

https://dspace.org/

Adaptation strategies against drought: The case of rain-fed subsistence crop farmers in Mphego village in the Vhembe District of Limpopo province, South Africa

Ntuli, Nokutenda Chantelle

2023

University of the Witwatersrand, Johannesburg

https://hdl.handle.net/10539/40086

Ntuli, Nokutenda Chantelle. (2023). Adaptation strategies against drought: The case of rain-fed subsistence crop farmers in Mphego village in the Vhembe District of Limpopo province, South Africa. [Master's dissertation, University of the Witwatersrand, Johannesburg]. WIReDSpace. https://hdl.handle.net/10539/40086

Downloaded from a DSpace repository. https://dspace.org/



Adaptation strategies against drought: The case of rain-fed subsistence crop farmers in Mphego village in the Vhembe District of Limpopo province, South Africa

Thesis submitted in partial fulfilment of the requirements for the degree of Master of Arts in Development Sociology to the Faculty of Humanities, University of the Witwatersrand

By

Nokutenda Chantelle Ntuli

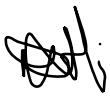
Student number: 1889081

Supervisor: Dr Tatenda Mukwedeya

October 2023

DECLARATION

I, Nokutenda Chantelle Ntuli, student number 1889081, earnestly declare that this research report is entirely my own work, and it has not been submitted for examination at any other academic institution. I'm fully aware of the ethical implications of plagiarism, as well as the significance of academic integrity. Therefore, all external sources used in this research have been cited and referenced in compliance with academic standards of the University of the Witwatersrand.

Signature:  **Date: 2023/10/06**

ACKNOWLEDGEMENTS

I sincerely express my profound gratitude to each and every person who contributed to the successful completion of this research report.

First and foremost, I give special thanks to my supervisor Dr. T. Mukwedeya for his unwavering support and guidance in the completion of this dissertation. His patience, expertise and constructive feedback were essential in shaping and improving this research study.

I would like to extend my heartfelt appreciation to the Emancipatory Futures Studies (EFS) Research Committee for funding this research and for providing valuable insights that shaped the outcomes of this study.

I'm grateful for the invaluable assistance provided by my colleague Mr. D. Nevhudoli in the data collection process. I highly appreciate your efforts and everything you taught me about research.

I deeply express my gratitude to my sister Miracle and her husband Clive for their constant love and sacrifices that necessitated the completion of this academic journey. Not forgetting my brother-in-law Mr. S. Chirikure, who provided academic and moral support. Thank you all for giving me hope when I doubted my abilities.

Above all, I'm grateful to God for being my pillar of strength throughout the research process. I'm forever grateful.

ABSTRACT

South Africa's Limpopo province is recognized as one of the drought prone regions of the country. Incessant droughts in Limpopo are compromising agricultural productivity in both the large-scale commercial and smallholder farming sectors. Regardless, smallholder farmers, especially those located in historically marginalized settings (former homeland areas) that experience socio-economic deprivation at the hands of the state, and practice rain-fed subsistence agriculture bear the disproportionate burden of drought. These farmers lack adequate finances, agri-mechanization as well as state support to sufficiently cushion them against drought. Such is the plight of rain-fed subsistence in Mphego village, a former homeland area of the Venda Bantustan now known as Vhembe district.

This study contributes to understanding how drought is impacting the practices of rain-fed subsistence crop farmers in the rural community of Mphego. Attention is placed on investigating the ways in which drought intersects with existing politically engineered social and economic constraints experienced by subsistence farmers in Mphego village to exacerbate systemic vulnerabilities. Moreover, it explores the adaptation strategies that are being employed by these subsistence farmers to cope with drought impacts. Qualitative interviews were used to investigate these dynamics, and the data was analysed using the thematic approach.

The results obtained from Mphego revealed that drought vulnerabilities experienced by subsistence farmers should be understood in light of other converging state orchestrated socio-economic structures of deprivation in local rural communities that shape outcomes in the smallholder agricultural sector. The state is contributing to the expansion of agri-capitalist practices and its drought relief support is biased towards large-scale commercial farmers at the expense of subsistence livelihoods. Given these circumstances, subsistence farmers in Mphego have been employing their own agency to adapt to drought conditions. The livelihood capitals possessed by the farmers were found to play a significant role in influencing and shaping their choice of adaptation practices.

LIST OF ACRONYMS

ANC	African National Congress
FAO	Food and Agriculture Organization
IPCC	Intergovernmental Panel on Climate Change
RWH	Rainwater harvesting
SADC	Southern African Development Community
SLF	Sustainable Livelihoods Framework
SSA	Sub Saharan Africa
UNFCCC	United Nations Framework Convention on Climate

Contents

DECLARATION 2
ACKNOWLEDGEMENTS 3
ABSTRACT 4
LIST OF ACRONYMS 5
CHAPTER ONE 9
Introduction 9
1.1. Study background 9
1.2. Problem statement 13
1.3. Main research Question 14
1.4. Sub questions 14
1.5. Research Objectives 14
The objective for asking these research questions is to: 14
1.6. Chapter outline 14
Literature Review 16
2.1. Introduction 16
2.2. Definitions and characteristics of subsistence agriculture 16
2.3. Subsistence agriculture in the South African context 18
2.4. Defining food security and contextualizing it at the household level 20
2.5. The role of subsistence agriculture in improving household food security among rural households 21
2.6. Defining drought 23
2.7. An overview of drought conditions in Africa 24
2.8. Prolonged drought in South Africa 24
2.9. The impacts of drought on rain-fed subsistence crop production 25
2.10. Adaptation and coping mechanisms 27
2.11. The importance of subsistence farmers' perceptions of drought in their adaptation responses 28
2.12. Strategies used by subsistence farmers in Africa and South Africa in particular to cope with and adapt to drought trends 29
2.13. Conceptual tool for analysing the livelihood assets that influence the subsistence farmers' choice of adaptation strategies 31
Livelihood assets 32
Human capital 32
Social capital 33
Natural capital 33
Physical capital 33
Financial capital 34
2.14. Critique of the Sustainable Livelihoods Framework (SLF) 34
2.15. Chapter summary 36
CHAPTER THREE 37
Research Methodology 37

3.1. Introduction 37
3.2. Description of the study area 37
3.3. Research approach 38
3.4. A brief description of population under study and selection of participants 39
Age group 41
Gender 41
Educational level 42
Farming experience 42
Employment status 42
3.5. An enquiry of subsistence farmers' drought adaptation strategies using semi-structured interviews 43
3.6. Conducting a pilot study to test the interview guide 44
3.7. Data collection and fieldwork experience using semi-structured interviews 44
3.8. Data analysis using the thematic approach 46
3.9. Ethical considerations 47
3.10. Chapter summary 47
CHAPTER FOUR 48
Drought impacts on rain-fed subsistence cropping practices 48
4.1. Introduction 48
4.2. The participants' socio-economic demographic characteristics 48
Age group 48
Gender 49
Educational level 50
Farming experience 51
4.3. Reasons for practicing subsistence agriculture 52
4.4. Characteristics of subsistence crop production in Mphego village 53
The dominant types of crops cultivated 53
Farm size 54
Farming equipment 54
Access to agricultural extension services 55
4.5. The role of subsistence crop production in enhancing the farmers' household food security 56
Food availability 56
Food accessibility 57
4.6. The subsistence farmers' perceptions of drought 58
Changes in rainfall patterns 59
4.7. The interplay of drought and state orchestrated socio-economic constraints 62
Shift of planting dates 63
Increased soil infertility and aridity 66
Crop pests and pest borne disease 67
Crop yield deficit 68
4.8. Chapter summary 69

CHAPTER FIVE 70
Drought adaptation strategies by rain-fed subsistence crop farmers 70
5.1. Introduction 70
5.2. Adaptation strategies 70
Alteration of the cropping calendar 73
Soil fertility and moisture management practices 75
Rainwater harvesting (RWH) methods 83
Diversification of indigenous and hybrid crop varieties 88
5.3. Chapter summary 93
CHAPTER SIX 94
Conclusion and Recommendations 94
6.1. Introduction 94
6.2. Drought impacts on rain-fed subsistence cropping practices in Mphego 94
6.3. The interplay of drought and state orchestrated socio-economic constraints 95
6.4. Drought adaptation strategies 97
6.5. Evaluating the effectiveness of the drought adaptation strategies 99
6.7. Limitations of study and suggestions for future research 101
REFERENCE LIST 103
APPENDIX A 119
Participation information sheet 119
APPENDIX B 121
Consent form 121
APPENDIX C 123
Research instrument: Semi-structured interviews 123

CHAPTER ONE
Introduction

1.1. Study background

This thesis focuses on the adaptation strategies adopted by rain-fed subsistence crop farmers to cope with climate change induced droughts drawing on the case study of Mphego village, Vhembe District in the arid Limpopo province of South Africa. Climate change was declared as one of the most intricate and destructive environmental catastrophes that befalls the 21st century human civilization (IPCC, 2001). The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) (2022) evinced that climate change is patently a 'grave', meaning that it is an escalating threat with deadly consequences that impede development and endangers every form of life on our planet. Article 1 of the United Nations Framework Convention on Climate Change (UNFCCC) (1992, p. 7), defines climate change as a "change of climate which is attributed directly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".

Based on this definition, it is clear that various human activities that are being rapidly exercised on the planetary commons are disrupting the planet's biophysical system (Satgar, 2018). This has been explicitly verified by the Anthropocene scientific discourse which ascribes the changes in the earth's climate system to human generated carbon emissions (Satgar, 2018). Steffen et al. (2011) propounded that the geological era of the Anthropocene commenced with the creation of the world's first carbon-driven capitalist economy during the advent of the British industrial revolution. The discernible influence of anthropogenic activities thus contributes to and amplifies natural processes that warm the planet. The IPCC (2007) reported that greenhouse gas (GHG) emissions associated with anthropogenic activities have been on a rapid rise since the mid-20th century. Steffen et al. (2011) further argued that as the human footprint on the planetary commons worsens in the 21st century, this is a global emergency as we are reaching the third phase of the Anthropocene.

With the amplified frequency of climate extremes associated with both anthropogenic activities and natural processes, every corner of the globe has been raptured by their grievous consequences. Despite being faced with this devastating reality, the UNFCCC has been lagging when it comes to implementing climate solutions that comprehensively address the systemic roots of the crisis and this is undoubtedly leading the world towards a dystopian future (Satgar, 2018). The World Meteorological Organization (WMO) (2022) confirmed that in 2021 carbon emissions had increased by 415.7 parts

per million (ppm), making it almost impossible to keep planetary temperatures below the 1.5°C pre-industrial level threshold recommended by the Paris Accord (COP21) of 2015. Satgar (2018) averred this rise in planetary temperatures is exacerbating the occurrence and intensity of climate extremes such as drought, heat waves, hurricanes and floods.

The severe impacts of climate change affect various sectors that sustain the livelihood and food security of the global population, including agriculture. The United Nations Food and Agriculture Organization (FAO) (2008) unequivocally proclaimed that the apocalyptic consequences of climate change have led to the dramatic failure and worldwide collapse of the agricultural sector. Satgar & Cherry (2019, p. 1) divulged that this is a "systemic crisis" which is compromising the food and nutrition security of billions of people across the globally. However, poor and marginalized populations involved in agriculture have been identified as highly susceptible to climate change impacts. This argument was mirrored by the International Fund for Agricultural Development (IFAD) and the Global Environment Facility (GEF) (2008) who reported that rural subsistence farmers especially those in the developing world are disproportionately affected by climate change because they are financially and technologically poor.

Africa as part of the developing world is a significant example in illustrating this point. The African continent is among the world regions that bear the largest burden of climate change (Niang et al., 2014). The negative impacts of climate change are felt all over the continent, and mostly in sub-Saharan Africa (SSA) with a rural population of roughly 60 percent which predominantly consists of poorly resourced smallholder farmers (Thorpe et al., 2020). Drought has been declared as one of the most costly and destructive climatic conditions affecting the livelihood of millions of people in SSA (World Bank, 2021). According to the World Bank (2021), the occurrence of drought has rapidly increased in the region, nearly tripling from the period of 2010 to 2019. Congruently, it has been predicted that in the future, drought events will exacerbate in water-stressed African countries (IPCC, 2018; Niang et al, 2014).

While agriculture is a key economic sector for most countries in SSA contributing more than 30 percent of their gross domestic product (GDP) (World Bank, 2013), the frequency and intensity of drought in the region has triggered a massive crop yield deficit. The IPCC Fourth Assessment Report (AR4) (2007) recognized rain-fed agriculture as the most vulnerable with an estimated 50 percent decline in agricultural output in 2020. Unfortunately, drought has intensified the food crisis in sub-Saharan African countries who are already at the grip of poverty owing to deteriorated economies. This is the reality especially in rural areas where bulk of the population are poor smallholder subsistence farmers

who are heavily reliant on rain-fed agriculture as their primary source of food security and livelihood (Thorpe et al., 2020).

Drought is a regular feature of the weather extremes in South Africa, occurring at varying degrees throughout the country. Meza et al. (2021) ascertained that South Africa has been confronted by drought events over the past four decades, and in recent years from 2015 to 2016 and 2018 to 2020. South Africa's policy makers declared the 2015 drought as the worst drought to have been experienced in the country's history due to its horrendous impacts on both small-scale and commercial agricultural sectors and vulnerable populations (Baudoin et al., 2017). Limpopo was among the six provinces that were recognised as drought disaster areas (Satgar & Cherry, 2019). Satgar & Cherry (2019) avowed that drought events in South Africa have worsened food insecurity and poverty especially among the rural poor. Fundamentally, it has been noted that highly socio-economically deprived rural communities in Limpopo province are high poverty and food insecurity hotspots of South Africa (DPLG et al., 2007). This is because the bulk of the population in those areas are small-scale farmers who are largely dependent on rain-fed agriculture (Vhembe District Municipality, 2014).

An Oxfam report for South Africa by Hornby et al. (2016, p. 13) highlighted that the increased drought vulnerability of rural small-scale farmers (and other vulnerable populations) in South Africa is inherently "political in nature". It strongly intersects with state-centric policies which are tied to colonial deprivation. Aliber & Hall (2012) confirmed that the African National Congress (ANC) -led government has been lagging when it comes to decolonising the agricultural landscape as it continues to be shaped by the Apartheid segregationist capitalist developmental policies.

As of today, the country has a racially skewed dual agrarian structure orchestrated by the Apartheid colonial government. On one hand is a white dominated technologically advanced commercial agricultural sector closely linked to international markets. On the other hand, is a poorly resourced and labour-intensive smallholder farming sector in mostly in former homelands which is dominated by black people who engage in subsistence production to secure their livelihoods and food security (Hall, 2004; Oni et al., 2012). Despite the prominent feature of smallholder farmers in state policy documents, little has been done to support them in practice (Okunlola et al., 2016). The reality is that the state has failed to transform the agricultural sector. As was with apartheid, the state's resource provision policies continue to be biased towards white commercial farmers, whereas smallholder farmers remain marginal in the agricultural economy as they are deprived of sufficient institutional support and agricultural resources (Makhura, 2001; Aliber et al., 2011; Okunlola et al., 2016).

As drought has become the 'new normal' (Hornby et al., 2016) affecting both commercial and smallholder agrarian systems in South Africa. It is evident that this ecological crisis has worsened the existing structural inequalities that shape South Africa's dual agrarian system as poorly resourced rural smallholder farmers are at the receiving end of its disproportionate impacts (Hornby et al., 2016). In this regard, Madzwamuse (2010) vehemently asserted there is need to consider the institutional factors that predominantly favour large scale commercial farmers, while neglecting smallholder farmers, despite them being confronted by similar climatic conditions.

Similarly, Turpie & Visser (2013) and Hornby et al. (2016) have shown that unlike commercial farmers who have easy access to credit and insurance to cushion themselves against climate risks, the increased vulnerability of rural smallholder to drought episodes has been aggravated by the lack of the state. To this accord, Satgar & Cherry (2019, p. 10) confirmed that "drought has further exposed state constructed inequalities ..." due to corruption and lack of political will to address the needs of small-scale farmers. This line of argument was further echoed by Hornby et al. (2016), who attested that the drought response initiatives have been sporadic, limited and overlooking vulnerable populations who require the most support to recover from its impacts. Therefore, the limited adaptive capacity of rural smallholder farmers to incessant climate challenges can also be attributed to the state's failure to improve their access to public infrastructures (such as water, electricity, transportation facilities), financial subsidies and extension services (Mpandeli & Maponya, 2013; Moeletsi et al., 2013; Mpandeli & Maponya, 2014; Satgar & Cherry, 2019). This is questionably the case for smallholder farmers in Vhembe district, Limpopo province.

The Vhembe District Municipality (2014) report revealed that 90 percent of rural areas in the district of Vhembe practice smallholder farming as a means for survival. Empirical literature demonstrates that smallholder farmers in rural Vhembe are highly vulnerable to fluctuations in rain and atmospheric temperatures because they are ill-equipped (lack adequate financial and technological resources) and predominantly operate under rain-fed systems (LDA, 2012; Ubisi et al., 2017). Given policy inadequacies and the apparent failure of conventional top-down approaches in South Africa to improve the drought adaptive capacity of poorly resourced rural smallholder agrarian communities in Limpopo and other provinces, it was important for this research to take a bottom-up approach to drought adaptation.

This study acknowledges that autonomous or community-led adaptation is a fundamental prerequisite for strengthening the resilience of rural smallholder farmers in Vhembe District, Limpopo province and particularly the village of Mphego in the face of drought. As the bulk of smallholder farmers in

rural communities of Vhembe and the broader Limpopo province are largely dependent on subsistence production as an essential component of their livelihood and food security (Oni et at al., 2012), autonomous drought adaptation is a grassroot approach that empowers these vulnerable farmers to achieve sustainable livelihoods and household food security without so much dependence on the state support (and other development agencies).

1.2. Problem statement

An engagement with existing literature revealed that subsistence farmers have for centuries developed adaptation strategies to keep agricultural production afloat in periods of climatic stress, including drought trends (for example see Hart & Vorster 2007; Stringer et al., 2009; Vincent et al., 2013; Theodory, 2016; Aniah et al., 2019 among others). Studies on drought induced vulnerabilities and adaptation strategies by rural smallholder farmers have been conducted South Africa (see for example, Muthelo, 2018; Khumalo, 2020; Kom, 2020). However, the bulk of these studies mainly focused on the farmers' perceptions of drought and some almost exclusively restricted their analysis of drought vulnerability as a stand-alone issue. They overlooked how drought potentially intersects with other structural challenges that are linked to the historical legacies of social and economic deprivation found in local rural communities. The role of the state in facilitating the expansion of agri-capitalist practices that reproduce structural tensions known to exacerbate vulnerabilities of smallholder farmers to ecological challenges such as drought is synonymously ignored. Therefore, little is known about how rural smallholder farmers adapt to drought, and the interwoven politically engineered social and economic dynamics that shape outcomes in the smallholder agriculture sector.

This study sought to fill in this gap by shedding light on how smallholder farmers particularly those involved in rain-fed subsistence crop production in Mphego village in Vhembe district, Limpopo adapt to drought and converging politico-socio-economic constraints that shape the subsistence agriculture economy. A review of the farmers' agency in mitigating these multifaceted but intersecting factors that impact the contemporary subsistence agriculture landscape in South Africa and Africa at large makes this study unique by mapping transformative futures particularly in the agricultural economy. Transitioning beyond understanding the farmers daily agricultural practices by way of exploring their agency in combating the nexus of climate change and other structural challenges in an evolving capitalist economy further makes this study relevant to social sciences. Moreover, it helps in understanding the socially constructed knowledges and practices by the subalterns in mitigating both climate change and the ailing subsistence agricultural economy in order to improve their household food security and livelihoods.

