* (2nd ed.). Sudbury, Mass: Jones and Bartlett Publisher.

Risiro, J.D., Mashoko, D., Tshuma, T., & Rurinda, E. (2012). Weather forecasting and indigenous knowledge systems in Chimanimani district of Manicaland, Zimbabwe. *Journal of Emerging Trends in Educational Research and Policy Studies,* 3 (4), pp. 561–566.

Robinson, J., & Herbert, D. (2001). Integrating climate change and sustainable development. *International Journal of Global Environmental Issues,* 1, pp. 130-148.

Roudier, P., Muller, B., d'Aquino, P., Roncoli, C., Soumaré, M. A., Batté, L., & Sultan, B. (2014). The role of climate forecasts in smallholder agriculture: Lessons from participatory research in two communities in Senegal. *Climate Risk Management,* 2, pp. 42-55.

Rukuni, M., Eicher, C. K., & Blackie, (2006). *Zimbabwe's Agricultural Revolution*, Revisited, University of Zimbabwe, Publications, Harare.

Rurinda, J., Van Wijk, M. T., Mapfumo, P., Descheemaeker, K., Supit, I., & Giller, K. E. (2015). Climate change and maize yield in Southern Africa. What can farm management do? *Global Change*, 21, pp. 4588-4601.

Smit, B., Burton, I., Klein, R. J. T., & Street, R. (1999): The science of adaptation: a framework for assessment. *Mitigation and Adaptation Strategies for Global Change*, 4, pp. 199–213.

Saitabau, H. 2014. *Impacts of Climate Change on the Livelihoods of Loita Maasai Pastoral Community and Related Indigenous Knowledge on Adaptation and Mitigation.* Available at: http:// www.ethnobiology.net/wp-content/uploads/From-the-Field_ Henry_ISE-Paper-2014.pdf (Accessed 15/10/2021).

Sandelowski M. (2000). Whatever happened to qualitative description? *Research in Nursing and Health.* 23 (4), pp. 334–340.

Sale, J. E., Lohfeld, L. H., & Brazil, K. (2002). Revisiting the quantitative-qualitative debate: Implications for mixed-methods research. *Quality and quantity*, 36 (1), pp. 43-53.

Sarantakos, S. (2013). *Social Research*. (4thed). Hampshire: Palgrave Macmillan; The Macmillan Campus, 4 Crinan St, London, N1 9XW, United Kingdom.

Savary S, Waddington S, Akter S, Almekinders CJM, Harris J, Korsten L, Rötter RP, Van den Broeck G. Revisiting food security in 2021: an overview of the past year. *Food Security*, 14 (1). pp. 1-7.

Schoenhoff, D. M. (1993). *The barefoot Expert: the interface of computerized Knowledge systems and indigenous knowledge systems*. Greenwood Press, Westport, CT,

Scoones, I. (2009). Livelihood perspectives and rural development. *The Journal of Peasant Studies*, 36 (1), pp. 171-196.

Scoones, I. (2018). *The conservation*: *ten priorities for getting agriculture moving in Zimbabwe*, Institute of Development Studies, University of Sussex, UK

Shepherd, A., Mitchell, T., Lewis, K., Lenhardt, A., Jones, L., Muir-Wood, R. (2013). *The geography of poverty, disasters, and climate extremes in 2030.* http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8633.pdf (Accessed 20/10/2020).

Shiferaw, A. (2014). Smallholder farmers adaptation strategies to climate change in Ethiopia: evidence from Adola Rede Woreda. Oromia Region. *Journal of Economics and Sustainable Development*, 5 (7), pp. 162–181.

Shiferaw, B., & Holden, S. T. (1998). Resource degradation and adoption of land conservation technologies in the Ethiopian highlands: a case study in Andit Tid. North Shewa. *Journal of Agricultural Economics*, 18 (3), pp. 233–247.

Shizha E., (2006). 'Legitimizing indigenous knowledge in Zimbabwe: a theoretical analysis of postcolonial school knowledge and its colonial legacy. *Journal of Contemporary Issues in Education* 1 (1), pp. 20–35.

Skelton, T. (2001). Cross-cultural research: issues of power, positionality, and 'race'. In: Limb, B. & Dwyer, C. (eds.) *Qualitative methodologies for geographers*. London: Arnold.

Shoko, K., & Shoko, N. (2013). Indigenous weather forecasting systems: a case study of the abiotic weather forecasting indicators for wards 12 and 13 in Mberengwa District Zimbabwe. *Journal of Asian Social Science* 9 (5), pp. 285–297.

Shumba, E. M., Wallgren, V. L., Carlson, A., Kuona, M., & Moyo, N. (2012). *Community climate change vulnerability assessment in miombo woodlands*. WWF, Harare.

SI. (2017). *Agriculture Marketing Authority* (Command Agriculture Scheme for Domestic Crop, Livestock and Fisheries Production) Regulations, Harare Zimbabwe.

Sillitoe, P., Bicker, A., & Pottier, J. (2002). *Participating in Development: Approaches to indigenous knowledge.* London: Routledge.

Simatele, D. (2009). *Urban climate change adaptation and assets: a background review of current community-focused and conceptual and methodological approaches* Unpublished Paper University of St-Andrews, Scotland.

Simatele, D. (2010). *Climate change adaptation in Lusaka, Zambia: a case of Kalingalinga and Linda compounds.* Working Paper. N0.6, Global Urban Research Centre. The University of Manchester, UK.

Simatele, D., Binns, T., & Simatele, M. (2012). Urban livelihoods under a changing climate: perspectives on urban agriculture and planning in Lusaka, Zambia. *Journal of Human Development and Capabilities*, 13, pp. 269– 293.

Simatele, D., Simatele, M. (2015). Climate variability and urban food security in sub-Saharan Africa: lessons from Zambia using an asset-based adaptation framework. *South African Geographical Journal* 97, pp. 243–263.

Slater, A. G. (2007). Chapter 8, Climate Models and Their Evaluation. In: Solomon, S., , D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* pp. 589-662. Cambridge University Press, Cambridge.

Smit, B., & Pilifosova, O. (2001). Adaptation to Climate Change in the Context of Sustainable Development and Equity. In A. Patwardhan & J-F. Soussana (Eds.), *Climate Change 2001: Impacts, Adaptation and Vulnerability*, pp. 895-897. United Kingdom: Cambridge University Press.

Smith, E. A. (2001). The role of tacit and explicit knowledge in the workplace. *Journal of Knowledge Management*, 5 (4), pp. 311-321.