1.3. Main research Question

1. How do rain-fed subsistence crop farmers in Mphego village adapt to the prevailing impact of drought?

1.4. Sub questions

The sub questions that inform the main research questions are as follows:

1. How does drought impact the practices of rain-fed subsistence crop farmers in Mphego village?

2. In what ways is drought intersecting with existing state orchestrated social and economic challenges experienced by subsistence farmers in Mphego village to exacerbate their vulnerabilities?

3. How valuable are the adaptation practices employed by subsistence farmers in mitigating the nexus of drought and the politically engineered socio-economic challenges affecting rain-fed crop production?

1.5. Research Objectives

The objective for asking these research questions is to:

(a). Investigate drought impacts on rain-fed subsistence cropping practices in Mphego village.

(b). Explore the intersection of drought with existing state orchestrated social and economic constraints experienced by subsistence farmers to reproduce their vulnerabilities.

(c). Identify the adaptation strategies that are being employed by subsistence farmers to mitigate the impact of drought on rain-fed crop production, and to analyse the livelihood assets that influence their choice of adaptation strategies.

(d) Evaluate the effectiveness of these adaptation strategies in mitigating the nexus of drought and other politically engineered socio-economic challenges affecting rain-fed agricultural production.

These research questions and objectives will be pursued through the qualitative research methodology.

1.6. Chapter outline

Adaptation to climate change ranks as one of the most urgent priorities of the 21st century. However, subsistence farmers in arid regions such as Mphego village in Northern South Africa are suffering

from droughts whose impact is often magnified by structural effects of the residues of the discriminatory Apartheid system and lack of government support. Furthermore, capitalist market forces create conditions where subsistence farmers struggle to raise sufficient capital to invest in climate change mitigation strategies often forcing them to be labourers. The organisation of this thesis is as follows: *Chapter two* is the literature review. It discusses and critically analyses previous studies that have been conducted locally and internationally that are pertinent in addressing the research question. It also provides an overview of the Sustainable livelihoods Framework, the theoretical underpinning of this research study.

Chapter three provides a discussion of the research methods employed in gathering data to address the research question of this study. It also details relevant information about the study area, research approach, sampling procedures and research instruments used in this study, while also highlighting my field work experience. Moreover, it pays attention to the ethical procedures observed in the research process.

Chapter four presents the research findings on the impacts of drought on rain-fed subsistence crop production. It will show how drought intersects with longstanding state orchestrated socio-economic challenges experienced by rural subsistence farmers to exacerbate their vulnerabilities. It also provides information on the participants' demographic characteristics, the reason for their involvement in subsistence farming, the types and characteristics of subsistence agriculture in the research area and its role in enhancing the farmers' household food security.

Chapter five discusses the research findings on the adaptation strategies that are being employed by subsistence farmers to mitigate the impact of drought on rain-fed crop production. It will show that the farmers adaptive capacity and choice of adaptation strategies is informed by the different livelihood capitals they possess.

Chapter six is the conclusion, it summarizes the key research findings of the study based on each research objective. It also provides an evaluation of the effectiveness of the adaptation strategies that are being employed by subsistence farmers in mitigating the nexus of drought and other politically engineered socio-economic challenges affecting rain-fed agricultural production.

CHAPTER TWO

Literature Review

2.1. Introduction

This chapter reviews literature pertinent to this study. It starts by providing the general definitions and characteristics of subsistence agriculture in the developing world and in South Africa in particular. This is succeeded by a discussion on the role of subsistence agriculture in ensuring food security among rural households. Focus was also placed on unpacking the definitions of drought as well as drought trends in Africa which were narrowed down to the South African context. Subsequently, attention was directed towards reviewing literature that highlights the impacts drought on subsistence agriculture especially rain-fed crop production, a source of food security and livelihood among rural households. After this, it went on to discuss the adaptation strategies that are being employed by subsistence farmers to build resilience against drought conditions. This chapter was concluded by a discussion of the theoretical underpinning of this study, the Sustainable Livelihoods Framework (SLF), which was deemed significant in analysing the livelihood assets that influence the subsistence farmers' choice of drought adaptation strategies.

2.2. Definitions and characteristics of subsistence agriculture

Agrarian literature recognizes subsistence agriculture as the dominant source of adequate food provision and livelihood among the rural poor, mostly in developing countries (Fawzy & Shedeed, 2020). Recent data from FAO (2021) confirmed that the largest portion of the world's agricultural land is utilized by over 608 million subsistence farmers. Interestingly, in terms of value, these farmers are said to produce approximately 80 percent of the overall agricultural yields on a global scale (FAO, 2021).

Defining subsistence agriculture is very complicated owing to context issues. As Van Averberke et al. (2011) notes, subsistence agriculture is practiced by a diverse group of individuals and households who encounter different challenges that impede them from practicing lucrative agricultural operations. However, it is difficult to establish an all-encompassing definition of subsistence agriculture across disciplines because these farming systems vary across different world regions, economies, and cultures (Morton, 2007). Considering these complexities, sociological literature has shown that the term subsistence agriculture can be used interchangeably with small-scale, smallholder or peasant farming (Bruntrup & Heidhues, 2002). However, for the purpose of this research, I mostly used the term

subsistence agriculture, but where literature used any of these synonymous terms, I quoted this verbatim.

One of the simplest definitions of subsistence agriculture is that of Morton (2007). He defines subsistence agriculture as a land-based livelihood strategy that involves the production of food mainly for household consumption, as well as the marketing of a little portion of the agricultural output for income generation (Morton, 2007). Thus, FAO (2015) has acknowledged subsistence agriculture as the panacea to alleviating poverty and hunger among low-income rural households in developing nations.

Subsistence farming is categorized as resource poor, it remains one of the most prominent agricultural sectors, whose functionality relies predominantly on family labour, the lesser use of technology and periodically employs hired labour (Cornish, 1998). To these observations, Morton (2007, p.1) emphasized that subsistence farmers depend on "the centrality of the social" as social relations between and within households largely determine production.

In terms of size of the plots, 'small' is context specific as in developed countries 'small' may mean farmers with larger plots than those in developing countries (Morton, 2007). Nonetheless, several studies, including articles from United Nations (UN) World Development Organizations have confirmed that most subsistence farms in the global South and in South Africa in particular, are 2 hectares and less (Wiggins et al., 2010; Mpandeli & Maponya, 2014; FAO, 2015; Mutero et al., 2016; FAO, 2021). Moreover, despite their significant contribution to reducing poverty and food insecurity, subsistence farmers experience marginalization in the globalized and market driven world. They are largely concentrated in remote areas with high environmental risks, limited access to markets and institutional support (Morton, 2007; IFAD/GEF, 2008; Murphy, 2010).

The body of literature reviewed in this section therefore provides an informative outlook about subsistence agriculture practices in Africa and elsewhere in the global South. In South Africa, subsistence agriculture is largely practiced by poor rural households who are predominantly black (Oni et al., 2012, Mutero et al., 2016). These farmers share a close relationship with the history of politico-socio-economic exclusion that is tied to race. Mphego village in Vhembe district, Limpopo province is one such example of a community of subsistence farmers whose location, settlement and practices have been shaped by settler colonialism, Apartheid and lack of investment by the post-Apartheid state.

The context which reproduces the current landscape of subsistence agriculture is characterized by competing political, economic and socio-cultural factors which demand a closer engagement with the thematic area of subsistence agriculture. In so doing, the study sought an understanding of how subsistence agriculture in Mphego village (a historically marginalized community), specifically that which is dependent on rainfall is impacted by drought as well as other intersecting factors linked to political (governance practices), economic (land holding, commodity markets and financial capital) and socio-cultural (race, gender, modern and indigenous farming practices) tensions. To gain a deeper understating of subsistence agriculture in South Africa where Mphego is situated, the following section unpacks the historical dynamics that characterizes the landscape.

2.3. Subsistence agriculture in the South African context

The multiple challenges encountered by subsistence farming households in rural communities of South Africa including those in the Limpopo region have a distinct historical connotation. The colonial government orchestrated the Apartheid system which saw the implementation of a series of segregationist socio-economic and political statutory laws that reinforced the domination of the white minority over non-whites, and mostly the black indigenous ethnic groups (Coombes, 2003). As Luiz (1998, p. 49) puts it, "The state fashioned almost every facet of South African life." A significant body of literature has highlighted that the Natives Land Act of 1913 which led to the mass eviction of black South Africans from their land is one of the prominent laws or rather the 'backbone bone of apartheid' that spearheaded this racial segregation (Lahiff, 1997; Hall, 2004; Walker, 2005; Ntsebeza, 2007).

Hall (2004) posited that this act was responsible for the emergence of a 'dualistic' agricultural system in South Africa characterized by an imbalanced racialized distribution of the country's agricultural land. A study conducted by Walker (2005) indicated that 87 percent of South Africa's most fertile land was appropriated by white minority settlers and such land had the most economic potential. The remaining land (13 percent) that was predominantly non-arable, infertile and vulnerable to environmental risks was allocated to the black majority.

This racially skewed dual agrarian structure and support provided by the government to white farmers resulted in the development of a white dominated technologically advanced large scale commercial agricultural sector closely linked to international markets. On the other hand, was a poorly resourced and labour-intensive smallholder farming sector in 'homeland' areas largely dominated by blacks who were involved in the subsistence production to sustain their livelihoods (Hall, 2004; Oni et al., 2012; Okunlola et al., 2016). Even though the two sectors were portrayed by Apartheid government as

symbolizing 'modernity' and 'tradition', the reality is that the black reserves served the purpose of reproducing and lowering the cost of labour (Hall, 2004). Resultantly, Lipton (1985) contended that this dual agricultural sector was a key element of "racial capitalism understood as the collusion of racism and capitalist interests" (Cited in Hall, 2004, p. 213). It proletarianized most subsistence farmers who in addition to feeding their families were often forced to pay taxes.

From the onset, apartheid's agricultural policy was crafted in a way that legitimized racial stratification and structural inequalities that promoted the development and competitiveness of white farmers, while impeding that of black smallholder farmers. Studies conducted by Van Rooyen (1995); De Villiers (1995), Makhura, (2001) revealed that black smallholder farmers were restricted to homeland areas where they were largely neglected and excluded from accessing socio-economic and political benefits by the state. They were deprived adequate access to essential resources required for agricultural development, including technological equipment, transportation, infrastructure, funding, commodity markets, extension services and land (von Rooyen 1995; De Villiers, 1995; Makhura, 2001). As a result of these institutionalised racial disparities, the smallholder agricultural sector, acquired a distinctive status as the country's second economy characterized by high levels of poverty and underdevelopment (Okunlola et al., 2016). Unable to make ends meet, often, husbands were forced to look for work in mines and urban areas, creating labour shortages on family plots. The wages were often too low that they could not be invested back into agriculture.

Following South Africa's democratic transition in 1994, the agricultural sector continues to be scarred by the segregationist agricultural policies that emanated with Apartheid (see, Hall, 2004; Walker; 2005). The ANC-led democratic government implemented macro-economic policies such as Reconstruction and Development Programme (RDP) in 1994 and the Growth, Employment and Reconstruction (GEAR) strategy in 1996 to try and redress the socio-economic inequalities in the agricultural sector (see, RDP White Paper, 1994; GEAR, 1996). However, the state chose to continue with the Apartheid regime's market-oriented policies in its administrative and resource provision system rather than opting for more inclusive and progressive policies (Makhura, 2001; Hall, 2004; Okunlola et al., 2016; Maake et al., 2016).

As such, apartheid's legacy of a dual and unequal agrarian structure is still persistent and it has entrenched the racial inequalities that perpetually affect the development of the smallholder agricultural sector in post-Apartheid South Africa (Hall, 2004; Walker, 2005; Aliber & Cousins, 2012). The reality is that the state resource provision policies continue to have a bias towards the white dominated market-oriented agriculture, whereas black smallholder farmers in rural areas of former

homelands continue to be deprived of institutional support and agricultural resources, thus reinforcing their marginal position in agricultural economy (Makhura, 2001; Aliber et al., 2011; Maake et al., 2016; Okunlola et al., 2016). This is undoubtedly the case in Limpopo province where rural smallholder farmers are confronted with many challenges that impede agricultural development in former homeland areas. These include poor access to credit, commodity markets, irrigation facilities, technical equipment, hybrid seeds, fertilizers and extension services (see, Oni et al., 2012; Moeletsi et al., 2013; Mpandeli & Maponya, 2013; Mpandeli & Maponya, 2014; Ubisi et al., 2017).

Therefore, by conducting this research in South Africa and specifically Mphego village in Vhembe district, Limpopo province that is in the periphery of development, governance interest and bears the disproportionate burden of climatic risks such as drought, the study is important in providing a solicit understanding of how subsistence farmers particularly those involved in non-irrigated rain-fed crop production in other marginalized settings experience similar challenges and how they adapt to them to enhance their household food security.

2.4. Defining food security and contextualizing it at the household level

FAO (2008, 2015) has shown that climate change, adaptation and food security are inextricably linked. In this light, this study sought to investigate how drought affects rain-fed subsistence cropping practices in the village of Mphego, as well as how these subsistence farmers adapt to their drought prone agro-ecological zone to enhance their food security.

Food security is a multifaceted concept, it has been interpreted and defined distinctively by various world organizations. Babu et al. (2014) thus stipulated that it is understood differently depending on the region in question, context, and time frame. The notion of food security gained prominence around the mid-1970's to address the global food crisis and hunger (FAO, 2003). The principal focus was on increasing the supply of food as a panacea to this problem (Wiggins, 2004). Since the 1974 Rome conference, definitions of food security have been under constant modification such that in the 1980's the focus had shifted from the increase of food supply to the access of food (FAO, 1983). In this light, Maxwell & Smith (1992) purported that there are nearly two hundred published definitions of food security, which amply demonstrates the diverse perspectives and contextual specificities that shape the definition.

Nonetheless, this study employed the broadly accepted definition of food security established by the World Food Summit (WFS) in 1996, which states that "Food security exists when all people, at all

times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life" (FAO, 2015, p. 1). FAO (2008, 2015) pinpointed that environmental factors have a significant role in determining the food security of agriculture dependent communities throughout the world. Any disruption of the agricultural ecosystem by climate change has a negative influence on food production, which raises the incidence of food insecurity (ibid). Therefore, given the impact of climate change in developing countries where impoverished rural populations are already experiencing its detrimental effects, the general need for adaptation to ensure food security is now more apparent.

The FAO Policy Brief on Food Security (2006) highlighted that the definition of food security proposed by the World Food Summit (1996), emphasizes four key indicators/elements of food security. These are: (i) food availability, denoting to adequate supplies quantity and quality food, whether from local production or imports, (ii) food access, referring to people's ability to acquire sufficient resources for purchasing appropriate food for their nutritional requirements, (iii) food utilization, which entails consuming enough food, making use of clean water, sanitary services and medical attention in order to achieve a nutritional wellbeing that satisfies all physiological requirements and (iv) food stability, which is simply the constant availability of food. Both the availability and accessibility components of food security are covered under the idea of stability (FAO, 2006).

Studies by Ericksen (2008) and Chinnakali et al. (2014) have shown that food security can be examined and measured at the individual/household, community, national, regional and global level. This study was mainly interested in the household level food security. Household food security is defined as the accessibility of adequate food to all household members to meet their nutrition requirements (Tonukari & Omotor, 2010). Ultimately, a household is categorized as food secure when all its members are hunger free (Radimer et al., 1990). This study operationalized the concept of food security on the household level, with subsistence crop farming households in the rural community of Mphego the focus of concern. The key indicators of food security that were utilised are, food availability and accessibility. As shall be seen in the following section, there are many caveats especially in terms of the extent to which rural subsistence households depend on the farm output as a source of their food security.

2.5. The role of subsistence agriculture in improving household food security among rural households

Dependence on subsistence production of food by rural households varies according to geographical regions depending on the socio-economic dynamics and historical factors in those areas. It has been observed that despite these variations, many rural families rely on various livelihood strategies for food security, with some mainly relying on subsistence production while others harnessing other avenues that may not be related to farming (Gebretsadik et al., 2020). Evidence from parts of sub-Saharan Africa, particularly Tanzania, shows that rural households in those parts heavily depended on subsistence farming. It was discovered that half of most rural households' income mainly came from crops and livestock (Ellis & Mdoe, 2003). Yet, evidence from some 11 Latin American countries showed that around 40 percent of household income came from non-agricultural related activities (Reardon et al., 2001). This shows that we should understand dependence on subsistence agriculture for food security in terms of context and mixed avenues in livelihood strategies (Baiphethi & Jacobs, 2009; Gebretsadik et al., 2020; Reardon et al., 2001).

Regardless of the extent to which various communities rely on subsistence agriculture, in South Africa, and in concert with trends elsewhere, evidence shows that subsistence farming has been declining as a main source of food. It is becoming a supplementary food source due to food-price inflation, and the underutilization of communal land in former homeland areas bears testimony to this fact (Aliber, 2009). Very few rural households in South Africa report subsistence agriculture as contributing to significant household food security. For example, household survey of black people owning agricultural land reported that agriculture only contributed to 15 percent of household income, while among the poorest it was 35 percent (Aliber, 2009). Thus, very few can attribute household food security to subsistence farming, it is a supplementary activity. Therefore, subsistence farming, whilst it remains an important livelihood for many and a contributor to food security in the continent and in South Africa, it is critical to understand that many rural families and farmers rely on diverse livelihood strategies for food security.

Nevertheless, with worldwide decrease in subsistence farming and sole reliance on it as a food security mechanism equally waning, we should however not be tempted to downplay its importance. In Sub–Saharan Africa, many households still rely on subsistence production. As at 2001, whilst there is a decrease, subsistence agriculture was still very high on the continent, standing at around 73percent (Rahman & Westley, 2001). Also, with the higher dependency on market purchases among rural and urban households in South Africa, it is argued that smallholder/subsistence agriculture can play a greater role in mitigating food price inflation (Baiphethi & Jacobs, 2009). The crux of the foregoing is that subsistence farming can still be very instrumental in rural household food security, especially

considering that market purchase is taxing on the poor and therefore an unsustainable and expensive way to attainment of food security.

Furthermore, some studies conducted in South Africa have shown the majority of the rural poor continues to be reliant on subsistence agriculture as a food security and livelihood source because of the high unemployment and poverty rates in rural areas (Mashamaite, 2014; Myeni et al., 2019). Averbeke & Khosa (2007) further argue that in the developing world, subsistence farming is a significant contributor towards roughly 40 percent of household income improving the purchasing power of the poor to access food from the market. Likewise, a study by Machete (2020) emphasized that income generated from subsistence farming enables households to buy food stuff they are not able to produce on their own to meet all their dietary requirements. Given the significant role of subsistence agriculture in promoting household food security, rural development studies in South Africa have recommended the broadening of smallholder development agricultural policies as the antidote to food insecurity and persistent hunger in rural areas (Von Loeper et al., 2016).

However, for many rural farmers who still maintain subsistence food production, myriad challenges hamper their efforts. Chief among them are climatic hazards such as drought, which has now become a reality for many rural households in Africa and elsewhere, making it difficult for them to be food secure. The following section chronicles how climate change and particularly drought proves to be a huge challenge to subsistence farming and therefore food security.