Smith, J.B., & Lenhart, S. S. (1996). Climate change adaptation policy options. *Journal of Climate Research*, 6 (2), pp. 193–201.

Stake, R. E. (1995). *The Art of Case Study Research,* Sage Publications Inc. Thousand Oaks, London, New Delhi.

Sultan, B., & Gaetani, M. (2016). Agriculture in West Africa in the Twenty-First Century: Climate Change and Impacts Scenarios, and Potential for Adaptation. *Frontiers in Plant Science, 7*, 211434.

Swift, J. (1993). Understanding and preventing famine and famine mortality. *IDS Bulletin*, 24 (4), pp. 1-16.

Swinkels, R. A., Norman-Monroe, T. C., Blankespoor, B., Munditi, N. P., & Zvirereh, H. (2019). *Analysis of Spatial Patterns of Settlement, Internal Migration, and Welfare Inequality in Zimbabwe*, The World Bank.

Tadross, M., Suarez, P., Lotsch, A., Hachigonta, S., Mdoka, M., Unganai, L., Lucio, F., Kamdonyo D., & Muchinda, M. (2009). Growing-season rainfall and scenarios of future change in southeast Africa: implications for cultivating maize. *Climate Research*, 40, pp. 147-161.

Tafesse, A., Ayele, G., Ketema, M., & Geta, E. (2013). Adaptation to climate change and variability in Eastern Ethiopia. *Journal of Economics and Sustainable Development*, 4 (6), pp. 91-103.

Takacs, D. (2002). Positionality, epistemology, and social justice in the classroom. *Social Justice,* 29 (4), pp. 168-181.

Tavana, N. (2002). Traditional Knowledge is the Key to Sustainable Development in Samoa: Examples of Ecological, Botanical, and Taxonomical Knowledge: *Proceedings of the National 2001 National Environment Form,* No. 3, pp. 19-26. Apia Samoa: Ministry of Natural Resources and Environment.

Tawodzera, G. (2012). *Urban Household Vulnerability to Food Security and Climate Change: Experiences from urban areas of Zimbabwe.* New York . Earthscan.

Taylor, S., Bogdan, R., & DeVault, M. (2016). *Introduction to Qualitative Research Methods: a Guidebook and Resource*. (4 ed), John Wiley & Sons, Canada.

Tengö, M., Brondizio, E.S., Elmqvist, T., Malmer, P., Spierenburg, M., 2014. Connecting diverse knowledge systems for enhanced ecosystem governance*:* the multiple evidence base approach. *Ambio* 43, pp. 579–591.

TerreBlanche, M., & Durrheim, K. (2007). Histories of the present: Social science research in Context. (2nd), *Research in Practice: Applied Methods for the Social Sciences*. p. 566-586). University of Cape Town, Cape Town

Thomson, M. C., Doblas-Reyes, F. J., Mason, S. J., Hagedorn, R., Connor, S. J., Phindela, T., & Palmer, T. N. (2006). Malaria early warnings based on seasonal climate forecasts from multi-model ensembles. *Nature* , 439 (7076), pp. 576-9.

Thorlakson, T. (2011). Reducing Subsistence Farmers Vulnerability to Climate Change*: The Potential Contributions of Agroforestry in Western Kenya*. Occasional Paper 16. World Agroforestry Centre, Nairobi.

Thornton, P. K., Jones, P. G., Owiyo, T. M., Kruska, R. L., Herero, M., Kristjanson, P., Notenbaert, A., & Bekele, N. (2006). *Mapping Climate Vulnerability and Poverty in Africa.* Report to the Department for International Development, Nairobi. ILRI, 200.

Toendepi, S. (2019). Tractors and Agrarian Transformation in Zimbabwe*: Insights from Mvurwi:* Working Paper 021, Agricultural Research Policy in Africa.

Tengö M, Brondizio ES, Elmqvist T, Malmer P, Spierenburg M. Connecting diverse knowledge systems for enhanced ecosystem governance: the multiple evidence base approach. *Ambio,* 43 (5), pp. 579-91.

Tongco, M. D. C. (2007). Purposive sampling as a tool for informant selection. *Journal of Ethnobotany Research and Applications*, 5, pp. 147-158.

Toner, A. (2003). Exploring sustainable livelihoods approaches about two interventions in Tanzania. *Journal of International Development*, 15, (6), pp. 771-781.

Tschakert, P. & Dietrich, K. A. (2010). Anticipatory learning for climate change adaptation and resilience. *Ecology and Society,* 15 (2), pp. 11.

Tuli, F. (2010). The basis of the distinction between quantitative and qualitative in social science: reflection on ontological, epistemological, and methodological perspectives. *Ethiopian Journal of Education and Science*, 6 (1), pp. 97-108.

Turner, N. J., Clifton, H. (2009). It's so different today: climate change and indigenous lifeways in British Columbia, Canada. *Journal of Global Environmental Change*, 19 (2), pp. 180-190.

Twyman, C., Morrison, J. & Sporton, S. (1999). The final fifth: is autobiography, reflexivity and interpretation in cross-cultural research. *Area*, 31 (4), pp. 313-325.

United Nations (2017). *Capacity Assessment of the Disaster Risk Management System in Zimbabwe* , 20-31 March 2017, United Nations, Zimbabwe

UNFCCC, (2007). Climate Change*: Impacts, Vulnerabilities and Adaptations in Developing Countries.* UNFCCC. Least Developed Countries under the UNFCCC. 53175 Bonn, Germany.

Unganai, L. S., & Murwira, A. (2010). *Challenges and opportunities for climate change adaptation among smallholder farmers in southeast Zimbabwe*. 2nd International Conference: Climate, Sustainability and Development in Semiarid Regions. August 16 2010, Fortaleza - Ceará, Brazil.

United Nations International Strategy for Disaster Reduction (UNISDR), (2009). UNISDR Terminology on Disaster Risk Reduction. *International Strategy for Disaster Reduction (ISDR),* pp. 1–30. http://doi.org/978-600-6937-11-3

United Nations Development Programme (UNDP) (2016). Zimbabwe*: Adapting together,* viewed 19 July 2018, from https://undp-adaptation.exposure.co (Accessed on 26/11/2020).

United States Agency for International Development (USAID), (2007). Adapting to Climate Variability and Change: *a Guide Manual for Development Planning* Washington DC. USA.

Uzuegbu, C. P. (2016). Effective information service delivery to rural dwellers in Sub-Saharan Africa: whose job? *IFLA Journal,* 42 (1), pp. 49–58.

Van Dijk, T. (2011). Livelihoods, capitals, and livelihood trajectories a more sociological conceptualisation. *Journal of Progress in Development Studies*, 11 (2), pp. 101-117.

Vásquez-León, M., West, C. T., & Finan, T. J. (2003). A comparative assessment of climate vulnerability: agriculture and ranching on both sides of the US-Mexico border. *Journal of Global Environmental Change*, 13, pp. 159–173.

Vijfhuizen, C. (1997). Rain-making, political conflicts and gender images: a case from Mutema chieftaincy in Zimbabwe. *Zambezia The Journal of Humanities of the University of Zimbabwe,* 24 (i) , pp. 31–49.

Vincent, K. (2007). Uncertainty in adaptive capacity and the importance of scale. *Journal of Global Environmental Change,* 17, pp. 12-24.

Vincent, K., Cull, T., Chanika, D., Hamazakaza, P., Joubert, A., Macome, E., & Mutonhodza-Davies, C. (2013). Farmers' responses to climate variability and change in southern Africa–Is it coping or adaptation? *Climate and Development*, 5 (3), pp. 194–205.

Walker D. H., Thorne, P. J., Sinclair, F. L., Thapa, B., Wood, C. D., & Subba, D. B. (1999). A systems approach to comparing indigenous and scientific knowledge: consistency and discriminatory power of indigenous and laboratory assessment of the nutritive value of tree fodder. *Journal of Agricultural Systems*, 62 (2), pp. 87-103.

Wang'ati, F. J., (1996). The impact of climate variation and sustainable development in the Sudano-Sahelian region. In: *Climate Variability, Climate Change and Social Vulnerability in the Semi-Arid Tropics* [Ribot, J.C., A.R. Magalhães, and S.S. Panagides (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 71–91.

Warren, D. M., & McKiernan, G. (1995). CIKARD: A global approach to documenting indigenous knowledge for development. In D. M. Warren, L. J. Slikkeveer, & D. Brokensha (Eds.). *The cultural dimension of development: Indigenous knowledge systems.* London: Intermediate Technology Publications Ltd.

Wellington, J., & Szczerbinski, M. (2007). *Research Methods for the Social Sciences*: Continuum, International Publication Group, London.

Wickham, M., & Woods, M. (2005). Reflecting on the Strategic Use of CAQDAS to Manage and Report on the Qualitative Research Process. *The Qualitative Report*, 10 (4), 687-702.

Wisner, B., O'Keefe, P., Westgate, K., 1977. Global systems and local disasters: the untapped power of peoples' science. *Disasters*, 1, pp. 47–57.

World Bank, (2010). *World Development Report 2010*. World Bank, Washington, D.C.

World Bank, (2012). *Turn Down the Heat*: *Why a 4 °C Warmer World Must be Avoided*. World Bank, Washington, DC.

World Bank, (2010). World Development Report: *Climate Change and Development*. World Bank, Washington, DC.

World Bank, (2011). The World Bank annual report 2011*: Year in review*, The World Bank, Washington, D.C.

World Economic Forum, (2021). Davos Agenda 2021*: The zero that every investment needs*: www.weforum.org (Accessed on 10/11/2022).

World Food Summit (1996). *Rome Declaration on World Food Security*, 12-17 November Rome, Italy

Wyatt, J. C. (2001). Management of explicit and tacit knowledge. *Journal of the Royal Society of Medicine*, 94 (1), pp. 6-9.

Yegbemey, R. N., Yabi, J. A., Tovignan, S. D., Gantoli, G., & Haroll Kokoye, S. E. (2013). Farmers' decisions to adapt to climate change under various property rights: a case study of maize farming in northern Benin (West Africa). *Land Use Policy*, 34, pp.168–175.

Young, I. (1988). The five faces of oppression. *Philosophical Forum*, 19 (4), pp. 270–90.

Young, I. (1990). *Justice and the Politics of Difference*. Princeton University Press, Princeton, NJ.

Zhai, F., & Zhuang, J. (2009). *Agricultural impact of climate change: A general equilibrium analysis with special reference to Southeast Asia.* ADBI Working Paper 131. Tokyo: Asian Development Bank Institute. http://www.adbi.org/workingpaper/2009/02/23/2887.(Accessed on 12 /09/2020).

Ziervogel, G., & Calder, R. (2003). Climate variability and rural livelihoods: assessing the impact of seasonal climate forecasts in Lesotho. *Area*, 35, pp. 403-417.

Ziervogel, G., & Opere, A. (2010). *Integrating meteorological and indigenous knowledge-based seasonal climate forecasts in the agricultural sector*. https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/46185/132676.pdf?sequence=1&isAllowed=y (Accessed 10.9.20)

ZimStat (2012). *Census 2012*: *Preliminary Report*. ZimStat. Causeway, Harare, Zimbabwe

ZimVac (2013). *Rural Livelihoods Assessment*, Harare. Government of Zimbabwe.

ZimVAC. (2019). *Zimbabwe Vulnerability Assessment Committee Report* . Harare, Zimbabwe.

Zinyengere, N., Crespo, O., & Hachigonta, S. (2013). Crop response to climate change in southern Africa: A comprehensive review. *Global and Planetary Change*, 111, pp. 118-126.

Zinyowera, M. C., Jallow, B. P., Maya, R. S., & Okoth-Ogende, H. W. O. (1998). "Africa" In Zinyowera, M. C. and Moss, R. H. (eds.) *The Regional Impacts of Climate Change: An Assessment of Vulnerability.* Cambridge. Cambridge University Press.

Zvamasiya, B., Nyikahadzoi, K., & Mukamuri, B. B. (2017). Factors influencing smallholder farmers' behavioural intention towards adaptation to climate change in transitional climatic zones: a case study of Hwedza District in Zimbabwe. *Journal of Environmental Management,* 198, pp. 233–239.

Zuka, S. P. (2015). *Prospects and challenges of local community adaptation to climate*

change in developing countries: the case study of Malawi. In the Handbook of Climate Change Adaptation, pp. 1883–1898. http://doi.org/10.1007/978-3-642-38670-1_85 : (Accessed 20/10/20).

Zimbabwe's Intended Nationally Determined Contribution (2015). Harare: Ministry of Environment, Water and Climate, Government of Zimbabwe.