2.6. Defining drought

Parry et al. (2016) highlighted that drought is a multifaceted phenomenon that lacks a universally accepted definition. In this accord, Wilhite & Glantz (1985) contended that the varying definitions of drought predominantly capture the severity of its impacts and the distinctiveness of its trends across regions (Wilhite & Glantz, 1985). As a result, the drought climatic condition is largely understood in terms of its conceptual and operational definitions. Conceptual definitions assist in identifying the boundaries of phenomenon of drought, and how to implement them in real time drought evaluations (Wilhite & Glantz, 1985). Operational definitions mainly identify the frequency, severity level, duration and termination of drought episodes (Wilhite & Glantz, 1985). Below is a discussion of the multiple and varying definitions of drought drawn from pertinent academic literature.

Meteorologists have defined drought as natural calamity triggered by prolonged interseason (between seasons) or intraseason (within a season) dry spells in a geographical area, which mostly results in

water scarcity for particular activities, populations and ecosystems (Van Loon et al., 2016; Vogel, 2005). Likewise, Yang et al. (2017) has defined drought as a relatively low precipitation level that is inadequate to sustain human needs and activities for a prolonged period, consequently breeding socio-economic and environmental challenges. Halenchoger et al. (2019) further averred that climatic conditions such as rising atmospheric temperatures, strong winds and low humidity levels can significantly worsen the occurrence and intensity of drought. Moreover, Van Loon et al. (2016) considered drought to be a manageable climatic risk, it allows the identification of areas of vulnerability and provides room to strengthen drought resilience capabilities.

2.7. An overview of drought conditions in Africa

Drought is a regular feature of the volatile climate and weather extremes that are ravaging the African continent (Bassey, 2018). The main variables affecting climate change on the continent are increased temperatures (including the number of extremely hot days) and change in precipitation patterns (Pereira, 2017). In the space of the last century, atmospheric temperatures have risen by +0.5 °C, heatwaves have increased and rainfall is becoming more erratic (Seneviratne, 2012). This is highly compromising agricultural production, which is worrying in a context where agriculture forms the larger share of the national economy than anywhere in the world (Cline, 2008; Lobell et al., 2008).

In Southern African countries like Zimbabwe, South Africa and Botswana, with respect to rainfall, the onset, duration and intensity has changed (Pereira, 2017), and from the 1960s to 2000, there has been long dry spells interrupted by high intensity rainfall, which influences run-off (New et al., 2006). Research has shown that extreme droughts in Southern Africa are caused by the El Niño event, and higher frequent dry spells have long been predicted in the region (Rouault & Richard 2003; Engelbrecht et al., 2015). Moreover, as the most vulnerable region to climate change, tales of climate woes in Africa are unending (Bassey, 2018) and it has been predicted drought events will intensify in water-stressed African countries in future (IPCC, 2018; Niang et al, 2014). These changes affect specific locations in specific ways, but the effects are largely negative, especially on poor rural households that rely on rain-fed agriculture to sustain their food and livelihood needs.

2.8. Prolonged drought in South Africa

South Africa is a water scarce country, it receives an average precipitation of roughly 450 mm yearly, making it susceptible to drought (Water Research Commission, 2015). The El Niño Southern Oscillation (ENSO), defined by Baudoin et al. (2017, p. 128) as “a quasi-periodic invasion of warm

sea surface waters into the central and eastern tropical Pacific Ocean, returning at least once in any ten-year period" is what stimulates the frequency of drought events in South Africa. Since the late 1970's, South Africa has been hit by severe droughts during the "mature phase of El Niño, when the central and eastern Pacific and the Indian Ocean are warmer than normal" (Baudoin et al., 2017, p. 27).

Over the last four decades, South Africa is said to have been experiencing a severe meteorological drought with a major part of the country receiving below-average rainfall (less than 75 percent) (Meza et al., 2021). The notably extensive drought periods that that have been recorded in the country date back from "1982–1984, 1991–1992, 1994–1995, 2004–2005, 2008–2009, 2015–2016, and the most recent in 2018–2020" (Mahlalela et al., 2020; FAO, 2019; Walz et al., 2020; Unganai & Kogan, 1998 cited in Meza et al., 2021, p. 4).

The 2015-16 drought was declared by South Africa's national authorities as the worst to have ever been experienced in 23 years because its scale and intensity had horrendous impacts on both small-scale and commercial agricultural sectors and vulnerable populations (Baudoin et al., 2017). Forecasts suggest that during this period the country received an annual rainfall of 403 mm, the lowest ever recorded in the country's history (De Jager, 2016). During this period, the provinces of Kwa Zulu Natal (KZN), Mpumalanga, North-West, Limpopo, the Free State and Northern Cape were officially declared as drought disaster areas (Satgar & Cherry, 2019). The impacts of drought have been seen to affect the agricultural sector, with poorly resourced rural smallholder farmers bearing its disproportionate burden.

Poor drought governance has been seen to reproduce and exacerbate the vulnerability of these farmers to drought (Hornby et al., 2016; Satgar & Cherry, 2019). Several studies have shown that the state has failed to improve preparedness to cope with drought conditions among the rural populations including smallholder farmers due to corruption, inadequate provision of a public water infrastructure, agricultural technologies, finance subsidies and extension services (Mpandeli & Maponya, 2013; Moeletsi et al., 2013; Mpandeli & Maponya, 2014; Ncube, 2020; Satgar & Cherry, 2019). This has posed to be a severe livelihood crisis especially for smallholder farmers who are highly dependent on rain-fed agriculture for their food and income needs (Satgar & Cherry, 2019).

2.9. The impacts of drought on rain-fed subsistence crop production

Adequate rainfall patterns significantly determine the agricultural outcomes of rural subsistence farmers. The devastating effects of drought in SSA are causing crop failures and concomitantly

affecting the livelihoods under resourced rain-fed subsistence farmers who are largely located in marginal rural areas (Pereira, 2017). This section reviews literary studies conducted in different countries across the African continent, including South Africa that have revealed the diverse impacts of drought on rain-fed subsistence cropping systems.

A study conducted in rural Chiredzi, Zimbabwe by Unganai & Murwira (2010) demonstrated that frequent drought contributed to limited soil moisture, resulting in the failure of maize, cassava, and cowpeas in communal rain-fed smallholder farms. Corroborating with this finding, Sharmake et al. (2022) revealed that in Western Somaliland, reduced soil moisture was one of the notable drought impacts that reduced the production of crops such as maize, beans, sorghum and millet in rain-fed agricultural systems. Similar results were found in South Africa's Limpopo province where small-holder crop production in some rural areas of Vhembe district was severely hampered by dry soils associated with the prolonged drought conditions (Kom, 2020).

Additionally, the IPCC (2007) reported an increase in the incidents of crop pests and diseases as a result of high temperatures and changing precipitation patterns, which is predicted to exacerbate in the upcoming decades. This was confirmed in a study conducted in semi-arid Tanzania by Mongi et al. (2010) which found that there was a decrease in the overall productivity rain-fed food and cash crops heat stress, new pest invasions and diseases. In South Africa, similar observations were made Phophi (2018), who revealed that climate change including high temperatures and low rainfall contributed to new crop pest and disease invasions in both smallholder rain-fed and irrigated farming systems in Limpopo, which affected crop growth.

Furthermore, Ngumbi (2019) argued that rainfall dependent smallholder farmers in Africa are highly vulnerable to drought because they lack irrigation technology, making it difficult for them to adequately plan their planting seasons. This has been confirmed in a study conducted in Kenya by Huho et al. (2012) which revealed that low and unreliable rainfall shortened the growing season in subsistence rain-fed agriculture, resulting in a shift of planting dates and crop yield uncertainties. Likewise, a study conducted by Ubisi et al. (2017) in rural Limpopo, South Africa discovered that dry spells were getting worse, and the lack of irrigation was a prominent challenge that that resulted in the postponement of the planting season by smallholder farmers in anticipating for sufficient rainfall until it became too late to plant.

Lastly, the IPCC (2007) speculated that in 2020, rain-fed agricultural systems in several African countries experienced a massive crop yield deficit of 50 percent as a result of climate change and

variability. This is a serious problem that has been confirmed by several studies conducted in South Africa, Central Tunisia, Zimbabwe, Ghana and Western Somaliland which found that high temperatures and low/erratic rainfall has triggered a sharp decrease especially on maize, wheat and sugar cane-based systems which heavily rely on natural rainfall (Lobell, et al., 2008; Mougou et al., 2011; AgriSA, 2016; Jiri et al., 2017; Cudjoe et al., 2021; Sharmake, 2022). The implications of drought risks on small-scale rain-fed agricultural systems can be highly severe for poor rural households, these include chronic hunger, malnutrition, diseases or death (Thapa & Gaiha, 2010).

In overall, studies on subsistence agriculture and drought have focused more on the relationship between the two while oversighting the relevance of political, economic and social factors that shape the rural agrarian economy and livelihoods. Therefore, this study acknowledges that the consequences of drought in Mphego village cannot be separated from other structural challenges linked to the historical legacies of socio-economic deprivation of rural communities by the state. An exploration of the nexus of drought and the political, economic and social factors that shape the subsistence agricultural landscape in Mphego was therefore deemed crucial in understanding the subsistence farmers' agency in adapting and coping with this ecological challenge.

2.10. Adaptation and coping mechanisms

Climate adaptation and coping strategies are interwoven yet different terms. Coping is underlined by short term measures to address immediate needs in a context of abrupt shock (Ellis, 2000) – it is reactive, not planned, while adaptation is a process of adjustment in the long term and it involves behavioural changes that are long term and harness practices that address the underlying causes of a problem, for example, climate change (Vincent et al., 2013). Despite efforts to distinguish these two concepts, the difference is not clear cut in practice as it is in definition. A coping mechanism can morph into adaptation. Therefore, this study will use these two concepts interchangeably.

Climate change adaptation is not a recent phenomenon. In every historical epoch to the present, societies have been seen to adapt to natural climate change through the alteration of various aspects of their lifestyles, including their economic systems, patterns of settlement and agricultural activities (Theodory, 2016). However, anthropogenic climate change has introduced a relatively new and intricate dimension to this topic (Burton et al., 2006). This study adopted the IPCC Third Assessment Report (2001, p. 365) definition of adaptation which is the "adjustments in human and natural systems, in response to actual or expected climate stimuli or their effects, that moderate harm or exploit beneficial opportunities".

The process of climate adaptation comprises of two primary components which are, building adaptive capacity and the implementation of adaptation decisions. The former simply refers to the enhancement of an organization's, community's or individual's ability to adjust to climate change, while the latter involves the transformation of that capacity into action (IPCC, 2001; UNFCCC, 2006). From this backdrop, a high adaptive capacity enables individuals and communities reduce their vulnerability to climate change and variability, whereas an 'adaptation deficit' is likely to increase vulnerability (IPCC, 2001; UNFCCC, 2006).

The IPCC (2001) has indicated that there are different adaptation strategies to climate change namely, anticipatory "takes place before the impacts of climate change are observed", autonomous "prompted by ecological changes in natural systems" and planned adaptation "result of a deliberate policy decision" (UNFCCC, 2006, p. 17). These adaptation strategies are implemented at different scales i.e., household, community, and national levels. The focus of this research is on autonomous adaptation, which is usually reactive and involves initiatives taken by non-state actors such as farmers, communities and or firms (among others) to adapt to environmental risks outside of intervention (IPCC, 2001; FAO, 2008; Bruin, 2011). Autonomous adaptation is also better as decentralized, or community led solutions to climate change (FAO, 2008).

According to FAO (2008), agriculture-dependent communities have a long history of developing ways to cope with climate change in their operational environment, which is reflective of an autonomous adaptation. Today's rate of climate change will alter recognized variability patterns to the point that humans will face challenges they are ill-prepared to meet. As a result, autonomous adaptation strategies have their limitations, which makes it vital to increasingly implement anticipatory and planned adaptation mechanisms. However, FAO (2008), acknowledges that vulnerabilities to climate change are predominantly local, thus it is essential for communities to autonomously develop adaptation strategies that respond to the heterogeneous impacts of climate change in their local environments. This approach to climate change adaptation is based on the premise that local solutions are required to local problems. This outlook is relevant for my study as I seek to investigate adaptation strategies that are autonomously developed by subsistence farmers in Mphego village to mitigate the impacts of drought on rain-fed crop production.

2.11. The importance of subsistence farmers' perceptions of drought in their adaptation responses

Before reviewing empirical literature on the various drought adaptation strategies employed by rain-fed subsistence farmers, it is essential to gain insights on how these farmers interpret their local drought conditions. As Sam et al. (2020) notes, the drought adaptation process is comprised of two stages. The first stage involves the perception of drought which is then followed by the implementation of adaptation mechanisms to lower its impacts. Drawing on this contention, a background understanding of how subsistence farmers in Mphego perceive their local drought trends was deemed important in this study in understanding their coping and adaptation responses.

According to Seyoum (2016) perception relates to how individuals interpret, understand and attach meaning to their immediate environment and its changing dynamics, including climate catastrophes (Seyoum, 2016). Byg & Salick (2009) and Pauw (2013) alluded that the way people perceive an environmental phenomenon to a larger extent determines their adaptation options and outcomes. Equally, several studies conducted in Africa have confirmed that the knowledge held by smallholder farmers about their context specific drought trends and associated risks immensely influences the effective implementation of coping and adaptation practices at both the household and community level to minimize its impacts (Theodory, 2016; Ubisi, 2016; Kom, 2020, Abaje & Magaji, 2022). Grothmann & Patt (2015) alluded that the misinterpretation of climate change and its impacts most likely results in maladaptation. However, agrarian communities have over the centuries developed ways to cope with and adapt to climate change (FAO). Therefore, it is necessary to comprehend their local level perceptions of climate change and variability.

2.12. Strategies used by subsistence farmers in Africa and South Africa in particular to cope with and adapt to drought trends

According to FOA (2008), food security needs to be accounted for as a primary criterion for the efficacy of climate adaptation at the individual, community and national levels. This section discusses existing literature on adaptation and coping mechanisms used by subsistence farmers to combat the effects of climate change on agricultural production, and therefore secure their household food needs.

To begin with, farmers engage in modification of their farming practices. This involves an alteration in planting dates and planting crops with a shorter growing period as a way of reducing the impacts of rainfall variability on crop production (Stringer et al., 2009). Literature has shown that this adaptation practice has become a very common Zimbabwe, Malawi Zambia, Kenya, Mozambique and the Free State and Limpopo province of South Africa (Stringer et al; 2009; Huho et al., 2012; Gandure et al., 2013; Vincent et al., 2013; Rankoana, 2022).

Farmers are also increasingly engaging in intercropping, which is the cultivation of more than one crop in the same plot, which improves soil fertility and reduces soil degradation since the different crops have different nutritional needs (Vincent et al., 2013). This is very popular in Malawi (Stringer et al., 2009; Vincent et al., 2013). In South Africa, intercropping was also found to be prominent in the Berlyn and Molati in the Tzaneen area Vhembe district, Limpopo province (Hart & Vorster, 2007; Kom, 2020). All these methods are mostly from knowledge passed down from generation to generation (Pereira, 2017). Although NGOs and government can intervene to fund or encourage these practices, they are forms of knowledge that are readily available and have been used across generations.

Farmers are also known to engage in the modification of their farming practices. Farmers in the SADC region are now known to change crops and varieties they cultivate owing to climate variability. In South Africa, Limpopo province, smallholder farmers have been found to be growing hybrid crops which are early maturing and drought tolerant (Mpandeli & Maponya, 2013; Kom, 2020). In Zimbabwe, farmers are increasingly growing small grains like sorghum and millet which are drought resistant, while in Zambia cassava is also becoming popular because of its drought resistant qualities (Vincent et al., 2013). In Lesotho, they also grow drought resistant crops in drought times and when there is above average rainfall, they grow cash crops like vegetables (Ziervogel et al., 2008).

Smallholder farmers also practice rainwater harvesting (RWH) as a way of improving the resilience of rain-fed agriculture against the adverse impacts of drought. Macro catchment (ex-situ) rainwater harvesting which involves the capturing and storage of rainwater in manmade reservoirs outside the farming area (Biazin et al., 2012; Kiggundu et al., 2018) has been found in literature to be widely used by farmers for supplemental irrigation of rainfed crops during intra and inter season rainfall variability A comprehensive review of RWH techniques in SSA by Biazin et al. (2012) revealed that some of the most common ex-situ practices used by farmers in countries like Kenya, Tanzania, and Ethiopia include traditional open ponds, micro dams sand dams and cisterns.

In addition, smallholder farmers also utilize micro-catchment (in-situ) RWH which involves the collection of rainwater in the cropping land for retention of soil moisture and fertility (Biazin et al., 2012, Kiggundu et al., 2018). A study conducted by Ndlovhu et al. (2020) found that small holder farmers employed the farming methods such as pit planting, ridge and furrows, dead level contours and ephemeral stream diversion to maximize agricultural productivity when faced with dry spells. In South Africa, it was found that smallholder farmers in semi-arid areas of Limpopo and Eastern Cape also use the ridge and furrow farming methods to maximize crop yields (Kruger et al., 2021).

Farmers also employ various soil moisture and fertility management practices. Several studies revealed that farmers have increased the use of synthetic fertilizers in drought and climate change adaptation. This is a common phenomenon in Benin, Gambia, Mauritius and South Africa (Fadina & Barjolle, 2018; Bagagnan et al., 2019, Ramborun et al., 2020; Rankoana, 2021). Mulching, crop-rotation and no-tillage systems are increasingly being used in Malawi, Eswatini, Botswana and Zimbabwe (Rockström et al., 2009; Stringer et al., 2009; Vincent et al., 2013, Chineka , 2020). Most of these foregoing techniques were also used in Limpopo province of South Africa and Zimbabwe where farmers used mulch and animal manure in maintaining soil fertility, the main reason for their use was because synthetic fertilizers were deemed expensive by the farmers (Hart & Vorster, 2007; Svotwa et al., 2009). In Ghana, the use of manuring and compost by smallholder farmers was perceived to be an indigenous agronomic practice (Aniah et al., 2019).

Lastly, numerous studies have shown that smallholder farmers in some parts of Sub-Saharan Africa are engaging in efforts to minimize crop pests and diseases outbreaks exacerbated by drought and other climatic conditions through the rapid use of synthetic pesticides (Opio, 2021). This is true of farmers in Benin, South Africa's Limpopo province, Zimbabwe, Mauritius, and Uganda who were found to highly preferred to use synthetic pesticides to increase crop productivity (Fadina and Barjolle, 2018; Phophi, 2018; Zinyemba et al., 2020, Ramborun et al., 2020; Atube et al., 2021).

By focusing on the adaptation and coping practices employed by subsistence farmers who experience drought conditions and politico-economic marginalization, this study revisits the debate and empirics to understand the agency by subsistence farmers that ought to have been crumbled under the pressure of structural forces.

2.13. Conceptual tool for analysing the livelihood assets that influence the subsistence farmers' choice of adaptation strategies

This study employed the commonly used livelihoods framework in sustainability works developed by the UK Department for International Development (DFID). It served as the theoretical tool for analysing the livelihood assets at the farmers disposal that played a pivotal role in enhancing their drought adaptive capacity. A livelihood is sustainable in accordance with the DFID (2001, np) "when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future without depleting the natural resource base". The DFID's Sustainable Livelihoods Framework (SLF) was relevant to this study because it focuses on people's adaptive capacity or survival skills in their different vulnerability contexts (external environments)

characterized by factors such as trends (in population, national or international economics, governance, resources and technological innovations), shocks (i.e., illnesses, conflict, climatic hazards etc.) and seasonality (of employment opportunities, prices and production cycles) which are beyond people's control (DFID, 1999).