APPENDICES

Appendix A -Ethical Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Chatsiwa

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H18/11/05**
PROJECT TITLE	Climate variability and asset adaptation of small scale farmers in Zimbabwe's Gokwe South District: A search for a knowledge integration approach
INVESTIGATOR(S)	Mr J Chatsiwa
SCHOOL/DEPARTMENT	Geography, Archaeology and Environmental Studies/
DATE CONSIDERED	16 November 2018
DECISION OF THE COMMITTEE	Approved
EXPIRY DATE	21 October 2022

DATE 22 October 2019 **CHAIRPERSON** pp (Professor J Knight)

cc: Supervisor : Professor M Simatele

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

_____ **Signature**

_____/_____/_____ **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Appendix B - Request to access information-government officials

School of Geography, Archaeology and Environmental Studies
Private Bag 3, Wits 2050, South Africa Enquiries: GEOGRAPHY: TEL: +27 11 717-6503 •
ARCHAEOLOGY: TEL: +27 11 717-6045 •
http://www.wits.ac.za/geography/

My name is Jaison Chatsiwa; I am a PhD candidate at the University of Witwatersrand (WITS) doing research. My research is entitled 'Climate Variability and asset adaptation of Small-Scale Farmers in Zimbabwe's Gokwe South District: A search for a Knowledge Integration Approach' Therefore requests to access information related to my study such as rainfall and temperature figures, maps, demographic information etc. *This questionnaire seeks to collect empirical data in partial fulfilment for a PhD degree in the School of Geography and Environmental Studies at the University of the Witwatersrand, South Africa, the study seeks to understand how climate variability has impacted small-scale farmers and a search for knowledge integration to reduce the future impacts on farmers in Gokwe central, Sengwa, Mapfungabutsi, Kana, and Sesame communities. It also seeks to households- assets can be used to improve their adaptive capacity against the impact of climate change and variability. This study is also interested in various forms of indigenous knowledge systems used to forecast rainfall patterns in the district. Your cooperation is greatly appreciated.*

Name of Researcher: Jaison Chatsiwa (Ph.D. Researcher): 1803536@student.wits.za Cell +263779430277
Name of Supervisor: Prof. Danny Mulala Simatele: Mulala.simatele@wits.ac.za

Appendix C– Semi-structured interview questions for the Meteorological Department

Background

This questionnaire aims to collect primary data in partial fulfilment of the requirement for a PhD in the School of Geography and Environmental Studies at the University of the Witwatersrand, South Africa. The study seeks to see how small-scale farmers modify their asset portfolios to fight against climate change and variability and a search for knowledge integration to reduce the future impacts on farmers in Gokwe central, Sengwa, Mapfungabutsi, Kana, and Sesame communities. It also seeks to households- assets can be used to improve

their adaptive capacity against the impact of climate change and variability. This study also analyses the advantages and disadvantages of indigenous and scientific knowledge systems. Thank you for your cooperation.

1. How many years have you been employed in the Meteorological Department
2. What is your goal as a department
3. How many weather stations are there in the Gokwe South district?
4. How many of the weather stations are functional?
5. What problems are you facing in collecting meteorological data in the Gokwe South district?
6. Are there weather stations evenly distributed in the district?
7. How are you disseminating the meteorological data to the small-scale farmers
8. Are there any challenges for small-scale farmers to make use of scientific or modern information?
9. What do you think such problems can be solved?
10. What mechanisms have you put in place to improve how the Meteorological department works?
11. What type of language do you use to communicate with the small-scale farmers when disseminating information to them?
12. How reliable are your meteorological equipment when doing your forecasts and measurement of the meteorological data?
13. Do you use computerised weather stations?
14. When do you provide meteorological information to small-scale farmers?
15. What do you use to disseminate weather information to small-scale farmers?

Thank you for your cooperation

Name of Researcher: Jaison Chatsiwa (PhD Researcher): 1803536@student.wits.za Cell +263779430277

Name of Supervisor: Prof. Danny Mulala Simatele: Mulala.simatele@wits.ac.za

Appendix D- **Questionnaire for Government Officials including Extension Officials**

School of Geography, Archaeology and Environmental Studies

Private Bag 3, Wits 2050, South Africa Enquiries: **GEOGRAPHY:** TEL: +27 11 717-6503 •
ARCHAEOLOGY: TEL: +27 11 717-6045 •
http://www.wits.ac.za/geography/

To whom it may concern

My name is Jaison Chatsiwa; I am a PhD candidate at the University of the Witwatersrand (WITS) doing research. The research I want to conduct is entitled 'Climate Variability and asset adaptation in Zimbabwe's Gokwe South District: A search for a Knowledge Integration Approach

1. What type of job do you do in the government? Specify ……

2. Name the wards and constituencies you operate in the Gokwe South district……
…….

3. For how long you have been doing your job in Gokwe South District.....

4. What are your educational qualifications? List below

i. ……
ii. ……
iii. ……
iv. ……
v. ……

5. List the major problems you are facing when working with the rural communities in the Gokwe South district

i. ……
ii. ……
iii. ……
iv. ……

6. What are the challenges faced by small-scale farmers and how these challenges were solved?
……
……
……

7. Do you register small-scale farmers with your department

Yes No

8. Are the farmers paying any subscription to the meteorological data?
……
……
……

9. What are the advantages and disadvantages of registering small-scale farmers?
……
……
……

10. How are the inputs from your department shared among the small-scale farmers /? How are the small-scale farmers informed?
……
……
……
……

13. How frequently do you meet with the small-scale farmers and what are the topics discussed?
……
……
……

14. How often do you have meetings with the small-scale farmers in Gokwe South?
……
……
……
……

15. Outline the problems you faced when trying to teach small-scale farmers n skills……
……
……
……

16. How do you resolve the challenges you face when trying to disseminate information to farmers?
……
……
……

17. Do you think farmers rely on the weather forecast information you give them

Yes No Not sure

18. List the modes of communication you use to disseminate your weather forecast information

a……b

……c

……

d……

19. How many qualified extension workers are there in the Gokwe South district?

……

……

……

20. Do you think they are enough, or more are needed and why?

……

……..

22. Is there any additional information that you think we may have omitted? If any add it to the space provided below

……

……

……

Thank you for your cooperation

Name of Researcher: Jaison Chatsiwa (PhD Researcher): **1803536@student.wits.za** Cell +263779430277Name of Supervisor: Prof. Mulala Danny Simatele. Email: Mulala.simatele@wits.ac.za

Appendix E - Questionnaire for Community Leaders and elders

School of Geography, Archaeology and Environmental Studies

Private Bag 3, Wits 2050, South Africa Enquiries: **GEOGRAPHY:** TEL: +27 11 717-6503 •
ARCHAEOLOGY: TEL: +27 11 717-6045 •
http://www.wits.ac.za/geography/

1. Is there any evidence of climate change in the past three decades? ***1=Yes 0=No,***

2. If YES, describe the evidence

……

……

3.

Variables	What effects of these changes on livelihoods?	What are the effects observed on the environment?	What action was taken in your ward to respond to these effects
Rain: a) Increasing b) Decreasing			
Rainfall Regime a) Early start b) Late start c) Erratic rainfall d) Occurrence of dry spells			
Temperature: a) Increases b) Decreases c) Summer becomes hotter d) Winter becomes colder			
Other variables: wind			

4. Do you get any weather and climate information 1= Yes 2= No

5. If Yes: Elaborate……

Type of information	Source of information *1= Television* *2=Newspaper*	Rating of weather information received Rating Scale 1= Poor 2= Average 3=Good	Justification for rating	Solutions

	3= Other colleagues *4= Radio* 5= Other	Timelines	Adequacy	Number of times dissemination	significance	Themes	Distribution channels	Language relevance		
1										
2										
3										
4										
5										

5. What traditional ways do you forecast the weather?

Condition of weather	Phenological attributes
Above normal rains	
Below normal rains	
Normal rains	
Very hot dry season(drought)	
Very wet season (floods)	

6. Weather patterns observed over the past 3 decades

Variables	Improved	No change	Decreased	What are the causes of climate change	What are your adaptation strategies
Production of crops					
Crop cultivars					
Diseases					
Animal population					
Animal diseases					
Grazing lands					

Rainfall amounts					
Scarcity of water					
Income from crops					
Income from livestock					
Food availability					
Soil erosion					
Donor aid					
Migrations					

7. State the factors that influence the choice of climate adaptation strategies……

……

……

……

8. What are the adaptation strategies commonly practised in your area?

Adaptation Strategy		1 Yes	2 No

Name of Researcher: Jaison Chatsiwa (PhD Researcher): **1803536@student.wits.za** Cell +263779430277

Name of Supervisor: Prof. Danny Mulala Simatele Mulala.simatele@wits.ac.za

Appendix F- Research Instrument for Focus Group Discussions

School of Geography, Archaeology and Environmental Studies

Private Bag 3, Wits 2050, South Africa Enquiries: GEOGRAPHY: TEL: +27 11 717-6503 • ARCHAEOLOGY: TEL: +27 11 717-6045 • http://www.wits.ac.za/geography/

Questions to be asked			
Parameters	Questions in general	Guiding Questions	Respondents
Climate Characteristics Changes in climate variables for the past 3 decades (Rainfall and temperature)	Is there any evidence of climate change in the past 3 decades? How are the changes perceived by the local people?	What changes are there showing that the climate has changed and variable on rainfall and temperature over the past 3 decades	Districts/village Agricultural extension officers and Village leaders
		How are small-scale farmers perceiving climate change in their constituencies?	
		How would you explain the changes/	
Farming Practices Farming practices that changed over the past 3 decades. How viable are those practices?	What are the new farming techniques used because of climate variability in the past 3 decades? How viable and sustainable are these new farming techniques?	In what ways do the new farming techniques are an adaptive response to climate variability?	Districts/village Agricultural extension officers and communal leaders
Perceptions of Farmers Perception, ability, and obstacles /barriers/constraints faced by small-scale farmers to adaptive strategies	What are the perceptions of climate variability in general What are the constraints /barriers/ or obstacles faced by farmers to adaptive strategies? What abilities and	What are the socio-economic and environmental constraints/ barriers and obstacles faced by small-scale farmers? What adaptive strategies were	Districts/village Agricultural extension officers and village leaders

	capacities do farmers have to implement adaptive strategies?	implemented to achieve food security?	
Policy Intervention Policy and strategic influence on adaptive capacity to climate change and climate variability	How do ongoing policy interventions to climate change and climate variability influence the farmer's adaptive capacity?	What policy frameworks and documents are available to act in liaison with adaptive strategies in your constituencies?	Districts/village Agricultural extension officers and village leaders

Appendix G- Guiding questions for in-depth interviews for small-scale farmers

School of Geography, Archaeology and Environmental Studies

Private Bag 3, Wits 2050, South Africa Enquiries: **GEOGRAPHY:** TEL: +27 11 717-6503 •
ARCHAEOLOGY: TEL: +27 11 717-6045 •
http://www.wits.ac.za/geography/

This questionnaire aims to collect primary data required in partial fulfilment of a PhD degree in the School of Geography and Environmental studies at the University of the Witwatersrand, South Africa. The study seeks to understand how climate change and variability have impacted small-scale farmers and a search for knowledge integration to reduce the future impacts on farmers in Gokwe central, Sengwa, Mapfungabutsi, Kana, and Sesame communities.

Background Information

Kindly state your name and ward where you come from
What is your level of education?

For how many years have you been cultivating your fields?

Are you married?

How many dependents do you have?

Do you know what is climate change?

What communication gadgets do you have?

What assets do you need to produce enough food for your family??

Do you receive any form of financial assistance to help you in reducing the impact the s of climate change?

Do you belong to any social group which helps you with labour requirements?

Which asset would you consider the most influential in reducing the impacts of climate change?

Which institutions were of great assistance with agricultural inputs for the past 10 years?

Do you belong to any cooperative?

Is there been anyone sick in your household for the past 5 years?

What is your opinion on rainfall and temperature changes in your constituency?

How are the livelihoods affected by climate variability?

What is your view on rainfall figures received in the past 3 decades?

What is your comment on temperature figures in the last 3 decades?

Do you think temperatures have increased or decreased in the last 30 years?

In times of extreme weather conditions, kindly explain how it affects your health and that of your households, your ability to produce food, and household properties.

Did you ever experience floods or drought in the last 30 years?

Indigenous knowledge systems Scientific Knowledge Systems in Gokwe South district

Do you use indigenous knowledge systems in weather forecasting in preparation for your agricultural activities?

How reliable are local knowledge systems in your farming activities?

Do you use scientific knowledge systems in forecasting weather conditions in the Gokwe South district?

How reliable are the scientific knowledge systems in forecasting weather conditions in the Gokwe South district?

How do you get meteorological information from scientific knowledge systems?

What type of language or languages do you receive meteorological data from?