Livelihood assets

The SLF transcends the conventional approaches which primarily focus on understanding and advancing sustainable livelihoods through employment and income generation. It provides a realistic and accurate understanding of the livelihoods of the poor by paying attention to the various capital assets they can utilize to achieve positive livelihood outcomes (DFID, 1999). The SLF has advanced that an individual's capacity to partake multiple livelihood strategies is significantly influenced by the range of tangible and intangible assets that are at their disposal (Ashley & Carney, 1999). The DFID identifies five main types of capitals that can be utilized to build sustainable livelihoods namely: "human, social, natural, physical and financial" capital (DFID, 1999, np), which were of primary concern in this study. These capital assets have been referred to by Scoones (1998, p. 7) as "the capital base from which different productive streams are derived [and] from which livelihoods are constructed". The following is a discussion of each livelihood capital.

Human capital

According to the DFID (1999, 2000), human capital encompasses the knowledge, skills and experiences that individuals possess to improve their ability to achieve their livelihood prospects. Human capital is accumulated from different sources including formal education, training, work experience (DFID, 1999) as well as informal learning experiences (OECD, 2010). Experts have suggested that it is essential for individuals and communities to invest in human capital. This is because it enables them to acquire necessary skills to build innovative and resilient livelihoods in their environmental context characterized by external shocks and stressors including climate change (Monsalve & Watsa, 2020). This was confirmed in a study conducted in the Nile Basin of Ethiopia by Deressa et al., (2009) which revealed that farmers with formal education or training in agriculture have a higher chance of responding better to climate change as they have access to information on climate and weather forecasting as well as new farming technologies. Likewise, numerous studies have shown that agricultural skills and practices acquired by smallholder through informal learning experiences including their indigenous knowledge have indeed promoted climate change resilient agrarian livelihoods (see for example, Hart & Vorster 2007; Theodory, 2016; Aniah et al., 2019).

Social capital

Social capital is described as an intangible resource solidly embedded in shared norms and values, interconnectedness, trust-based reciprocal social networks, membership to formal groups and other social structures that facilitate a collective action to successfully accomplish a common goal (Ashley & Carney, 1999; Bhandari & Yasunobu, 2009). Aparku (2015) stipulated that social capital mostly prevails at the micro-institutional for example in households, clans and communities. In the agricultural landscape, social capital is established through farmers unions and cooperatives facilitated at the grassroot level (FAO, 2020) as well as the number of members within a farming household (Deressa et al., 2009). Asfaw & Lipper (2011) have noted that these associations provide a pathway for farmers to easily access relevant information for improving production and to adapt to myriad challenges including climate change. Essentially, empirical literature has shown that collective action and farmer-based networks positively impact the choice of climate change adaptation strategies utilized by farmers (Deressa et al., 2009; Ubisi, 2016; Thamaga-Chitja & Tamako, 2017). Thamaga-Chitja & Tamako (2017) thus recommended the expansion of social networks among farmers and their increased involvement is vital in strengthening their adaptive capacity.

Natural capital

Ashely & Carney (1999) defined natural capital as the stock of natural resources such as water, trees, wildlife, minerals, land, and all of biodiversity. Dulal et al. (2010) buttressed that the ability of households and communities to protect and sustainably use their natural resource base is integral in coping and adapting to climate-induced impacts. In this light, a study by Salick & Byg (2007) revealed that indigenous agrarian communities harness biodiversity to buffer themselves against environmental catastrophes. Consequently, rural farming households with a depleted natural resource base are more susceptible to climate change impacts impact (Muthelo, 2018; Dulal et al., 2018). Therefore, the sustainable use of locally available natural resources by smallholder agrarian communities is fundamental in improving their resilience to climate change impacts.

Physical capital

Physical capital refers to man-made tangible assets utilized in the production process of goods and services (Scoones, 1998). Examples of physical capital include adequate infrastructure, buildings, vehicles, machinery owned by individuals, groups or the state (DFID, 1999; Moser, 1998). Agrarian literature has shown that physical capital resources such as adequate transportation systems, hybrid

seeds, electricity, irrigation infrastructure and technical equipment are crucial for the development of the smallholder agriculture economy (see, Oni et al., 2012; Mpandeli & Maponya, 2014). In relation to climate change adaptation, research has shown the accessibility of physical capital improves agricultural production and eventuates in food security among smallholder farmers (Ncube, 2020; Ngumbi, 2019; Kom, 2020; Biazin et al., 2012; Kiggundu et al.,2018, Ubisi et al., 2017). On the contrary, households or communities with limited physical capital have been found to be at highly susceptible to climatic shocks partly because of weak resilience (Dulal et al., 2010)

Financial capital

According to Ashely & Carney (1999), financial capital denotes the monetary resources that individuals employ to accomplish their livelihood goals. The DFID (1999) reported that financial capital is derived from readily available stocks and cash inflows. The former refers to financial savings, this is inclusive of bank deposits, hard cash and liquid assets, the latter comprises of cash inflows such as state granted pensions and remittances etc. (DFID, 1999). Unfortunately, most rural households are poor and lack adequate access to financial capital (DFID, 1999). There is increasing proof on the role of financial capital in hedging farmers against climate induced calamities. For instance, a study conducted in Northern Uganda by Atube et al., (2021) clearly demonstrated that farmers sufficient access to finances were able to engage in long-term planning and adopt advanced agricultural technologies in response to climate change in comparison to poor farmers. Moreover, the Lutz (2008) conferred that individuals and households with a strong financial capital base have a high adaptive capacity to climate change in comparison to their less endowed counterparts.

Therefore, the Sustainable Livelihoods Framework served as a useful conceptual tool in this study. As rural subsistence farmers in South Africa including those in Mphego are seen to lack adequate access to state support especially drought relief resources, this research study sought to explore the ways in which the livelihood assets that the farmers possess influence and shape their adaptation responses against drought.

2.14. Critique of the Sustainable Livelihoods Framework (SLF)

This section presents some of the key criticisms of the SLF that have emerged from various strands of development literature. It also illustrates how these criticisms have been addressed in this thesis.

One of the prominent critiques of the SLF revolves around its tendency to categorize livelihood capitals into discrete compartments. According to critics, this reductionist approach runs the risk of excessively simplifying the intricate relationships and dynamics that characterize rural livelihoods (see for example, Scoones, 1998; Morse et al., 2009). In his exploration of the operational and practical implications of the SLF, Scoones (1998) problematizes this framework for failing to account for the dynamic and interconnected nature of livelihood capitals. He emphasizes the complexity of livelihoods, stressing that the single categories of assets presented by the SLF cannot sufficiently yield the various livelihood outcomes that people seek to achieve. Scoones (1998) thus brings to our attention the need to consider how capital endowments that rural people possess often intersect or work simultaneously as they pursue different livelihood strategies in dynamic historical contexts. This study managed to effectively bridge the limitation of reductionism associated with the SLF by conducting of a rigorous analysis of how the livelihood assets possessed by subsistence farmers in Mphego operate in isolation and in synergy to improve and strengthen their drought adaptive capacity.

Additionally, numerous scholars including Morse, McNamara & Acholo (2009) have raised concerns about the lack of the failure of the SLF to fully incorporate a temporal dimension. This implies that it presents livelihoods as static which limits its ability to capture the dynamic nature of livelihoods and the impacts of various temporal factors, such as historical events (Morse et al., 2009). To overcome the inherent static nature of the SLF, this study incorporated a temporal dimension of livelihoods by accounting for the historical and previous drought experiences of subsistence farmers in Mphego and how they are harnessing different livelihood capitals to adapt to this ongoing ecological challenge.

Furthermore, Scoones (2009) criticizes the SLF for overly embedding its capital and asset pentagon in an economic deterministic approach. He propounded that this economic approach establishes a link between various capitals and livelihood outcomes. These outcomes consist of various aspects such as poverty lines and unemployment levels as well as other issues related to well-being and sustainability (Scoones, 2009). In this regard, the SLF presents a limited focus on other factors including environmental ones, which had significant implications especially for my study which is focused on agrarian livelihoods especially in an environmental context characterized by climate change and variability. Therefore, to adequately account for the specific ecological challenges faced by rain-fed subsistence crop farmers in Mphego, this study thoroughly engaged with the farmers. It sought a detailed account of their understanding of drought and drought trends that have occurred in their local environment in the past and recent years, and how they have adapted to these changes to achieve positive livelihood outcomes.

Lastly, Baumann (2000) critiqued the SLF for paying inadequate attention to the political and power dynamics that shape people's access to assets in the pursuit of different livelihoods opportunities (Cited in Scoones, 2009). This study addressed this limitation by investigating how the institutional factors affect access to resources and decision-making among subsistence farmers in Mphego. Moreover, despite its limitations, the SLF remains a valuable conceptual tool in this study because it is a people-centered approach. It empowers subaltern populations, such as subsistence farmers in Mphego to employ their livelihood capitals as a means of adapting to and building sustainable livelihoods in the face of climate change and other converging structural constraints.

2.15. Chapter summary

This chapter has introduced the theoretical and empirical studies relating to the concept of subsistence agriculture in the global South and including South Africa, as well as its contributions towards the household food security of rural households. This chapter documents literature from all over the African continent on some of the prominent impacts of drought on subsistence agriculture, particularly rain-fed crop farming. The different adaptation strategies employed by farmers from all over the continent to reduce the impacts of drought on rain-fed subsistence crop production were also discussed. This chapter was wrapped up by an overview of the Sustainable Livelihoods Framework, the theoretical tool for this study. The following chapter is the research methodology.

CHAPTER THREE

Research Methodology

3.1. Introduction

This chapter discusses the research methods employed in gathering data to address the research question of this study: How do rain-fed subsistence crop farmers in Mphego village adapt to the prevailing impact of drought? The chapter details relevant information about the study area, research approach, sampling procedure and research instruments, while also highlighting my field work experience. Moreover, it pays attention to the ethical procedures observed in the research process as well as the overall limitations of the study.

3.2. Description of the study area

This research was conducted in Mphego, a rural settlement in Vhembe district, Limpopo province. The Cooperative Governance and Traditional Affairs Department (2020) reported that Vhembe district has a total land mass of around 25 597 km², the vast majority of which is rural, and an estimated population of 1 402 779 people composed predominantly of black Africans of Tshivenda and Tsonga ethnic groups. Mphego village in particular covers a land mass of about 1 156 km² and has an average population of 1 743 people mostly of Tshivenda origin (City Facts, 2019-2020).

The history of Apartheid has profoundly shaped the current politico-socio-economic landscape of Vhembe district. During apartheid, the Venda Bantustan was created in the eastern region of Vhembe, with Tohoyandou as its capital (Cooperative Governance and Traditional Affairs Department, 2020). As of today, Vhembe district encompasses all territories that were formally recognized as a part of the Venda Bantustan and Thohoyandou remains its capital (Cooperative Governance and Traditional Affairs Department, 2020). As a result of this colonial history, Vhembe district exhibits many rural settlements in former homeland areas and Mphego is one such example.

The fact that most of the marginalized rural communities in Vhembe and the broader Limpopo province are reliant on smallholder subsistence agriculture as a source of livelihood motivated the choice for selecting Vhembe district as a study area (see for example, Oni et al., 2012; Mpandeli and Maponya, 2013; Ubisi, 2016; Kom, 2020; Materechera & Scholes, 2022). Smallholder agriculture accounts for roughly 30 percent of land-use in Vhembe (IDP, Vhembe District Municipalicty, 2022) and is typically located in former homeland areas (Oni et al., 2012). The smallholder production of

crops and livestock is mainly for subsistence use, with little surplus for sale (Odhiambo & Nemadodzi, 2007). These farming systems are characterized by poor productivity, farm sizes of less than 2 hectares, as well as insufficient access to agricultural technologies, infrastructure, institutional support, extension services and commodity markets (Odhiambo & Nemadodzi, 2007; Oni et al., 2007; Moeletsi et al., 2013; Mpadeli & Maponya, 2013; Mutero et al., 2016). The bulk of smallholder subsistence farmers in low-income villages of Vhembe district including Mphego either operate under intensive (high input usage) or extensive (low input usage) rain-fed agricultural production.

The final selection of Mphego village as the case study for this research was based upon feedback from the pilot study. A significant number of households in Mphego village are involved in subsistence agriculture as a source of food and livelihood and are dependent on seasonal rainfall for agricultural production. Although the dependence on rainfall is a cheap alternative for crop irrigation among these resource-poor farmers who lack adequate access to irrigation infrastructure, the village is located in a drought prone agro-ecological zone which poses a threat to the rain-fed agricultural activities of subsistence farmers. While there's limited data on the current climate patterns of Mphego village itself, Vhembe district is located in a semi-arid region that is consistently impacted by dry spells that intensify the severity of drought (Mpandeli & Maponya, 2013), worsening this situation is the inherently low soil fertility in the region (Odhiambo & Nemadodzi, 2007). Therefore, Mphego was deemed crucial in understanding drought impacts on rain-fed subsistence crop production that are seen to converge with structural challenges (politico-socio-economic exclusion) linked to the community's history, as well as the farmers agency in adapting and coping with this situation.

3.3. Research approach

The ontological and epistemological underpinnings of the qualitative research approach served as the foundation of this research study. According to Denzin & Lincoln (2000, p. 3), qualitative research is largely based on "an interpretive, naturalistic approach to the world". This suggests the investigation of life events in their natural setting as a prerequisite for comprehending the actual meaning attached to them by people. (Denzin & Lincoln, 2000). As a result, qualitative research is contextual, it is linked to the social and cultural contexts in which data is generated (Denzin & Lincoln, 2000; Bryman, 2012). The qualitative research approach highly suited this study because it is a holistic data collection approach that enabled an exploration of the complexities of my research question. It was useful in equipping me with rich insights of the contextualized drought vulnerabilities experienced by rain-fed subsistence crop farmers in Mphego village, how these vulnerabilities are being exacerbated by state deprivation and market related challenges, as well as the adapting practices being employed by the

farmers to averting the risks posed by these of ecological and structural constraints on agricultural production.

Additionally, scholars like Hiatt (1986) and Merriam (2009) emphasized that qualitative research method is exploratory. This means that researchers should prioritize discovering their participants' behavioural patterns, worldview, perceptions, sentiments, and experiences in interpreting and assigning meaning to the social world. Being an outsider to the Mphego community, I was very much aware of the difficulties I was likely to encounter in accessing the research area and gaining detailed accounts of the subsistence farmers' experiences of drought, perception of the phenomenon, as well as the different strategies they have adopted overtime to build resilient rain-fed food systems in this unfavourable climatic condition. The major one being language barriers in speaking Tshivenda, the dominant language used by Mphego residents.

To overcome this challenge, I conducted this study with the help of an intermediary, Dolphus,[1] who is a colleague and PhD candidate at the University of Venda and originates from Mphego village. This intermediary was chosen on the basis that he is well experienced in data collection and is a native Tshivenda speaker with a considerable knowledge base of the socio-cultural practices of the research community. At the beginning of September 2022, I went to Mphego village to begin the data collection process. To gain access to the research community, I considered it important to respect the leadership structures of the village. Dolphus introduced me to one of the community leaders to whom I explained the purpose of my visit and the nature of my research. Thereafter, the community leader gave me the green light to conduct my research. Dolphus further assisted me in getting accommodation in the research area and I immediately started the data collection process which spanned for a period of two weeks. He then introduced me to some members of the community who are involved in rain-fed subsistence crop production and assisted me to explain the purpose of my presence in Mphego. This helped me to fit into the social fabric of the community as well as forging a rapport with the study participants.

3.4. A brief description of population under study and selection of participants

This section largely describes the population under study and how participants were selected. A study population is defined as a large group of people who share certain traits that are of interest to the researcher (Creswell, 2003). By selection of study participants, I refer to the techniques used in

[1] I used pseudonyms to protect the identity of the intermediary who assisted me in carrying out this research as well as those who participated in the research.

drawing out the study sample from the larger population to ensure that it represents the broader views, and lived experiences of subsistence farmers that encounter drought and other challenges but manage exercise their agency to stay relevant in the subsistence agricultural economy.

The study sought to engage the views of subsistence farmers in a historically marginalised rural setting in South Africa. Therefore, any farmer in Mphego village that practices subsistence agriculture was eligible for selection. Secondly, any farmer deemed as historically marginalised, living and growing crops in Mphego village was eligible for selection. Thirdly, the study sought farmers that rely on rain-fed agriculture. Priority was placed on understanding their perceptions of drought and its impact on agricultural production as well as their adaptation and coping mechanisms (agency to confront drought). The sample was drawn from the population that met the study selection criteria. The majority of the participants in this study were purposively selected.

Purposive sampling is a nonprobability sampling method, which according to Singleton et al. (1988, p. 153) involves a deliberate procedure of choosing participants in "a sample composed of elements that contain the most characteristic, representative or typical attributes of the population" (Cited in Strydom and Venter, 2002, p. 207). It is generally accepted that the participant selection process is solely dependent on the researcher. The researcher determines what must be known about the subject of study, then searches for and recruits people who are willing to contribute information on that subject based on their knowledge and experience (Singleton et al., 1988 cited in Strydom & Venter, 2002; Bernard, 2002). However, this study adopted a grounded approach whereby the dominant characteristics in a subsistence agriculture economy were informed by existing literature in South Africa and Africa broadly.

Literature points out that the subsistence agriculture economy in South Africa is not only shaped by farmers, but also is influenced by other stakeholders in the agriculture economy such as traditional leaders, extension service workers, government departments (through administrators), Non-Governmental Organizations (NGO's) and other development agents (see for example, Bikam & Chikwizira, 2014, Ubisi, 2016; Siphesihle & Lelethu, 2020). This study has solely focused on soliciting the views of subsistence farmers that are depended on rain-fed agriculture, have a land holding of less than 2 hectares, have been politically and economically excluded by the state and experience climatic challenges such as drought. While purposive sampling proved useful in selecting the study participants, the fact that it does not rely on a systematic selection criterion, but rather on the researcher's point of view usually generates an uneven selection of study participants. To mitigate this shortfall, the research

also made use of referrals from subsistence farmers who were aware of other farmers who endowed the characteristics sought in this study, this approach can be described as snowballing.

Subsistence farmers in Mphego are not a homogenous group. They have distinct demographic profiles that can be grouped into the following categories: age group, gender, educational level, farming experience and employment status (among others). Therefore, when identifying respondents for the study, I, as the researcher was cognisant of these dynamics. I sought to minimise bias by selecting participants that met these different dynamics. Importantly, these demographic characteristics were pertinent to this study because they constitute livelihood assets that influence the subsistence farmers' choice of drought adaptation strategies. Below is the justification of the study sample based on the aforementioned variables.