Thank you for your cooperation

Appendix H - Written Consent Form

School of Geography, Archaeology and Environmental Studies

Private Bag 3, Wits 2050, South Africa Enquiries: **GEOGRAPHY:** TEL: +27 11 717-6503 •
ARCHAEOLOGY: TEL: +27 11 717-6045 •
http://www.wits.ac.za/geography/

Written Consent Form

Thesis Title: Climate Variability and asset adaptation of Small-Scale Farmers in Zimbabwe's Gokwe South District: A search for a Knowledge Integration Approach

Instruction: Encircle the appropriate option

I ……. agree to take part in this research. The aims of the research have been explained to me.

I know that I will not get any financial benefit from participating in this research project YES NO

My name will remain anonymous YES NO

I agree that the researcher will use anonymous quotes YES NO

I agree that I will disclose full information on the questions being asked about households I agree that I will tell the researcher full information about household assets and indigenous knowledge YES NO

I agree that our discussion can be recorded YES NO

I agree that the information may be used anonymously by other researchers following this study YES NO

I agree to answer even sensitive questions if I remain anonymous YES NO

Name of Respondent……

Signature…….

Constituency/ Ward……

Date……

Name of Researcher: Jaison Chatsiwa (PhD Researcher): **1803536@student.wits.za** Cell +263779430277

Name of Supervisor: Professor Mulala Danny Simatele Mulala.simalete@wits.ac.za

Appendix I- Informed Consent Form

School of Geography, Archaeology and Environmental Studies

Private Bag 3, Wits 2050, South Africa Enquiries: **GEOGRAPHY:** TEL: +27 11 717-6503 •
ARCHAEOLOGY: TEL: +27 11 717-6045 •
http://www.wits.ac.za/geography/

Consent to participate in interviews

I greatly appreciate that you agreed to participate in this interview. Any contribution that you want to make towards this study. If you agree to the outlined requirement, you should sign as a sign of consent. I freely agreed to participate in this study. I am also aware of the Participation Sheet and its contents. I am aware that there is no financial reward for this participation. I am also aware that I can withdraw from participating at any stage of the data collection process. I agree and am I also aware that my name will not be published. I am also aware that the information I am giving will be treated with confidentiality. I am also aware that the purpose of the study is for learning purposes and not for profit. I also agree that the information I am providing can be published.

I also agree that all the discussions were clear, and I was allowed to ask anything for clarity concerning the study.

Name of Participant: _____

ID Number: _____

Signature----------

Date----------

I, Jaison Chatsiwa confirm that the above respondent has filled out the informed consent form for this study.

Signature: _____

Date: _____

Name of Researcher: Jaison Chatsiwa (PhD Researcher): **1803536@students.wits.za**

Cell +263779430277

Name of Supervisor: Prof. Mulala Danny Simatele Mulala.simatele@wits.ac.za

Appendix J- Household Questionnaire Survey

School of Geography, Archaeology and Environmental Studies

Private Bag 3, Wits 2050, South Africa Enquiries: **GEOGRAPHY:** TEL: +27 11 717-6503 •
ARCHAEOLOGY: TEL: +27 11 717-6045 •
http://www.wits.ac.za/geography/

This questionnaire is designed to collect information required in the partial fulfilment for a PhD degree in the School of Geography and Environmental Studies, at the University of the Witwatersrand, South Africa. *The aim of the study seeks to understand how small-scale farmers are modifying their asset portfolios to fight against challenges of climate variability in the Gokwe South District in the following constituencies: Gokwe central, Sengwa, Mapfungabutsi, Kana, and Sesame communities. It also seeks to find ways in which small-scale farmers can improve their adaptive capacity against climate variability. This study also seeks to see the possibility of integrating indigenous knowledge systems and scientific knowledge systems to improve the adaptive capacity against climate variability in the Gokwe South district. Your cooperation is greatly appreciated*

HOUSEHOLD QUESTIONNAIRE SURVEY

Questionnaire N^0 ……..	Date / / 2019

Human and socio-economic characteristics of participants

Background

Village / District	Ward
Area	

Personal Identification

1.1 Sex (Tick)

A. male [ ] B. Female [ ]

1.2 What is your age group?

A . 20-30 years [ ]

B. 31-40 years [ ]

C. 41- 50 years [ ]

D. 5-60 years [ ]

E. 61-70years [ ]

1.3 How do you group house size (Tick)

A. 1-3 [ ]

B. 4-6 [ ]

C. 7-9 [ ]

D. 10 and more [ ]

1.4 What is the highest level of education or qualification (Tick)

A. No education [ ]

B. Primary School [ ]

C. Middle School [ ]

D. Secondary school [ ]

E. Poly-Technical [ ]

F. Vocational [ ]

G. College [ ]

H. University [ ]

I. Informal or Other Specify ……

1.5 What is your income in US$ (Tick)

A. Less than two hundred

B. 201- 400

C. 401- 600

D. 601- 800

E. 800 and above

1.6 Do you have any of the following (Tick)

House Yes [ ] No [ ]

Land Yes [ ] No [ ]

2. Respondent's agricultural land ownership details (Tick the appropriate)

Question	Land Ownership	Tick
What is the type of land ownership?	Private property with title deeds	
	Communal land	
	Ancestral land	
	Leasehold	
	Government	

2.1 What is the area/ size of your land (Tick)

	Size of land	Tick
What is the size of your land?	Less than an acre	
	1 to 3 acres	
	4 to 5 Acres	
	6 to 10 Acres	
	Over 10 acres	
	Do not know	

2.2 Land holding details according to usage (Fill in the box)

Area of land	Area under cultivation	Pastures	The area under cultivation this year	Area under irrigation	Area under fallow

2.2 Agricultural Intensity in acres

Area cropped once per year	Twice per year	Trice per year	Continuous

2.3 Amount of production per year

Crop	Land under cultivation	Production per year (Bugs)	
		Good harvest	Bad year

		year	

2.4 What type of crop do you produce (Tick)

A. Cash [ ] B. Subsistence [ ]

2.5 List the types of crops you grow under the table below

Type of crop	Food crop	Cash crop

3. Climate perception

3.1 What is your experience on climate change and variability since when you were young/since when you started farming/for the last 15-20 years? (Tick and explain)

Code	Perceptions	Tick		
		YES	NO	Explain
A	Rainfall changes			
B	Rainfall increases			
C	Rainfall decreases			
D	Shifting rainfall onset			
E	Rainfall very erratic			
F	Rain starting earlier than usual			
G	Short summer			
H	Extended rainy summer season			
I	Changing planting dates			
J	Temperature decreasing			
K	Temperature increasing			
L	Increase in pests and diseases			
M	Temperature rained constantly			

N	Floods increases			
O	Floods dec			
P	Droughts			
Q	Droughts decreases			

3.2 How have you experienced the changes in climate and variability impact(s) on your farm?

Impact	Tick	How
Drought		
Floods		
Other specify…….		

3.3 How is your experience with food insecurity?

……

……

4. Role played by assets to small-scale farmers

4.1 To what extent do you think the following assets affect small-scale farmers' vulnerability (Tick the appropriate box).

code	Assets	Effects			
		Don't Know	Don't Agree	Agree	Strongly Agree
A	Financial assets				
B	Human assets				
C	Social assets				
D	Natural assets				
E	Physical assets				

4.2 Household Assets

Please indicate the types of assets that you own

Equipment/ Tools	
Assets	Number
Tractor	

Ox Plough	
Cart	
Wheelbarrow	
Water Pump	
Harrow	
Other (specify)……	

Livestock	
Assets	Number
Cattle	
Sheep	
Goats	
Pigs	
Poultry	
Donkeys	
Other (specify)……...	

4.3 Livestock problems faced (Number according to the figures given below)

	Problems	Tick
What is the main problem facing your livestock?	Lack pasture	
	Lack of water	
	Inadequate grazing land	
	Livestock diseases	
	Lack of market	
	Other (Specify)	

1= Not serious, 2. = Serious problem, 3 Very serious problem

5. Indigenous and Scientific Knowledge

5.1 How respondents perceive the effectiveness of Indigenous knowledge

Code	Indigenous Knowledge			Strongly agree	Agree	Not Sure	Disagree	
A	Lack of support from the government							
B	Gender-sensitive							
C	Not well known							
D	It's underrated							
C	Not reliable							
E	Eroded due to changing climates							
F	Not applicable everywhere							
G	Old fashioned							
H								

	Not documented							
I	Rooted in cultural beliefs							
J	Cannot be approved							
K	Inapplicability							
L	Eroded by technology							

5.2 Scientific / Modern Knowledge

5.2 Scientific Knowledge Scientific Knowledge	Strongly disagree	Don't know	Agree	Disagree	Strongly disagree
Reliability					
It is readily available					
Have been using it for years					
It is for the rich farmers					
It's better than indigenous knowledge					
It's worse than indigenous knowledge					
It must be combined with indigenous knowledge					

6. Adaptation strategies

6.1 Which of the following adaptations strategies did you implement (Tick the appropriate)

Adaptation Strategies	Tick
New crop cultivars	
Early Maturing varieties	
Change of crops completely	
Grow drought-resistant crop varieties	
Intensify irrigation	
Mulching	

Selling some of the assets e.g., Livestock and crops	
Diversify household income	
Getting external aid	
Crop rotation	
Use of organic or inorganic fertilisers	
Water Harvesting	
Reducing the number of livestock	
Barter Trade	
Other (specify) …….	

7 Institutional supports.

7.1 Are you getting any government support?

Yes [ ] No [ ]

7.2 If yes, fill in the table below

Government Department	Type of help			
	a). Education	b) Input suppliers	c) Food	d) Any other
AREX				
GMB				
NGO				
AGRITEX				
Other Specify) …….				

7.3 Suggestions to improve the community's adaptation

a.) The community leaders should……

b) Government departments should……...

……

c) Non- Governmental Organisations should……

… ……

d) Other (Specify)……

……

Thank you for your time and cooperation.

Name of Researcher: Jaison Chatsiwa (Ph.D. Researcher): 1803536@student.wits.za Cell +263779430277
Name of Supervisor: Prof. Mulala Danny Simatele: Mulala.simatele@wits.ac.za

Appendix K - Characteristics of Agro-ecological regions in Zimbabwe

Region	Climate and farming characteristics	Area and Percentage change
1 Specialised Diversified farming	Rainfall is usually900- 1000mm per annum Temperature 15 degrees Deciduous fruit production Beef cattle Dairy farming Forestry: Wattle Crops; apples, barley potatoes	Area contributed only about 1.8% of the whole country (7024 km^2), but according to this work, the NR has moved westwards. The NR has increased by 106%
2a Intensive Farming	Rainfall is around (750-1000mm). Temperature around 18-22degrees Cool winters 16-18 degrees Wet and warm summer	The area covers 29,658.62 km^2 translating to about 7.6% of the whole country (Fig. 3.2b). In the previous classification, the area covered 15% (58,536 km2)
2b Intensive Farming	Sub-region receives an average of 16-18 degrees Dry spells during the rainy season Short rainy seasons.	
3 Semi-Intensive Farming 7.3 million hectares	Moderate rainfall 650-800 moderate in total amount (550-800mm), Temperature 18-24 degrees Droughts are common Drought resistant Crops maize, tobacco, cotton, soya beans,	The area covers 62,829 km^2 comprising 16.1% of the whole country. In the previous (old map) classification the area covered 72, 975 km2 equivalent to 18.7% of

	sorghum	Zimbabwe
4 Semi Extensive Farming 14.8 million hectares	Rainfall (450-650mm) Droughts Irrigation Temperature 20-25 degrees Drought-resistant crops Livestock production	The area is 155, 707 km2 which translates to 39.9 % of the whole country. In the previous classification, the area occupied about 37.8% of Zimbabwe
5 Extensive Farming 10.4 million hectares	Erratic rainfall below 400mm Game reserves are common Temperature 22-30 degrees Drought-resistant crops grown Cattle ranching is common Drought-resistant crops and fodder crops	The new Natural Region V covers about 126, 829 km2 which is equivalent to about 32.5% of the whole country

Source: Mutasa, (2011).

Appendix L- Characteristics of adaptive capacity

Characteristics	Features that reflect adaptive capacity
Asset Base	Asset portfolios (pentagon of assets). These assets can be tangible, and some are intangible
Departments and Entitlements	Ensure a conducive environment for a fair distribution of assets to small-scale farmers, Accessibility and affordability of key resources should be ensured as well. These ensure a fair distribution of resources used to improve adaptive capacity.
Knowledge and Information	Appropriate climate information should be disseminated to small-scale farmers in time. Modes of communication, channels of communication, and in a language that is understood by the recipients. Early warning systems to be quickly sent to small-scale farmers in a languagethath they can understand,
Innovation	This involves new practices new crops, new livelihoods, new farming practices, and taking advantage of new opportunities to adapt to climate variability.
The way	There is a need for flexibility in the whole system to allow adjustments to the

forward, decision-making, and governance	new climate conditions. There is a need for transparency and prioritisation in the adaptive strategies of small-scale farmers.