Age group

Age was an important factor in considering and determining participants for this research. The study sought a balance between youth (18 to 34 years), middle aged (35 to 49 years) and elderly (50 years and above) subsistence farmers. The reason for seeking participants from different age categories stemmed from the fact that, age is generally associated with diverse beliefs, knowledge systems, attitudes, perspectives and worldviews which in turn influence the subsistence farmers' choice of adaptation strategies against drought. As, Bayard et al. (2007) note, climate change adaptation is positively associated with age. Youth farmers have been widely shown to embrace modern farming practices in climate change adaptation, while elderly farmers have been seen to prefer indigenous farming practices (Myeni et al., 2019), accustomed in the beliefs and worldviews of their forefathers. Therefore, interviewing subsistence farmers from different age groups was deemed crucial in gaining diverse outcomes on the drought adaptation strategies that are being employed by rain-fed subsistence crop farmers in the research area.

Gender

Gender dynamics were taken into consideration when selecting the participant pool. Women have been seen to dominate the smallholder agricultural sector (Ubisi, 2016; Kom, 2020). This study employed a gender inclusive approach where it sought to interview an equal number male and female subsistence agriculturalists in the research area. This was deemed crucial in identifying and gaining an in-depth understanding of gender-specific drought vulnerabilities and measures being employed in adapting to this ecological crisis, thus eliminating the potential gender inequalities in the study by ensuring that the findings are reflective of the experiences of both genders.

Educational level

Level of educational attainment was perceived as a crucial factor in selecting the study participants. Bearing in mind that the level of education among subsistence farmers in Mphego is inextricably linked their socio-economic status and structural factors such as the historical exclusion of blacks from accessing adequate educational facilities, this study ensured to approach this issue with delicacy. Any subsistence farmer with a high or low level of educational attainment was eligible for selection. A study by Deressa et al. (2009) confirmed that farmers with high levels of education have a higher chance of responding better to climate change because they have better access to climate information and new farming technologies, while those with low educational attainment are highly vulnerable and less adapted. Nonetheless, this study did not disqualify the importance and contributions of less educated subsistence farmers in Mphego to the subsistence agricultural economy. These farmers hold worthwhile knowledge and skills they harness to improve their adaptive capacity to climate change. Therefore, an unbiased approach in the selection process was paramount in identifying the drought vulnerabilities of both highly and lowly educated subsistence farmers in Mphego and how they are adapting to this ecological constraint.

Farming experience

Farming experience was also prioritized when selecting the research sample. This study primarily sought to interview subsistence farmers who are highly experienced in crop production and have lived through climatic hazards such as drought. This is because these farmers possess a wealth of agricultural knowledge and skills. Hence, they are in a better position to offer valuable and rich insights of the historical and contemporary drought trends, their long-term impacts on rain-fed crop production and how they have adapted over time to minimize the severity of these impacts. Therefore, the perspective of highly experienced subsistence farmers was deemed vital in strengthening the validity of the research findings.

Employment status

Employment status was also a key consideration in selecting the study population. This study was interested in interviewing both employed and unemployed subsistence farmers. Despite the employment status of these farmers, they all practice subsistence agriculture as a source of livelihood (either primary or supplementary) and encounter common challenges in accessing agricultural resources. Moreover, just like other subsistence agriculturalists in rural South Africa, they are the

periphery of agricultural and economic development initiatives (Maponya & Mpandeli, 2014) and also bear the disproportionate burden of climate change (Hart & Vorster, 2007; Ubisi, 2016). Therefore, this study saw it imperative to explore drought experiences and agency of both employed and unemployed subsistence farmers in rural Mphego who are poorly resourced and lack voice in mainstream development theorizing.

3.5. An enquiry of subsistence farmers' drought adaptation strategies using semi-structured interviews

Lincoln & Guba (1985) highlighted that qualitative research is a flexible exploratory approach which allows the researcher to collect data through the utilization of multiple data collection techniques such as case studies, ethnography and interviews. In-depth-face-to-face interviews were primarily used as the data collection tool for this study. Boyce & Neale (2006) propounded that in-depth interviews involve the collection of data through lengthy one-on-one interviews with a small fraction of the sampled respondents in order to gain a comprehensive understanding of their perspectives on the subject of inquiry. The motive for using this data collection method was its usefulness in unearthing of a detailed account of the impacts of drought on rain-fed subsistence crop production, the intersecting politically engineered socio-economic constraints that exacerbate the farmers vulnerabilities to drought and the various strategies that are being employed by farmers to minimize the severity of these impacts.

These three categories were all examined using a total of twelve semi-structured interviews with open-ended questions. According to Kvale (1996) a semi-structured interview equips the researcher with some leeway to pose a series of questions to the respondents that help in answering primary themes of the study. Dejonckheere & Vaughn (2019) further argue that semi-structured interviews necessitate an open and natural conversation between the researcher and the respondents which enables the researcher to further explore brief, incomplete, or unclear answers through follow-up questions. In this view, this qualitative research found semi-structured interviews to be a valuable data collection tool. Through semi-structured interviews I was able to engage in a purposeful dialogue with the participants that strongly resembled a natural conversation as farmers had the autonomy to freely voice their opinions without any influence being exerted on them. This natural conversation facilitated the establishment of a rapport with the subsistence farmers. This in turn provided some flexibility to gain rich insights and diverse perspectives on the numerous questions that informed this study. Moreover, asking follow-up questions to each participant's responses, especially those that were ambiguous, was an effective technique for obtaining detailed answers to the research questions.

3.6. Conducting a pilot study to test the interview guide

Prior to interviewing the larger sample population, it was paramount to pretest the interview guide on a small sample of respondents. Four participants were chosen to participate in the pretesting of the research questionnaire. As noted by Drennan (2003), conducting a pretesting process of the data collection tool necessitated the identification questions that appeared to be biased and irrelevant to the subsistence farmers in the rural community of Mphego. Such questions were completely removed from the questionnaire or rectified to improve their applicability in the research context.

Hughes (2004) goes on to suggest that a data collection instrument should be pre-examined to ensure the generation of questions that can be easily understood by the respondents. This recommendation was taken into consideration during the pilot study. When interviewing the pilot sample, a few questions appeared to be a bit complex and could not be easily understood by the farmers. For example, in one interview that I conducted in English, a farmer was asked the question: What is your perception of the drought climatic condition? Such compound questions with uncommon phrases to the farmers were carefully revised and simplified. The objective was to generate interview questions that were easily understood by the participants and stimulate valid responses that would capture the intended research objectives of the study. This approach helped to improve the validity of the data.

3.7. Data collection and fieldwork experience using semi-structured interviews

A total of twenty subsistence crop farmers were identified from the population as potential participants for this study. Unfortunately, only thirteen out of the twenty subsistence farmers were interviewed. Two potential participants declined to participate in this study after the research objectives were explained to them, which would indicate their disapproval of certain components of the study, and five were unavailable during the scheduled time of the interviews.

Generally, as an outsider to the research community, the process of conducting interviews was quite a challenging task for me due to language barriers. Hence, with the help of my intermediary, ten of the thirteen scheduled interviews were conducted in Tshivenda, the dominant language of the Mphego community. The use of the respondents' vernacular language proved significant to this study. It facilitated a more natural dialogue with the subsistence farmers where they were able to provide authentic responses to the interview questions because they were in a better position to understand and internalize them. Being present during the interview procedure, I managed to take note of a few things that I could easily grasp.

Nonetheless, I managed to conduct three interviews with participants who were comfortable to be interviewed in English. These participants were in their youth and had some level of secondary and tertiary education. While the use of English as the medium of communication was beneficial in allowing me as the principal researcher to lead the discussion, there are instances where it presented a challenge to the respondents. They were faced with difficulties in translating some Tshivenda words to English as well as providing accurate descriptions of the actual practices they employ in adapting to drought. Consequently, the use of English proved to be limiting factor in getting a rich description of some of their agricultural practices. To bridge this gap, my intermediary would chip in to ask some questions in Tshivenda.

As argued by De Vaus (2001) having a well-timed interview was integral in ensuring a focused conversation that covers all the relevant topics under study. In this research, the interviews were conducted face-to-face with each farmer in their respective homesteads and were scheduled to last for a maximum of forty-five minutes. Each participant was fully informed of this duration in the consent form, it was also recommunicated to them verbally prior to conducting the interviews. However, most interviews exceeded the time limit by roughly fifteen to twenty minutes. The participants showed a strong interest in fully engaging with the interview questions because they were comfortable answering them in their local language and in the comfort of their homes. This created a conducive environment for lengthy dialogues as well as the establishment of a rapport with the participants. This was beneficial in providing room for a thorough investigation of the research questions through the probing of ambiguous responses, further improving the validity of the collected data.

This study ensured the strict observation of the participants' confidentiality and anonymity throughout the interview procedure. The interviews were only recorded with the participants' written or verbal consent, the preferences of those who declined to be recorded were fully honoured. As a researcher, I was fully aware of the risks of conducting this study during the COVID 19 pandemic. Hence, all necessary precautions were prioritized to ensure everyone's safety. This included observing Covid-19 regulations such as social distancing, the wearing of masks, and sanitization throughout the interview process.

Moreover, the study utilized ethnographic observations as a way of gaining a thorough understanding of how rain-fed subsistence crop production in Mphego village is being affected by drought and the agency of the subsistence farmers in adapting to these impacts. Although I was faced with time constraints in conducting the fieldwork, the interview process was an informative experience that presented me to establish a trust-based relationship with the subsistence farmers and to fully observe

them in their natural setting. Through ethnographic observation and transect walks in Mphego, I was able to point out and document useful insights that would help in answering the research questions, including the politico-socio-economic conditions of the community to understand how these structural factors intersect with drought to reproduce an additional crisis. I also managed to capture some photographic evidence of some of the drought adaptation and coping mechanisms that were apparent during my visit to the research community such as water storage tanks and water pumps.

As most farming activities took place around late November, December and early January, after I had already conducted the field work in September, my intermediary managed to gather more photographic evidence around February and March this year of some of the practices that are being employed by farmers such as intercropping practices and in-field rainwater harvesting techniques. Ethnographic observation thus necessitated the gathering of some important evidence that would have been overlooked if the study solely relied on interviews. This made it possible to pinpoint the different challenges and opportunities encountered by the subsistence farmers in their drought adaptation efforts as well as to offer recommendations to improve their adaptive capacity.

3.8. Data analysis using the thematic approach

According to Le Compmte & Schensul (1999) and Braun & Clarke (2006), qualitative data analysis is a continuous process that transpires at every stage of the data collection procedure as the researcher interprets and identifies major themes emerging from the raw data, allowing an in-depth understanding of the data and refinement of the questions and methods. To this end, Anderson (2007) propounded that thematic data analysis captures the core content of interview transcripts. The first step involves the identification of central themes appearing from the data, which is then followed by listing and grouping of these themes accordingly to present the commonalities in the participants' responses.

Following these guidelines, the data for this qualitative study was analysed using the thematic approach. It involved a long process of interpreting, understanding and identification of relevant quotations and insights that surfaced from the raw data from transcripts and field notes and organizing them into themes. Most importantly, I ensured that these recurring themes adequately addressed all my research questions. In analysing the central themes of the study, I saw it was paramount to contextualize them within existing literature on this topic. This approach proved beneficial in enhancing the validity and reliability of this research. It confirmed the coherence of my findings with previous studies along unique insights and contributions.

Moreover, given that the agricultural practices that are being employed by the subsistence farmers in adapting to drought are subjective and embedded in their socio-cultural practices, it was necessary to use on direct quotes from the interview transcripts. For example, phrases like, “This was practiced by our forefathers”, “We have been using this method for generations’, and “When I was young my father taught me to ...” were quoted verbatim to capture their grounded experiences. This ensured the credibility of my findings as they were grounded in the subjective experiences of the subsistence farmers.

3.9. Ethical considerations

The British Sociology Association Statement of Ethical Practice (2017) emphasizes that sociological research should not violate the rights of others. Therefore, ethical considerations were incorporated throughout the research process. Ethical clearance was obtained from the Wits Research Ethics Committee (non-medical) prior to conducting the research. Informed consent and voluntary participation were prioritised during the data collection process. All interviews were conducted after the farmers had shown their willingness to participate in the study through signing the consent form. Participants were not obliged to answer any questions they did not wish to and were free to withdraw from the study at any time. During the interview procedure, I ensured that those who did not want their voices recorded were respected. Anonymity was observed in the writing of the research report, pseudonyms were used to conceal the identity of participants who preferred not to be publicly identified. Confidentiality was also taken into consideration; the participants were ensured that data for this study will be safeguarded from unauthorized access or disclosure.

3.10. Chapter summary

This chapter discussed the research approach that underpinned this study- the qualitative research approach and its importance in exploring the research objectives. It went on to provide a brief description of the study participants and sampling techniques that were used in their selection. This was accompanied by an elucidation of the data collection instrument, how it was pretested and improved, as well as the data collection process which also highlighted my field work experience. Moreover, it gave a description of the data analysis approach and the ethical considerations that were pertinent to this study.

CHAPTER FOUR

Drought impacts on rain-fed subsistence cropping practices

4.1. Introduction

The purpose of this chapter is to present the research findings on the impacts of drought on rain-fed subsistence cropping practices in Mphego village. The discussion also details how drought intersects with longstanding political and socio-economic challenges experienced by subsistence farmers to reproduce their vulnerability. Prior to engaging in this discussion, it was important to firstly understand the nature and dynamics of subsistence agricultural practices in Mphego. Hence, the chapter started by discussing the research findings on the participants demographic characteristics, the reasons for their involvement in subsistence farming. This is then succeeded by a discussion of the types and characteristics of subsistence farming practices in the research area as well the contribution of subsistence agriculture towards the food security of these rural households. The chapter was concluded by a discussion of drought impacts on rain-fed subsistence crop production, showing how these impacts are amplified by longstanding socio-economic and political constraints that undermine subsistence agricultural production.

4.2. The participants' socio-economic demographic characteristics

The participants' socio-economic demographic characteristics were pertinent to this study because they provide information of the types of people that are practicing subsistence crop farming in the study area. Demographic features were also found to have a significant role in shaping the farmers' agricultural practices and their choice of drought adaptation strategies as will be illustrated in Chapter five. This section is an analytical discussion of the respondents' demographic characteristics, which are classified into the following variables: age group, gender, educational level, farming experience and employment status.

Age group

This study found that there are more elderly people participating in the subsistence agriculture economy in Mphego village in comparison to the youth. The elderly generation of farmers gave corresponding explanations as to why there is a decreasing number of youths participating in subsistence agriculture in the area. For instance, two participants clearly expressed that,

Our kids are sometimes there to help us in cultivating the fields, but they do not want to engage in subsistence agriculture as a career. They always say that it's backward and non-profitable. Being exposed to the modern world, they prefer other jobs such as mining or retailing that can guarantee them a fixed salary (Respondent 5, September 2022)

I live with five of my grandchildren, but farming is not something they admire. Two of them ended up migrating to Johannesburg to look for jobs because they are very hard to find in this place. These days I do most of the farm work with the help of my three grandchildren who are still in secondary school, but I have to force them at times (Respondent 8, September 2022).

The results emanating from the study area confirmed previous studies in South Africa (and elsewhere) that have shown that subsistence agriculture is practiced more by older generations, compared to the younger generations that perceive it as archaic and incapable of improving their social and economic welfare. (Myeni et al., 2019; Ubisi, 2016, Water Research Commission, 2022). Regardless, there is ample evidence that subsistence agriculture, which has been in place for centuries in Mphego, continues to be a significant livelihood and food security source among these rural households even though youths are diversifying into other land-based livelihood sectors and professional carriers.

Gender

The findings of this study suggest that men constituted the majority of those participating in subsistence crop agriculture than women. An interesting trend unfolding in Mphego greatly contradicts numerous studies that recognized women as the dominant force in smallholder agriculture production, compared to their male counterparts (Maponya & Mpandeli, 2012; Ubisi, 2016; Kom, 2020). It was found that the possible shift taking place in the subsistence agriculture economy is associated with the changes taking in the broader economy. Due to high unemployment rates and limited economic opportunities in the rural areas, most men, identifying as heads of households, have been taking greater interest in subsistence agriculture to generate income to feed their families. This finding is underpinned by the following narrative,

In general jobs are now very difficult to find. Back then, I would get piece jobs at construction sites, but now everyone is competing for these jobs that is if they are even there. This is a difficult situation for me because my three kids and wife look up to me

for their food and financial needs. Practicing subsistence agriculture has really helped me to at least provide for my family (Respondent 7, September 2022).

Additionally, Mphego like other rural communities in South Africa is shaped by cultural ideologies that have entrenched pervasive gender disparities in the community's socio-economic structure, leading to the exclusion of the majority of women from land ownership. Consequently, this has increased the participation of elderly and young men in the subsistence agricultural sector in comparison to their female counterparts. However, this does not mean that women are completely absent in the subsistence agricultural economy. Some households were headed by women who because of their traditionally ascribed roles were seen to practice subsistence farming, as well as other domestic duties such as food preparation, cleaning, washing dishes and caring for their families. For instance, one of the women said,

... I'm a widow, I don't have a job and I have been trying to make ends meet in these hard times. I have three elderly married kids who send me money monthly, but it's not always enough to buy everything we need in this household. I'm currently staying here with two of my younger kids and four of my grandkids and it's my responsibility to take care of them and ensure that they do not go to bed on an empty stomach. I have been practicing subsistence agriculture for more than twenty-five years and it provides us with some food to eat, especially when we are low on cash and cannot afford to buy food from the market (Respondent 2, September 2022).

This demonstrated that despite the low participation of women in the subsistence farming, they are an essential resource contributing towards the growth of the subsistence agriculture economy in Mphego.

Educational level

The study findings revealed that a few subsistence farmers were educated up to secondary and tertiary level education. However, the majority were identified to have low literacy levels as they indicated having been educated up to primary level, while some had no formal education. Much of South Africa's agrarian literature indicates that most people practicing subsistence agriculture in rural areas have achieved low levels of educational attainment (Mudhara, 2010; Ubisi, 2016; Myeni et al., 2019). In this study, low literacy levels among the subsistence farmers may be linked to high levels of unemployment and poverty among the subsistence farming households. Moreover, the state's inadequate supply of educational resources in the former Bantustans of Venda (Lahiff, 1997). Given

this situation, South Africa's policy makers must focus on enhancing rural education and employment opportunities.

Farming experience

The participants in this study were found to be highly experienced in subsistence agriculture practices. Participants inclusive of both the elderly and younger generations of subsistence farmers reported to having attained agriculture knowledge and skills through informal learning experiences. The following remarks from some of the participants illustrates this point,

> *I can say that I have been a farmer since I was young. I'm in my fifties now and farming is something that I really enjoy doing. Both my parents were farmers, and they would always take me to the field with them where I would observe them farming. They would also let me do lighter work like picking up the weeds and the likes. Now I'm fully responsible for managing our farming field using the skills I learnt from both my parents* (Respondent 13, September 2022).

> *This is my fifteenth year in farming, and everything that I know about farming was taught to me by my grandfather. He is too old to farm now so I have taken over. I was never really interested in farming but being unemployed, I'm left with no option but to do it for a living.* (Respondent 4, September 2022).

Most of what these farmers said clearly shows that informal agricultural education accumulated over generations of use from family and community members through word of mouth and observation is essential in the growth and expansion of subsistence agricultural practices. This testifies to the fact that local communities, especially in rural areas, have for centuries developed and preserved agricultural practices unique to their cultural contexts (Hart & Vorster, 2007). Some farmers further indicated that they have some formal education in farming, which they acquired from their group interactions (organised workshops and field demonstrations) with agricultural extension officers. They reported that their interactions with extension officers have improved their understanding of some of the modern agricultural farming techniques and equipment they can use to maximize agricultural production and to adapt to climate change. However, the provision of formal education through extension services is limited in this study area. Given this situation, most farmers are reliant on informal sources of agricultural knowledge**.**

Employment status

Out of the thirteen respondents, nine were found to be unemployed, as a result they are dependent on remittances from family members and old age social grants from the government. The remaining participants were found to be self-employed or involved in wage work as alternative sources of income. The lack of formal employment among the subsistence farmers in Mphego is a complex issue that is largely shaped by historical and contemporary structural inequalities in South Africa. The socio-economic landscape of Mphego continues to be shaped by the legacies of apartheid. As a result, the residents of this rural community have access to low-quality, underfunded education, which leaves most people marginalized and excluded from mainstream high and medium level job opportunities. This is because they lack qualifications and essential skills to compete for better paying jobs. The results of this study, therefore, confirmed that poverty and unemployment has prompted the Mphego to engage in subsistence agriculture for survival. This finding speaks to existing studies, which proclaim that rising rates of rural poverty and unemployment, have made rural populations more dependent on smallholder subsistence agriculture as a source of food security and livelihood (Mashamaite, 2014; Myeni et al., 2019; Machete, 2020).

4.3. Reasons for practicing subsistence agriculture

This section is dedicated to explaining the reasons why these respondents practice subsistence agriculture. This finding shows that subsistence agriculture is a livelihood and survival strategy for black people in rural Mphego. They constitute the historically marginalized and continue to experience social-economic exclusion from the mainstream economy. Two major reasons were given by respondents to justify participation in the subsistence agriculture. Five farmers argued that the reason they engage in subsistence farming is to secure food for their family. However, because they also exist within the broader capitalist economy and in particular a rural area trapped in a vicious cycle of poverty and limited economic opportunities, eight respondents reinforced that in addition to securing their household food needs, they practice subsistence agriculture for economic empowerment, either as a primary or secondary source of income.

The results, therefore, indicate that subsistence agriculture is a significant source of household food security and a form of employment. It enables economically disadvantaged households to generate an income. This is primarily through the informal marketing of their farm output to relatives, community members and street vendors, thus improving their access to food from the market, healthcare, education, external farm inputs and other basic household needs. The different reasons provided by the respondents about their engagement in subsistence agriculture thus reflect Morton's (2007) assertion that the practice is largely to meet household food needs, with some agricultural output being marketed

for profit. The study findings are also consistent with the revelations of Baiphethi & Jacobs (2009) about the essential role of subsistence agriculture in the creation of employment and ensuring food security among the rural poor. Therefore, it is undeniable that subsistence agriculture is a key economic sector with the potential to alleviate households in Mphego village and elsewhere from high levels of poverty, food insecurity and unemployment.

4.4. Characteristics of subsistence crop production in Mphego village

The dominant types of crops cultivated

This section unveils the types and characteristics of rain-fed subsistence cropping systems in Mphego village. This was deemed vital in comprehending the different crops that constitute an integral part of their diets, how they are being affected by drought as well as the different adaptation strategies that are being implemented by farmers to sustain the productivity of these crops to break the cycle of food insecurity and to improve their livelihoods.

While acknowledging that there are different types of subsistence farming practices in Mphego for example livestock production and mixed farming methods, the most dominant form of subsistence agriculture being practiced by most households is crop production under rain fed farming systems. As observed from the field work, limited financial resources, agricultural land and government support services has greatly hampered these resource poor subsistence households from expanding their farming operations and to diversify their sources of livelihood. The study findings suggest that rain-fed subsistence cropping activities being practiced by the respondents are heterogeneous in nature. It appears that the farmers' choice of crops is dependent on a range factors, including their agro-climatic conditions (rainfall, temperature, soil composition), knowledge of the crop, farm inputs and the final use of the crop – whether for household consumption or sale.

Evidently, maize dominates smallholder production in the study area, and it is the most consumed crop at household level. In agreement with these findings, Ala-Koko et al. (2021) stipulates the majority of South Africa's population, especially low-income households are highly reliant on maize as a staple food. The study results went on to reveal that maize production is in most cases augmented by a variety of vegetables ranging sweet potatoes, spinach, cabbage, tomatoes, onions, groundnuts, groundnuts, beans, cowpeas and pumpkins (among others) that most households subsist on or sale. Generally, these findings are important, research has shown that smallholder crop production which is predominantly practiced former homeland areas of Limpopo has contributed to the province being one of South Africa's biggest producers of fruits and vegetables (Oni et al., 2012). This indicates that in order to

meet the Sustainable Development Goal of promoting zero hunger by 2030, South Africa's agricultural policy should effectively support and encourage the expansion of subsistence farmers in rural communities.

Farm size

The size of available land has a considerable impact on the success of subsistence farming and climate change adaptation. An interesting dynamic picked during the field work is that most farmers possessed land holding of less than 0.03 hectares (300 m^2) either in their home plots or fields outside their compounds. This further indicated that access to a large piece of productive land is a huge challenge for subsistence farmers in Mphego village particularly. The bulk of the land owned by these farmers is rain fed and devoid of irrigation systems. These results are consistent with prior studies which reported that 13 percent of the total agricultural land in the former Bantustan areas of South Africa is cultivated by impoverished black agrarian communities who lack agricultural technology, with the majority of households each possessing small plots of land less than 2 hectares (Oni et al., 2012; Mpandeli & Maponya, 2014; Mutero et al, 2016).

Farming equipment

The study discovered that most subsistence farmers have limited access to modern farming technologies such as tractors. The respondents felt that the size and power of tractors outmatched their land holdings and most importantly, they were faced with financial constraints to invest in or hire tractors. Given this challenge in accessing technical farming equipment, the functionality and success of rain-fed subsistence agricultural production in Mphego was found to be highly reliant on manual labour and animal draught power. Nine of the interviewees reported that they primarily rely on manual labour from the family using highly labour-intensive agricultural tools such as hand hoes, but they periodically hire additional labour to assist with planting or harvesting for a small fee. The remaining farmers (four) were seen to be utilizing both manual labour and animal draught power to cultivate their fields, in this particular case of cows – ox ploughing. The farmers however reported that use of animal traction is compromised by many challenges including diseases and deaths associated with the extreme drought conditions in the area.

The subsistence farmers further articulated that hand operated agricultural tools such as hoes and animal traction historically supported their agricultural activities and continue to play a vital role in enhancing crop production especially in rain-fed systems. This attests to the fact the racial segregationist policies of Apartheid deprived black smallholder adequate access to technical

equipment and other socio-economic resources required for crop production and agricultural development (Makhura, 2001; Vink, 2012). Being part of the historically marginalized groups, access to technical farming equipment remains a challenge for the subsistence farmers in Mphego. The use of hand operated agricultural tools and animal traction therefore emerged as a key agricultural practice deemed indigenous to the Mphego community and a significantly cheaper alternative to the expensive technical farming equipment. This is because they have been used for many generations and are deeply ingrained in the farmers' socio-cultural systems. Resultantly, this finding supports prior studies which affirmed that subsistence farming in the developing world and rural South Africa in particular is characterized by low levels of productivity and inadequate financial and technical resources (Morton, 2007; Murphy, 2010; Oni et al., 2012; Mpandeli and Maponya, 2014), and dependent on "the centrality of the social" as social relations between and within households largely determine production (Morton, 2007, p. 1).

Access to agricultural extension services

The responses provided by all interviewees when it comes to their access to extension services revealed that there is a negligence of subsistence farmers in the rural community of Mphego by the government when it comes to the sufficient provision of extension services. The subsistence farmers clearly expressed their dissatisfaction with the agricultural extension services that are being provided to them. They reported that extension officers fail to visit them on scheduled dates and times. As a result, they can go for months or even the entire year without extension advisory on their farming operations. The farmers also stipulated that if they do get extension visits, the quality of the services is substandard and unreliable. This is because the extension officers do not offer enough assistance to all farmers and follow up on their recommendations to ensure that they are being successfully implemented.

This finding has been confirmed in studies by Moeletsi et al., (2013) and Maponya & Mpandeli, (2013) which revealed that small-scale farmers in the province of Limpopo generally lack adequate access to agricultural extension services and support. The restricted operations of extension officers may be attributed to the failure of the national authorities to provide sufficient human and financial resources to the Limpopo Department of Agriculture (Mpandeli and Maponya, 2013). This is a matter of concern because agricultural extension services are vital in enhancing the adaptive capacity of smallholder farmers against climate related vulnerabilities (Ubisi, 2016). Given these institutional barriers and policy inadequacies, it has been discovered that most subsistence farmers in this study have reduced their dependence on extension services. They rely quite significantly on their agricultural expertise

and information from other farmers to improve their production activities as well as to cushion themselves against ecological challenges such as drought.

4.5. The role of subsistence crop production in enhancing the farmers' household food security

This section is a discussion of the research findings on the contributions of subsistence farming towards the food security of households engaged in practice. This study saw it imperative to acknowledge the role of subsistence crop production in enhancing the household food security of poor populations in the highly socio-economically deprived rural area of Mphego. Adaptation is therefore a prerequisite for creating resilient food systems and improving the food security of subsistence farming households in the face of the drought ecological crisis which persistently endangers their local environment. This study measured the household food security of the subsistence farming households using two of the key indicators of food security, namely food availability and accessibility.

Food availability

Food availability by definition refers to adequate supplies of quantity and quality food, whether from local production or imports (FAO, 2006). Drawing from this definition, the quantity and quality of food produced by farmers for subsistence use was used as the primary determinant for household food availability in this study. The study results demonstrated all interviewed rain-fed subsistence crop farmers produce an average to a high amount of agricultural output from their farming operations that is sufficient to meet their family's daily nutritional requirements. The farmers reported that their families are able to eat two to three meals per day from the food they produce. Nevertheless, they periodically obtain low crop yields as a result of multiple challenges that impede the growth and development of the rural subsistence agricultural economy. Chief among them is the persistent drought in their local environment which cannot be separated from structural constraints including the inadequate the access to a steady supply of municipal water, hybrid seeds, mechanized farming equipment, irrigation infrastructures, arable land and credit. This suggests that while subsistence farming is a key source of food among these low-income rural households, it does not supply them with all their food needs.

Despite this shortfall, the respondents vehemently stated that the quantities of food they produce from subsistence farming should not be taken for granted as it helps to do away with food insecurity in their households. It supplements the food they purchase from the local markets to provide them with a balanced diet and a safety net that significantly reduces household food shortages especially in times when they cannot afford to buy expensive food stuffs from the markets. This proves that subsistence

farming undoubtedly increases household food availability by contributing a sizeable portion of the total food consumed by these rural households on a daily basis. This finding is in congruence with a study by Baipheti & Jacobs (2009) which confirmed that historical dependence on subsistence agriculture as the main source of food has been declining in rural South Africa and Sub-Saharan Africa at large. Rather, it is becoming a supplementary source of food and a buffer against food price inflation. In this light, South Africa's rural development studies have recommended the upscaling of smallholder agriculture development policies as a solution to addressing food insecurity and persistent hunger in rural areas (Von Loeper et al., 2016).

Food accessibility

Food accessibility refers to people's ability to acquire sufficient resources for purchasing appropriate food for their nutritional requirements (FA0, 2006). In this study, food accessibility largely correlated with the income generated by farmers from selling some their agricultural produce and how it enhanced their capacity to purchase other food commodities required to meet their household dietary and nutrition needs. The research findings revealed that the role of subsistence farming in contributing towards household food accessibility should not be underestimated. Eight of the thirteen interviewed subsistence farmers emphasized that subsistence crop farming has largely helped them to break the cycle of poverty, food insecurity and unemployment. The farmers reported that they acquire considerable amount of money from selling their agricultural produce and they are in a better position to acquire other food stuffs from the market that they are incapacitated to produce on their own. For example, one farmer proclaimed that,

> *The money I get from selling my crops fluctuates all the time depending on the quality and quantity of my harvests. When things are good, I earn around R300 to R500 per month. If not, I get far less than that. You see, my family normally eats food like sweet potatoes or what we call* ***Tshidzimba*** *(a mixture of maize, beans and groundnuts) for breakfast. But with this money, I'm able to also buy bread to eat for breakfast on other days* (Respondent 3, September 2022).

Based on these insights, there is no doubt that subsistence agriculture is the panacea for alleviating the poor and unemployed in Mphego from pervasive food insecurity and hunger. This is because it provides them with financial resources to improve their purchasing power and to access marketed food commodities to secure dietary requirements. This finding corresponds with studies by Averbeke & Khosa (2007) and Machete (2020) which highlighted the importance of money generated from

subsistence agriculture as a means through which rural households are able to buy food from the market to improve their food security.

However, the external environment in which the farmers exist (vulnerability context) is characterised by a plethora of conditions including the frequency of climatic shocks such as droughts that undermine rain-fed subsistence crop production, hence their food security. As FAO (2015, p. vii) notes, the overbearing impact of climate change on agricultural systems has implications for the four dimensions of food security namely "access, availability, utilization and stability". In the village of Mphego, drought appears to be threatening the already fragile non irrigated subsistence crop production systems that highly dependent on rainfall which is compromising the household food availability and accessibility status of these vulnerable rural populations.

4.6. The subsistence farmers' perceptions of drought

Exploring the subsistence farmers' individual perceptions drought was deemed paramount in this study. Why was this important? The way subsistence farmers in Mphego interpret and understand their local drought conditions and its associated risks was seen to influence their coping and adaptation practices they employ at the household and community level to combat effects of drought on crop production. In so doing, the study contributes to the ongoing discussions about grassroots pathways to drought adaptation and mitigation in developing rural communities. The grassroots approach exposes the structural failures by the South African government to enhance the adaptive capacity of rural smallholder farmers against drought. This is due to inadequate provision of finance subsidies, agriculture technologies, extension services and water infrastructures in the rural communities (Oni et al., 2012; Turpie & Visser 2013; Mpandeli & Maponya, 2014; Ncube, 2020, Satgar, 2020). Mphego community in Limpopo province is one such community with is susceptible to perennial droughts and the shortages of drought adaptation infrastructures.

Recent studies focusing on subsistence agriculture and climate change suggest that the vulnerabilities experienced by rural dwellers is the result of their marginalization in development programmes by the state, as well as the double consequence of a scientific bias in favour of the conventional approaches (top-down development practices) to agriculture production and climate change (Byg & Salick, 2009; Theodory, 2016). Given that drought is one of the dire climatic conditions predicted to further worsen the plight of rain-fed subsistence farmers in Sub Saharan Africa, there is a strong need for the reconsideration of drought governance by South Africa's policy makers that would incorporate a critical examination of past drought encounters with a focus on local level perceptions and adaptation (Baudoin et al., 2017).

Perception relates to how a group or individual's understanding of their immediate environment and its changing dynamics shapes the nature of their adaptation decisions, processes and outcome (Pauw, 2013; Byg & Salick, 2009). In parallel to this line of argument, several agrarian studies have confirmed that the way farmers interpret and understand context specific drought trends and associated risks immensely influences the effective implementation of coping and adaptation practices at both the household and community level to minimize its impacts (Theodory, 2016; Ubisi, 2016; Kom, 2020, Abaje & Magaji, 2022). I therefore argue that the misinterpretation of context specific climatic conditions and its impacts on agricultural production could lead to poor grasp of the adaptation practices employed by rural subsistence farmers, who often lack a voice in mainstream development theorising. Moreover, this could potentially worsen both food and climate induced socio-economic vulnerabilities since the wrong intervention strategies are imposed by states on rural dwellers. This section therefore presents the research findings on the perceptions of drought among crop subsistence farmers in Mphego village.

According to the World Meteorological Organization (WMO, 2021), 30 years ideal in studying long term climate change trends. This study conformed to this recommendation as questions were probed on the subsistence farmers' perceptions of drought trends they have observed over the past 30 years. The study findings revealed that drought has exacerbated over the past 3 decades, although with varying perceptions on its observable patterns among the subsistence farmers. The most notable signs of drought that were consistently mentioned by the subsistence farmers were largely associated with changes in rainfall patterns and atmospheric temperatures as elaborated below.

Changes in rainfall patterns

The study participants expressed that the frequency and severity of droughts in Mphego village has increased over the past 30 years. Based on their observations of climate change over time, the farmers noted that their area has been experiencing a sharp decline in precipitation levels and intra-season dry spells. These extended dry periods have been said to have resulted in a shift and delay of rainfall seasons from normal precipitation patterns, implying that the local impact of drought is associated with low and unpredictable rainfall patterns. The farmers' perceptions views of drought are thus consistent with projections made by the IPCCC (2018) and Niang et al. (2014) of the occurrence of a semi-permanent drought in Africa's semi-arid ecological zones, which is a great source of concern. The farmers demonstrated an awareness of the disastrous effects of drought on rain-fed subsistence crop farming, the water commons and social cohesion as backed by the following interview narratives,

*We have not been receiving much rain over the years. This situation has highly affected the quality of our water sources. Most rivers have dried up and ground water levels in our community boreholes have extremely dropped because the rain that we are receiving throughout the year is not enough. So, we end up competing for water with others to use in our households and to water our crops (*Respondent 4, September 2022).

It appears that the timing of the rain is now very bad and inconsistent. Back then, we would receive our first rains around early or mid-October, but this trend is no more, there has been a shift of rainfall patterns. We now anticipate our first rains around early November, but they are usually accompanied by early dry spells. We sometimes receive heavy rains around late December that sometimes stretch to February and March thereof but it's not always the case (Respondent, 9, September 2022).

What I can say is that because of this drought our cropping season for summer crops has been delayed. Most of us now plant later in year or early next year the after enough rain has fallen and soils have been moisturized enough to sustain crop production. So, our summer crops have a short time to grow and fully mature before we can harvest them. This presents a challenge because they might not develop to their full size, and we might not get the yields we anticipate (Respondent 13, September 2022).

Therefore, there is reasonable consensus among the subsistence farmers that the incidence of drought in Mphego village is associated with the decrease and unpredictability of rainfall patterns, which is highly affecting rain-fed subsistence agricultural systems. This local understanding of drought is valid and backed by existing literature. For example, Satgar & Cherry (2019) confirmed that the rural areas of Limpopo province (including Kwa Zulu Natal, Mpumalanga, Northwest, the Free State and Northern Cape) were exposed to an extremely low rainfall season as a result of the 2015/16 drought which exacerbated stress on rain-fed smallholder agricultural systems. Likewise, a recent analysis of the rainfall trends by the South African Weather Service (SAWS, 2022) revealed some areas of the Limpopo province were exposed to severely dry conditions. This shows the drought condition is not only unique to Mphego village, but rather it is consistent with major droughts experienced at the provincial and national scale.

Changes in atmospheric temperatures

The subsistence farmers also shared a common understanding of drought as an increase in atmospheric temperatures. They felt that temperatures have been rapidly rising in recent years, with hotter days

becoming the new norm and massive heatwaves becoming more frequent. This drought condition has severely impacted their livelihoods, compromising rain-fed crop production and yields. The following remarks from the interview accounts give credence to this assertion,

> *I think temperatures have risen over the past few years. All I can say is that the heat is too much, drier and hotter seasons are becoming longer. This has not been good for our farming operations. This increase in temperature has resulted in extremely dry soils and also created a breeding ground for pests that cause high levels of crop damage, leaving us with a low yield* (Respondent 5, September 2022).