Source: ACCRA (2011). http://community.eldis.org/accra/

Appendix M -Approaches to climate change adaptation

School of Geography, Archaeology and Environmental Studies

Private Bag 3, Wits 2050, South Africa Enquiries: **GEOGRAPHY:** TEL: +27 11 717-6503 •
ARCHAEOLOGY: TEL: +27 11 717-6045 •
http://www.wits.ac.za/geography/

Name of Approach	Period of Development	Key Objectives and the current emphasis	Examples of the institution using the approach	Origin	Focus on Assets
Disaster Risk Reduction (DRR)/Disaster Risk Management (DRM)	1980s	Reduction of underlying factors of risk, intensity &/or frequency of disaster occurrence in the pre-disaster & post-disaster context (i.e., development, relief, and response) including climate-related and non-climate-related disasters. The current emphasis is on the integration of DRR into sustainable development through a management perspective	Tearfund, Environment, Climate Change & Bio-energy Division of FAO, GTZ; IDS, Sida, Dfid, etc.	DRM (emergency/relief organizations, social scientists)	In the context of strengthening, capacities & resilience of h/holds, communities & institutions' assets are a major theme.
Climate Risk Management (CRM)	1990S-00s	Reduction of vulnerability to climate risk by maximising positive & minimizing negative outcomes caused by climate change with the	IDS, Energy for Sustainable Development	Climate change adaptation	Due to its orientation towards community adaptation and

		final aim to promote sustainable development	Africa, UN Secretariat of ISDR, ADPC	community/DRM	institutional capacity building, assets are addressed.
Climate Change Adaptation	1990s-00s	Reduction of vulnerability to climate risk developed as a reaction to the 1990s greenhouse gas debate that promoted the mitigation agenda. The emphasis of adaptation is here on dealing with the physical impacts of climate change.	South North, Acclimatise; TCPA, IIED, ADPC, and ACTS.	DRM/ Climate Change Adaptation	Assets addressed through the interest in local knowledge & competence
Climate Change Vulnerability Resilience	2000s	Increasing the ability of communities to withstand and recover from climate change-related external shocks & stresses with an emphasis on economic well-being, stability of a community, social & political factors, institutional capacity, global interconnectivity, & natural resource dependence.	IDS, Tyndall Research Centre, Acclimatise, IIED, Practical Action, ITDG	DRM/ Climate Change Adaptation	Assets addressed implicitly as an approach attaches significance to governance quality at municipal & local levels.
Community - Based Adaptation	2007 (adapted from poverty-focused	Support of knowledge & coping strategies of individuals & communities to reduce vulnerabilities to climate risk, based on individual & community knowledge of climate variability.	IDS, Eldis, ACTS, ADPC, IISD, IIED, & Practical Action" ITGD	DRM/climate change adaptation (influenced by	Assets form a central theme due to their bottom-up approach emphasising people's capabilities and

	CBA of the 1990s)			development experts such as Robert Chambers)	abilities.
Asset-Based Vulnerability & Adaptation	2008 (building on asset vulnerability of the 1990s)	Analysis of asset vulnerability and asset adaptation relating to the erosion and/or protection of human, social, physical, and financial assets at the individual, household, and community level for resilience, pre-disaster damage limitation, immediate post-disaster response, and rebuilding	Global Urban Research Centre (GURC); IIED.	Asset vulnerability and asset accumulation framework; climate change adaptation	Assets' main basis of focus at different levels includes the role of external institutions such as municipalities, NGOs, and the private sector

Source: Simatele (2009).

Appendix N- Questions on assets, indicators, challenges, and solutions

Assets	Indicators	Questions	Problems and solutions
Financial	Credit Facilities Remittances received Donors Money from relatives	Do you have access to credit facilities? Are you getting any remittances from anybody Are getting any monetary donations from anywhere? Do you receive any money from your relatives?	Many people were able to answer this question so there was no need for solutions
Physical	Livestock Gadgets Scotch carts Irrigation facilities	Do you own livestock? What form of gadgets do you have? Do you have any irrigation facilities?	This was a straightforward question and therefore no solution was required.
Natural	Farm size Land tenure	What is the size of your farm? What type of land tenure do you hold on to that piece of the farm? Does your livestock have enough pastures?	There was a challenge on land tenure because some of the households were in resettlement farms. This was resolved by confirmation with the Extension officers
Human	Educational level Health status	What is the highest level of education attained? Is there been any member of your family admitted into the hospital in the past 30 years?	Many respondents were able to answer questions on their educational level. Respondents were able to tell us who was admitted to hospitals in the past 3 decades
Social	No. of clubs joined. Access to climate information	Are you registered with a club? Do you have access to climate information?	Some respondents were not able to define the term club. The classification was done and later the respondents were able to answer most of the questions.

Appendix O -Summary of research questions, sampling, strategy for data collection, and justification for the data collection methods

Question	Methods used for data collection	Sampling	Justification for methods used
Identify the agricultural practices used in your constituency.	Focus group discussions Observations and transect walks	Snowball	The methods were very objective and participatory.
Are there any problems encountered in using indigenous knowledge systems?	Focus group discussions Observations and transect walks	Random	Wide variety of suggestions and primary sources of information with evidence.
What is your perception of Scientific and IKS in agriculture (Small scale farmers)	Semi-structured interviews with small-scale farmers	Snowball	Establish the primary perception of scientific and indigenous knowledge
Name the type of assets used to adapt to climate variability,	Household questionnaire	Random	To assess the assets available to smallholder farmers with every farmer having an equal chance to be selected
How has rainfall and temperature changed over the years (Key informants)	Focus discussion group	Purposive	In-depth content on climate variability
What assets portfolios are available in Gokwe South District to improve their resilience and adaptive capacity to impacts of climate variability?	Household questionnaire Snowball	Random	To assess the types of assets used and to find out which assets are more influential than others to reduce vulnerability

What factors influence small-scale farmers' choice of adaptation strategies to climate variability in the Gokwe South district?	Household questionnaire Semi-structured interviews	Random	Cross-sectional and extensive suggestions
In what ways local knowledge systems can provide solutions to problems of climate variability?	Focus Group Discussion Semi-structured interviews	Cluster	Cross-sectional and extensive suggestions