This explanation clearly indicates that the subsistence farmers perceived drought in terms of temperature increases and prolonged heatwaves have been persistent in their local environment over the past 3 decades. Although the current study did not conduct a statistical analysis of the average annual atmospheric temperatures in the study area over the past 30 years, the farmers perceptions of drought as an increase in temperature is consistent with climatological evidence for Limpopo province over the 50 years. For example, a study Shikwambana et al. (2021) reported that from the period of 1960 to 2018 Mopani and Vhembe district (where the research site is) temperature significantly increased by 2.5°C resulting shifts in the crop growing season. Therefore, despite subsistence famers' perceptions of drought being specific to the environment in which they live, they appear to be valid and reliable because they are supported by statistical records from the broader district of Vhembe in which they exist.

The factors that influence the farmers' perceptions of drought within the context of rain-fed subsistence agriculture were taken into account during the data collection process. These include indigenous knowledge where farmers by virtue of occupying their territory for decades use their natural senses to predict weather and climate patterns. Apart from their lived experiences, most farmers acquired knowledge about the ongoing drought from their ability to access to their districts weather forecasts from mainstream media outlets such as radios, televisions and newspapers. Moreover, farmers were also found to rely on relatives, community members and extension services (to a certain extent) as instrumental sources for acquiring climate change information. These findings are in harmony with studies conducted by Theodory (2016) and Ubisi, (2016) which revealed the significance of some of these factors in influencing the perceptions of climate change and variability among smallholder farmers.

While it is important to identify the different factors that influence the subsistence farmers' interpretation of drought, the current study did not go into detail to explore these factors as they were

not the primary focus of this study. Focus was placed on the farmers' perceptions of the drought phenomenon itself given how these perceptions positively impacts their drought adaptation responses on their rain-fed crop production systems. The following section unravels how drought impacts rain-fed subsistence cropping practices in Mphego village, and how it intersects with the longstanding state facilitated structures of socio-economic deprivation in the subsistence agriculture economy to reproduce the myriad vulnerabilities faced by these subsistence farmers.

4.7. The interplay of drought and state orchestrated socio-economic constraints

The findings of this study explicitly demonstrated that the environmental constraints affecting rural subsistence farmers in Mphego and South Africa broadly tend to intersect with many other structural tensions inherited from colonial state policies and capitalist expansion practices. The Mphego community, shares a similar history of marginalization as the other black rural communities in South Africa. It is a product of the racialized land dispossession, forced resettlement and alienation from the centres of capital under Apartheid. Since South Africa transitioned to democracy 28 years ago (1994–2022), little has been accomplished in rescuing the Mphego community from the legacies of colonial socio-economic exclusion engineered by the state. At first glance, the notable challenges in today's Mphego community include landlessness of the commons, overcrowding, shortage of arable land for subsistence cultivation, poor fragile soils and depletion of natural water sources. Other challenges include inadequate investments in public infrastructure and agricultural development. This study found that the interplay of these politically engineered crisis exacerbates the structural exposure of subsistence farmers in the Mphego community to environmental hazards such as perennial droughts, which highly compromises subsistence agriculture with rain-fed production being the most vulnerable.

In this section, I will expose how perennial droughts, often understood as natural environmental occurrences are linked to other structural factors inherited from colonial state policies and capitalist expansion practices whose resource provision that largely benefit and promote the development of the large-scale commercial farming sector, while neglecting smallholder farmers. Based on the findings obtained from the Mphego community, it has been noted that state orchestrated socio-economic constraints such as lack of adequate access to extension services, arable land, tenure security, public water infrastructures and financial subsidies all converge with drought to exacerbate the manifold drought vulnerabilities encountered by rain-fed subsistence farmers. The experiences of subsistence farmers in the Mphego community are not unique to them. Rather, they relate with those of other historically marginalized black communities in South Africa, where similar problems suffice and can

be seen to compromise agriculture production and subsistence farming at large resulting in the socio-economic exclusion of the commons.

To start the discussion, I will present findings that show how drought directly impacts rain-fed subsistence cropping practiced in Mphego and relate the ongoing environmental challenges raised by the farmers to the broader structural tensions posed by global coloniality of power and the expansion of capitalism in African rural economies. Of importance to note, is the idea emerging from the findings that inadequate institutional support by the state in enhancing the adaptive capacity of marginalized subsistence farmers susceptible to drought, compromises on their potential to maximize agriculture outputs, thereby affecting household food stability. The multifaceted effects of drought on the rural poor culminate in their exposure to both food insecurity and income inequalities. This is the case for households dependent on smallholder, rain-fed agriculture as a primary source for food and livelihoods.

The study participants were asked to provide information on how drought is impacting their subsistence cropping practices. All thirteen participants contributed to the discussion. The findings suggest that the adverse impacts of lower/erratic rainfall and high temperatures on rain fed crop production varied across subsistence farmers, depending on the farmer's agricultural resources. However, the most common impacts that could be gleaned from their responses are: (i) a shift of planting dates (ii) increased incidence of crop pests and pest borne diseases, (iii) increased soil infertility and aridity and (iv) crop yield losses. The following is a detailed discussion of the findings on drought impacts on smallholder rain fed crop farming.

Shift of planting dates

Nine out of the thirteen interviewed subsistence farmers identified the shift in planting dates as one of the effects of the drought on rain-fed subsistence farming. The farmers proclaimed that the timeous planting of crops such as maize and legumes – beans, ground nuts and round nuts that constitute an integral part of their diets has been compromised by seasonal changes orchestrated by a delayed and shorter rainfall each year, marked by low rainfall. The farmers mentioned that rainfall season that started early or mid-October in the past has in recent years shifted to early November. Accordingly, this has led to precarious cropping patterns and a delayed planting season. Similar results were confirmed in conducted by Huho et al. (2012) which revealed declined and unreliable rainfall resulted in a shift of planting dates and crop yield uncertainties in some rain-fed subsistence farming communities of Laipikia East District in Kenya. In this study, one the farmers clearly stated that,

> *Historically we planted the maize crop with the early rains of October and by late February or early March it would have reached the maturity stage. This trend appears no more as the earliest rains are increasingly expected in November, while the early dry spells which usually start around mid-November make early maize cropping catastrophic. So, our planting season now spans from late November to January. Farmers plant at different times that are best for them* (Respondent 1, September 2022).

Late planting as a result of drought is a challenge that was seen to be exacerbated by other intersecting structural factors. That is, the legacies of apartheid's socio-economic exclusion of rural smallholder farmers by the state. Some of the farmers lamented that by virtue of their status as subsistence agriculturalists, the government has turned a blind eye on them when it comes to the provision of drought relief to support in the form of public water infrastructures and extension services, all of which are crucial social resources in improving their adaptive capacity. Moreover, as capitalist markets largely favour large scale farmers with adequate access to financial resources and agricultural technologies, the poorly resourced and tenure insecure subsistence farmers in Mphego remain marginalized in the broader capitalist economy as they lack access to financial subsidies from the state as well as banks. Given that the majority of these farmers are unemployed and financially poor, this economic exclusion at the hands of the state and other development agencies has further impeded them from investing in agri-intensive technologies. These include irrigation infrastructures and self-supply electric borehole water systems that they could use to supplement rain-fed agriculture during prolonged early dry spells that succeed the early rains, thus making it difficult for them to practice early planting. These findings mirror recent studies by Ubisi et al., (2017) and Magumbi (2019) which also verified that drought has made it more difficult for smallholder farmers who do not have irrigation technology and are heavily reliant on rainfall for crop production to plan adequately plan their planting seasons.

As these problems unfold in the rural community of Mphego, this has highly increased the vulnerability of subsistence farmers to drought as do not have enough access to an alternative agri-development infrastructure that can supplement rain-fed farming. This was a common issue that emerged from the participants. However, respondent twelve's sentiments were chosen to illustrate this point,

> *Under the best circumstances, it would be advantageous to have a combination rain-fed and irrigated farming. I grow a variety of crops including round nuts and ground nuts that require adequate amounts of water and average temperatures since their growth takes place in the soil. Unfortunately, prolonged dry spells that take place after the first*

rains make it almost impossible for these plants to fully mature. Because of the lack of `a steady supply of water some of us have delayed the time for planting these crops (Respondent 12, Septermber 2022).

Moreover, some farmers expressed a sigh of frustration for not being able to evade the worst effects of drought because they do not have enough financial resources to purchase early maturing hybrid seeds from the market. Similar results were obtained by Unganai & Murwira (2010) who revealed that smallholder rain-fed cropping in rural Chiredzi, Zimbabwe was highly compromised by dry spells due to challenges in hybrid seeds and institutional support. In this study, the farmers indicated that early maturing crops are an essential agricultural input especially now that they are faced with a shorter and low rainfall season. This is because of their higher yielding performance, early maturation and less water requirements. Late planting with traditional crop varieties was seen to be catastrophic because they require large amounts of water. Hence farmers were pessimistic about obtaining good yields from late planted traditional crop species. To justify this point, one of the farmers explicitly alluded that,

Some farmers are in a better position to cope with drought because they can at least afford to buy hybrid seeds which are known to be drought tolerant. However, farmers like myself who are really struggling to make ends meet cannot afford to buy hybrid crops from the market. We mainly use traditional crops varieties that we acquire as gifts from neighbours or those we save from our pervious harvests. Late planting with these crops can be problematic at times because they are highly vulnerable to drought, so we end up receiving very low yields (Respondent 8, September 2022).

Consequently, the shift of planting dates as a result of low and erratic rainfall patterns as revealed by the study findings reinforce the idea that 'dependence on upon fluctuating rains for agriculture is gamble' as propounded by Oestigaard (2016). These changes in climate have been observed to have greatly impacted the annual productivity of rain-fed crops to the point that some subsistence farmers have ceased to operate on the land. Bearing in mind that rain-fed agriculture is the ticket to a sustainable livelihood among the poor subsistence farming households in Mphego, the disruption of crop production by these drought conditions has undermined the farmers' household food security. Moreover, it has compromised their participation in the broader capitalist economy to generate an income (whether main or extra income) through the marketing of their produce, further depriving them from accessing basic services associated with having a stable income such as adequate healthcare, education for their kids and other household needs. So, we begin to see trends of poverty, food

insecurity linked to drought and other socio-economic and political (structural) factors reproducing inequalities in the study area.

Increased soil infertility and aridity

A common drought impact that emerged from all thirteen interviewed farmers is that increasing the problems of soil infertility and aridity in the area, which is affecting their cropping activities. From interviewing the farmers, as well as observing the agriculture and environmental landscape in Mphego, one can easily note the soil infertility crises in the community. Simply put, the bulk of the soils in Mphego are loam and sandy soils depending on the part of the village and they show signs of exhaustion due to continuous cultivation. The community's historical links to Apartheid, as a former homeland, makes it susceptible to social problems such as demographic imbalances that pose a serious threat to the environment.

For instance, one can observe that much of the land in Mphego village is either under human settlement, grazing or agriculture. This leaves limited room for forestry or vegetation renewal in the community. Because much of the land is pegged for either production or settlement, the soils themselves have been used again and again with limited rest, rendering them less fertile each coming season. Animal grazing (cattle, goats and sheep) seems to add more pressure on the few patches of grass and bushes that are visible, although some may argue that the animals are playing a role in naturally fertilizing the soils. However, what is beyond doubt is the scale of distraction caused by the number of domestic animals kept by each family and which outweighs what the vegetation can provide. In this arid region, it is not uncommon for a family of five to six people owning less than two hectares of land to also possess three to fifteen cattle and multiple goats and sheep, while all are subsisting on the land. This state orchestrated social constraint shares part of the blame for the ecological pressures experienced by subsistence farmers Mphego and other areas of South Africa. Subsistence farmers in Mphego are seen operate on poor and degraded soils that are highly susceptible to drought and other ecological constraints.

The soils receive poor annual rainfall, making it unfriendly for rain-fed subsistence cropping activities. The farmers reported that a combination of low rainfall and high temperatures further impacts the water holding capacity of their already poor and fragile soils, resulting higher levels of soil infertility and aridity. This problem was perceived to be causing an ecological imbalance in the soil profile associated with the death of microorganisms that aid in plant growth, thus increasing the incidences of crop failure and reduced crop yields. This finding resonates with previous studies conducted in Zimbabwe, Tanzania, Western Somaliland and South Africa which confirmed that drought conditions

affected crop yields in rain-fed smallholder farms by largely contributing to limited soil moisture and low soil productivity (Lema & Majule, 2009; Unganai & Murwira, 2010, Kom, 2020; Sharmake et al., 2022). This study found that increased soil infertility and aridity is impacting a range of horticultural crops. This argument is essentially backed by the following interview narratives,

> *The soils are becoming very dry which is impacting the growth of vegetables such as spinach, cabbage and onions because there is no moisture in the soil which can support their growth. Onion itself requires a lot of water and soil moisture for the bulb to start forming formation, but dry soils and heat stress constrain the growth of this crop* (Respondent 2, September 2022).

> *For a farmer like me who also grows root crops like sweet potatoes, getting high yields of this crop is determined by adequate soil moisture, favourable rains and temperatures. Unfortunately, because of these dry soils, we end up harvesting sweet potatoes with smaller roots and less flavoured than usual is adequate measures are not taken* (Respondent 5, September 2022)

This therefore suggests that drought is only exacerbating the plight of these rural subsistence farmers who are located already in a marginal environment with poor and fragile soils owing to the historical marginalisation of black communities in South Africa under apartheid. This finding is in consonance with prior studies which have revealed that one of the most concerning challenges for smallholder farming in former homeland areas that emanated from the unequal distribution of South Africa's agricultural land during expansion of capitalism in the country's rural economies during Apartheid is the access to fertile and arable land (Walker, 2005; De Villiers, 1995, Maake et al., 2016). The limited progression of the state in adequately addressing this historical injustice through its land redistribution programmes has left these subsistence marginal plots of land with poor fragile soils. This study confirmed that this politically engineered social constraint that subsistence farmers in Mphego are currently faced with reproduces drought vulnerabilities that further undermine the development of the subsistence agricultural sector, especially rain-fed systems. This has only perpetuated a cycle of poverty and food insecurity among these rural households given that subsistence agriculture makes significant contributions to their household food security and income.

Crop pests and pest borne disease

Eleven of the thirteen interviewed farmers pointed that drought has increased the prevalence of a host of pests that are primarily affecting rain-fed smallholder crop production in the study area. The farmers

indicated that high temperatures coupled with low rainfall has made the environment more favourable for the breeding and spreading crop pests. The feeding behaviour of the pests was seen to be causing severe damage to crops by spreading different kinds of diseases as well as stunting and wilting crops that are already under distress from water scarcity and heat, thus affecting the general growth and overall yields of crops. Similar studies conducted in semi-arid Tanzania and South Africa's Limpopo province also confirmed that crop pests compounded by drought constitute a major threat reducing crop productivity in rain-fed crop production systems (Mongi et al., 2010; Phophi, 2018). For instance, one of farmers unequivocally proclaimed that,

> *Growing crops in drought conditions is quite difficult. High temperatures and low rainfall have promoted a breeding ground and observable increases in crop pests and diseases. The army worm is one of the major serious pests affecting the maize crop. Aphids of different kinds are some problematic pests that are increasingly attacking leafy vegetables such as kale and other crops such as cowpeas, beans, which is affecting the general growth of these crops. Cabbages are being increasingly affected by the diamond back moth and tomatoes by the red spider mite. Sometimes we don't get much from our fields because these pests can wipe out the bulk of our crops due to the severe damage that they cause. They also inject toxins into our crops that result in the spread of diseases which in most cases result in the yellowing and curling of leaves, stunted growth and wilting of crops* (Respondent 8, September 2022).

Importantly, some farmers reported that crop pests are controllable using pesticides. However, because of their financial status the amount of expenditure required to invest in pesticides becomes a daunting task. Therefore, low-income smallholder farmers in Mphego village, just like other rural subsistence farmers in South Africa and African countries in general struggle to maintain a livelihood in the face of unfavourable climatic conditions such as drought. This is because they are faced with many challenges including lack of adequate support from agricultural extension officers, sufficient access to credit and agri-intensive agricultural inputs such as chemical pesticides (Unganai Murwira, 2010; Moeletsi et al., 2013; Mpandeli & Maponya, 2014), which only increases their vulnerability to environmental hazards. Therefore, improved access to institutional loans would play a vital role in assisting subsistence farmers in Mphego and elsewhere to purchase pesticides and other farm inputs that are necessary in combating the worst effects of drought on their rain-fed farming operations.

Crop yield deficit

Moreover, the responses obtained from all thirteen interviewed subsistence farmers revealed that the convergence of all drought induced penalties on rain-fed subsistence cropping practices - late planting, increased soil infertility and aridity and crop pests and pest borne diseases results in a massive crop yield deficit. Few examples of crops grown in Mphego are maize, beans, pumpkins cabbage, spinach, cowpeas, ground nuts, round nuts sweet potatoes, tomatoes and onions. Much of these crops are grown under rain-fed systems and were recognized to be sensitive to the various aforementioned impacts of drought, resulting in crop yield losses. The severity of this problem has resulted in some rain-fed subsistence farmers in Mphego with a poor adaptive capacity to abandon their farming activities. Drought induced crop yield deficit in rain-fed farming systems is not unique to the study area. It is a serious problem that has been confirmed by several studies conducted in other parts of South Africa, Central Tunisia, Zimbabwe, Ghana and Western Somaliland (Lobell, et al., 2008; Schlenker & Lobell, 2010; Mougou et al., 2011; AgriSA, 2016; Jiri et al., 2017; Cudjoe et al., 2021; Sharmake, 2022). As such, drought has been recognized as one of the biggest impediments towards the advancement and success of rain-fed subsistence cropping practices as well the achievement of food security among poorly resourced subsistence farming households in the rural community of Mphego and other parts of Africa.

4.8. Chapter summary

This chapter has shown that rain-fed crop production immensely contributes towards the food and monetary requirements of subsistence households in Mphego, yet these farmers are severely impacted by drought. Their drought vulnerabilities have been shown to be exacerbated by the longstanding historical legacies of social and economic deprivation in local rural communities that impede the growth and development of the smallholder agricultural sector. As seen in Mphego, the state has played a role of the state in facilitating the expansion of agri-capitalist practices that reproduce structural tensions that reproduce to the drought vulnerabilities of these poorly resourced rural subsistence farmers. Therefore, one ponders how the subsistence farmers in Mphego have managed remain relevant amidst these damning environmental and structural constraints. The succeeding chapter will unveil the adaptation strategies that are being employed by these farmers to minimize the aforementioned impacts of drought on their cropping activities.

CHAPTER FIVE

Drought adaptation strategies by rain-fed subsistence crop farmers

5.1. Introduction

The previous chapter has illustrated that prolonged drought is impacting rain-fed subsistence cropping activities in Mphego. Regardless of this situation at hand, the state has exhibited a lack of political will in improving the adaptive capacity of rural smallholder farmers and to cushion them against drought. This lack of support from the state was seen to embolden subsistence farmers into exercising their own agency to build rain-fed cropping systems that are resilient to drought and other climatic disasters. This chapter thus presents and discusses the research findings on the drought adaptation strategies that are being employed by rain-fed subsistence crop farmers in Mphego village. These adaptation practices were largely discussed and analysed in light of the Sustainable livelihood Framework (SLF).

5.2. Adaptation strategies

The findings obtained from Mphego broadly indicate that there are many reasons as to why autonomous adaptation to drought is crucial among subsistence farmers. Apart from experiencing socio-economic exclusion under Apartheid, subsistence farmers in today's Mphego remain marginalized in the market-driven agricultural economy. This study confirmed that state development initiatives that support the expansion of agri-capitalist practices have left subsistence farmers in Mphego (and other rural communities in South Africa) at the periphery of development, where they are deprived sufficient access to socio-economic resources that are crucial for agricultural development. These include extension services, public water infrastructures, arable land and financial subsidies. Moreover, highly capitalized agricultural inputs such as hybrid seeds, pesticides, fertilizers, irrigation technologies and tractors are beyond the reach of most of these farmers due to financial constraints. Conventional wisdom dictates that the aforementioned challenges can collapse any hope to maximize agricultural production on small pieces of land operated by poorly resourced subsistence farmers, while also crumbling their adaptive capacity to drought and other climatic conditions (Unganai & Murwira, 2010; Oni et al., 2012; Moeletsi et al., 2013; Mpandeli & Maponya, 2014; Ubisi et al., 2017; Ncube, 2020).

Evidence emerging from Mphego village however suggests that subsistence farmers are a powerful subaltern force with the capability to defy these odds. The use of autonomous adaptation strategies is an avenue through which these subsistence farmers have managed build resilient rain-fed cropping

systems in the face of drought and intersecting structural challenges. Subsistence farmers in the rural community of Mphego therefore emerged to be a crucial part of the inventive history and transformation of Africa's subsistence agriculture economy and climate change adaptation. As their African counterparts (see for example, Hart & Vorster, 2007; Ziervogel et al., 2008; Stringer et al., 2009; Vincent et al., 2013; Gandure et al., 2013, Kaczan et al., 2013; Theodory, 2016; Aniah et al., 2019, Ndlovhu et al., 2020; etc.), subsistence farmers in Mphego have over the decades developed and employed agricultural practices which are adaptive to their local environment to achieve positive livelihood outcomes i.e., sustain the food and income needs of their households.

The most prominent drought coping and adaptation practices that were found to be utilized by subsistence farmers in the study area are: **(**i) alteration of cropping calendar, (ii) natural and artificial soil conservation practices (i.e., use of chemical fertilizers, organic fertilizers and intercropping), (iii) Rainwater harvesting (RWH) techniques, (iv) pest and disease control practices and (v) diversification of drought tolerant hybrid crops and indigenous crop varieties. These adaptation strategies have been successfully implemented without the assistance of institutions such as the government and extension services. All these adaptation practices denote subaltern or grassroots innovations that empower subsistence households in Mphego to adapt to the localized effects of anthropogenic and natural climate change.

Importantly, the drought adaptation strategies used by the respondents are reflective of the two dominant practices that shape the agricultural landscape in Mphego specifically, modern agricultural practices and others deemed indigenous to the community. The following is a discussion provides insights of what I refer to as modern agriculture practices and indigenous agriculture practices respectively. By definition, the term modern agriculture relates to capital, labour and technology intensive agriculture, which is centred on the intensive use of external inputs such as industrially manufactured pesticides, fertilizers, seeds irrigation infrastructures and tractors (Altieri, 2011). The advanced technologies are often used on large tracts of land (Factory Farming Awareness Coalition, 2021) and operated by skilled/semi-skilled labourers that earn wages for a day's work. The ultimate goal is to ensure high mass production of commercial crops for the market as opposed to crops for household-community consumption. Finally, modern agriculture is reliant on agri-research, extension services and commodity markets and all these converge to determine outcomes in the agriculture economy (Alteri, 2011).

The term modern agriculture can be traced to Europe (Trautmann et al., 1985), particularly England, Germany and France, in the period between the 17th and 18th century, when these societies began to

transform from feudalism to industrial capitalism. As the brainchild of the second agriculture revolution in Europe, it was shaped also by ideas from the enlightenment (reference). The term modern agriculture came to be understood as referring to advanced mechanized agriculture and high mass production of mono-planted crops (Trautmann at al., 1985; Alteri, 2011). In addition, focus began to move from farming for subsistence purposes to farming for the urban populations, since crops were sold on open markets to generate revenue for other development projects (Alteri, 2011; Atkociuniene & Zemeckis, 2015). In Africa, this understanding of agriculture is closely linked to colonialism and the imposition of modern practices on native populations (Ocheni & Nkwankwo, 2012).

In contrast are the indigenous agricultural practices, which have existed in localized agrarian societies for generations, and which are believed to continuously stimulate agriculture production, despite their regular interactions with modern agriculture practices (Hart & Vorster, 2007). Indigenous agricultural practices are significantly shaped and influenced by the farmers' indigenous knowledge (IK). Although the concept lacks a universally agreed definition, IK relates to "the knowledge that local people in a given area or community have developed over time and which they continue to develop" (Hart & Vorster, 2007, p. 8). Boven & Moharasi (2002, p. 6) further argue that this body of knowledge has been developed and preserved by local communities especially in rural areas who have a long history of observing and engaging with the natural environment and its changing dynamics. In this view, Hart & Vorster (2007, p. 8) propounded that IK is "adapted to local environmental conditions and constitutes part of culture" and is mostly transferred from one generation to another orally through cultural networks available in a community. Moreover, this knowledge is dynamic and in a constant state of evolution because it is also influenced by other forms of externally sourced knowledge (Hart & Vorster, 2007).

Focus on and valorisation of IK follow on the heels of the understanding that agricultural systems are part of the local social systems. IK is closely embedded in the wider social contexts of where farming is done, and it encompasses low external input sustainable practices centred on using locally available natural resources (Boven & Morohashi, 2002; Hart & Vorster, 2007). Of importance to note is how beneficiaries use these practices to resolve the latest challenges they encounter on a daily basis including ecological ones that threaten agricultural production (Hart & Vorster, 2007). IK thus contradicts the modern knowledge and agriculture practices in terms of the philosophy and everyday social and cultural practices associated with these activities.

Although there appears to be a sharp dichotomy between the modern and indigenous agricultural practices. Evidence emerging from Mphego reinforces that there are instances where they often

intersect and function simultaneously, since the farmers engage with other stakeholders and institutions in their daily social life of agriculture production. Despite the advantages and disadvantages their relationship poses to subsistence agriculture in Mphego they are both significant to the farmers' drought adaptation efforts. This is an example of a hybrid approach to agriculture and can be witnessed throughout Mphego community. It illustrates how subsistence farmers in Mphego synchronously borrow from the both the indigenous and the modern agriculture practices in adapting to drought.

Moreover, this study took a holistic approach in discussing the various drought adaptation and coping practices that are being utilized by the rain-fed subsistence crop farmers in Mphego. As they are adapting with limited to no external help this study was grounded in a bottom-up approach. It was imperative to identify the livelihood capitals available to the subsistence farmers and analyse their role in enhancing their adaptive capacity to their local drought ecological challenges and structural barriers linked to the community's historical legacies of socio-economic marginalization. This study applied the five central livelihood capitals proposed by the Sustainable Livelihoods Framework namely human, social, natural, physical and financial capital (see pages 31 to 34 for definitions) to analyse and provide a comprehensive understanding of the independent and interconnected livelihood capitals, that have informed subsistence farmers' adaptation efforts to build sustainable food systems and livelihoods in the face of drought and other converging structural constraints. This will be elaborated on in the following discussion.

Alteration of the cropping calendar

Subsistence farmers were found to have altered their cropping calendar as a key adaptation tool against the impacts low and unpredictable rainfall patterns on their rain-fed cropping systems. Late planting has over the years become a norm among the rain-fed subsistence farmers in Mphego as they continuously aim to ensure the survival of their crops in the face of this ecological constraint. This is a common adaptation strategy that emerged to be practiced by nine of the thirteen interviewed farmers who were interviewed in this study. The subsistence farmers made it known that in the past, the rain season commenced around early or mid-October, and that's when they would start their planting practices. Nonetheless, in recent years, the first rains are anticipated around late October or early November which has resulted in a deviation of the planting period and a shortened growing season. To these observations, the farmers clearly indicated that the meticulous planning of agricultural activities is now highly recommended as this is essential in avoiding the risk of losing crop yields to intra-season rainfall variability.

They no longer practice early planting with the early rains as these rains can be misleading and are frequently preceded by early dry spells that hamper crop growth. This result closely relates with studies conducted in Kenya by Huho et al. (2012) which revealed that smallholder farmers no longer preferred early planting because the uncertainties of the first rains were seen to highly compromise crop harvests. In this study, challenges associated with early planting among the subsistence farmers have been noticeably worsened by the inadequate access to a steady supply of water from their homestead taps and community boreholes, as well as their inability to invest in a modern irrigation technology and homestead boreholes. Given these unfavourable circumstances, these farmers have resorted to commencing their planting period towards the end of year transcending to the early months of the following year to avoid the risk of losing all their crops to early dry spells.

The subsistence farmers' agency in adopting late planting as a coping mechanism against drought was therefore found to positively correlate with their human capital. The farmers' knowledge and awareness of low and unpredictable rainfall patterns as a drought trend that has been persistent in their local environment over the years and its associated impacts on their rain-fed cropping activities greatly influenced their decision to adjust their planting dates and crop varieties. The farmers indicated that late planting itself entails a shorter growing season that compromises agricultural productivity as a whole as well as their household food and income security. Nonetheless, they have turned this disadvantage to an advantage by adapting further again to this problem through the increased specialization in shorter cycle crops as well as hybrid crop varieties, in order to maximize agricultural productivity during the short rainfall season. This was clearly attested by one the farmers as follows,

> *Our survival on the land has become uncertain due to the change in rainfall patterns. This change makes it difficult for us to know when to plant or harvest. In recent years, we have seen a shift in the start and end of the rainy season. We used to receive our early rains in October, but nowadays, it's a blessing to have them around late October, early November. This has delayed our cropping season by about a month or two. I now grow fast growing maize and try to plant early December after enough rain has fallen and to wet the soils enough to support the growth of the crop. It is always my hope that by late February and early March thereof the maize crop would have matured and shown sign of bearing children. I know then the crop will survive even if the rains do not last till end of March. The reason I also grow ground nuts is because they can survive dry spells during the rainy season. This crop will do well with minimum rainfall, and I know my children and I can survive on this crop* (Respondent 9, September 2022).

Adapting to rainfall variability through the changing of sowing dates as well as the utilization of short cycle crop varieties is not limited to the study area. A considerable body of research on this topic has demonstrated that this adaptation strategy is also frequently used by farmers in Zimbabwe, Zambia, Malawi, Eswatini, Lesotho, Mozambique and the Free State province of South Africa (Ziervogel et al., 2008; Stringer et al., 2009; Gandure et al., 2013; Vincent et al., 2013). However, this study provided additional evidence that late planting is a 'game of chance'. Bearing in mind that these farmers lack technical agricultural equipment, they may be unable to take advantage of the short growing season. This will ultimately disrupt their cropping activities to the extent that some farmers will cease to operate on the land. Additionally, as drought is predicted to worsen in Africa (Niang et al., 2014; IPCC, 2018), the alteration of planting dates only proves to be effective in the short term and does not guarantee high crop harvests for subsistence farmers in Mphego in the near future. What this means is that farmers should have a stronger human capital and develop a deeper understanding and knowledge base of the future climatic conditions in their environment, as this is a crucial step in the trajectory of developing and adopting strategies that are more resilient to drought.

Soil fertility and moisture management practices

Subsistence farmers have devised a variety of methods to minimize agricultural risks associated with the impact of high temperatures and low rainfall on the soil ecosystem in their respective farms. It was found that the most dominant strategies that are utilized by farmers to improve soil fertility and retain soil moisture include in their drought prone environment include the use of chemical and organic fertilizers as well as intercropping. These strategies were deemed effective in improving the status of cropping and the dietary needs of subsistence agriculturalists in Mphego in their dire climatic conditions, although some were seen to lead to maladaptation.

Chemical fertilizers

The utilization of chemical fertilizers by subsistence farmers in Mphego sufficed to be a modern agricultural practice that is integral to their drought adaptation efforts. As these farmers are confronted with dry land conditions and a shorter growing season owing to rainfall variability in their local environment, four of the thirteen interviewed farmers were found to be more inclined towards the use industrially manufactured fertilizers to necessitate the boosting of soil fertility as well as their annual crop yields. Access to financial capital proved to be a significant livelihood asset that crucially improved the drought adaptive capacity of these farmers by necessitating their access to industrially manufactured chemical fertilizers. Farmers who opted to use chemical fertilizers were seen to obtain

higher monthly earnings from their on-farm activities as well as off-farm financial sources (such as social grants, remittances and wages) which enhanced their ability to invest in and purchase chemical fertilizers from the local markets. This finding is in consonance with a study by Atube et al. (2021) which showed that sufficient access to financial capital influenced long-term planning and adoption advanced agricultural technologies by farming households in climate change adaptation.

Although farmers in this study were found to be sometimes faced with constraints in accessing these fertilizers due to their price increment, they showed a strong interest in using and investing in compound fertilizers as opposed to organic fertilizers. This finding corresponds with the works of Bagagnan et al. (2019) which found that farmers in Gambia perceived chemical fertilizers as the best climate change adaptation measure in comparison to natural fertilizers. In this study, the farmers' preference of chemical fertilizers stemmed mainly from their belief that in addition to improving soil fertility, they are crucial in speeding up the growth process of their crops and ensuring healthy and larger crops in their water scarce environment marked by a short growing season. Some farmers explicitly said that,

> *As we experience low and unpredictable rainfall in this area, it is important that plant growth be promoted at a faster rate to cope with the drought period. For maize crops I highly prefer applying compound D as well as ammonium nitrate fertilizers. I apply compound D fertilizers directly to the soil during the sowing season. This fertilizer is important in promoting the growth of maize at a faster pace as well as promoting soil fertility for the next growing season. I then use the compound X top fertilizer aid in development of the maize crop. This fertilizer normally results in larger and healthier maize crops that we can subsist on or sell* (Respondent 13, September 2022).

The above remarks clearly indicate that the utilization of chemical fertilizers has been deemed by farmers to have made significant contributions in improving crop yields and soil fertility in the absence of sustainable rainfall, thus providing them with enough yields for family consumption and marketing. This result is in line with the findings of Fadina & Barjolle (2018), Bagagnan et al. (2019), Ramborun et al. (2020) Rankoana, (2022) which indicated that adaptation to drought conditions by smallholder farmers in Benin, Gambia, Mauritius and in Limpopo province, South Africa was influenced by the rate at which they preferred their crops to grow, as such, chemical fertilizers were seen as an essential component in maximizing the chances of resilient crop production.

A deeper analysis of these study findings revealed that, despite the acknowledged benefits of inorganic of the utilization of inorganic fertilizer by smallholder farmers in the study area, this form of drought adaptation produces an unintended maladaptive outcome. A few farmers indicated that in some instances, overuse of fertilizers in drought adaptation can adversely impact on their crops and therefore household food and income security. This observation was made by smallholder farmers who witnessed 'chemical burns' on their crops following the intense application of fertilizers during extremely low rainfall periods, resulting in the premature exhaustion and death of the crops. As one farmer put it,

> *Having been a farmer for more than twenty years, I think adapting to drought using chemical fertilizers is better in improving crop yields within a short period of time in comparison to animal manure. I use compound A or N lower dressing fertilizers to promote higher yields of crops such as tomatoes, onions and other vegetables. However, the overuse of these fertilizers especially when there is low rainfall can burn the crops which impacts their overall growth. With this challenge, it's always safe to use them with supplementary water sources* (Respondent 4, September 2022).

Despite the shortfalls associated with the utilization of synthetic fertilizer in drought adaptation, the overall results of this study indicated that synthetic fertilizer was the most preferred crop yield enhancing mechanism by subsistence farmers in the study area, over organic fertilizers such as animal manure, and composts for several reasons. Firstly, as shown in the above discussion, farmers reported that the use of compound fertilizers has improved crop yields in maize and other crop varieties in low rainfall periods because it is vital in speeding the growth process of these crops. Additionally, organic fertilizers were said to increase crop pests due to the nature of their origin, resultantly, farmers avoided the use of animal manure and composts to reduce crop yield losses associated with attack by pest attacks and diseases. Moreover, farmers indicated that organic fertilizers were less readily available in comparison to synthetic fertilizers and sourcing such manure that would cater for the sizes of their farms would undoubtedly be laborious. This result greatly corroborates with the findings of a study conducted in Gambia by Bagagnan et al. (2020). Importantly, in this study, chemical fertilizer proved to be a cash-intensive agricultural output, making affordability an important determinant for its usage in drought adaptation among the study participants.

Organic fertilizers

Seven of the thirteen interviewed subsistence farmers are making use of the organic fertilisers to abate the implications of high temperatures and low/erratic rainfall on their farms' soil ecosystems. The study findings point that exorbitant market prices, cash constraints and lack of credit was the biggest obstacle towards the usage of synthetic fertilisers among the majority of the historically marginalised subsistence farmers in Mphego who are largely under resourced. Due to these indefinite circumstances, these subsistence farmers have had to devise auxiliary practices that improve soil fertility and moisture in the semi-arid space they occupy and generate livelihoods. One such example is the use of organic fertilisers, which shows a purposeful attempt on part of the farmers to adapt to drought through the utilisation of locally accessible resources that are more affordable compared to synthetic fertilisers. For example, one farmer clearly articulated that,

> *The problem with compound fertilizers is that they are expensive, compared to the natural fertilizers. This year, the price of a 10 kg bag of gypsum that we use on our ground and round nuts is roughly R350.00 and up from R250.00 in the previous year. A 50 kg bag of compound D or X that you can use on maize and other grass crops is about 650.00 to R800.00. Many of us here cannot afford these prices. This is why you see many farmers using organic fertilisers which are cheap and readily available here* (Respondent 9, Septermber 2022*).*

This narrative is consistent with other studies conducted in Zimbabwe and South Africa's Limpopo province respectively which found that most farmers who used organic as a soil conservation practice likely experienced financial difficulty in accessing synthetic fertilizers (Hart & Vorster, 2007; Svotwa et al., 2009). This therefore illustrates the notion that using organic farming as a technique for drought adaptation can benefit rural smallholder farmers who lack the purchasing power of industrially manufactured fertilizers (Svotwa et al., 2009, Chineka, 2020).

In this study, the use of organic fertilizers by economically disadvantaged subsistence farmers is a clear indication of the importance and role of natural capital in sustaining their livelihoods in the face of drought. The use of organic fertilizers emerged to be an indigenous farming practice that is influenced by the subsistence farmers' understanding of their local environment, its natural resources and their use these resources to generate local solutions or subaltern remedies to improve crop yields in the face of their context specific drought conditions that they have consistently observed and interpreted overtime. Interestingly, research conducted by Salick & Byg (2007) also confirmed that

indigenous societies have historically and continue to make use of biodiversity to protect themselves from environmental catastrophes.

Composts made from animal manures, plant residues, charred ash and other natural wastes were found to be the most popular type of organic fertilizer used by subsistence farmers in the study area. The farmers indicated that they practice the mulching technique, where they spread a thin layer of compost manure over the topsoil of the planted crops. This is primarily done using manual labour and simple garden tools such as hand hoes, shovels and garden forks. The process of mulching was reported to be time consuming and labour-intensive. Although the study results revealed that land holding and cropping responsibilities are biased towards men, the application of organic fertilizers on crops using the mulching method was found to impact the division of labour within the family structure of subsistence farming households. It required women (and children) to contribute more to this farming activity, thereby placing an additional burden on women who because of their traditionally ascribed gender role are expected them to perform other household tasks. The farmers articulated that practice of mulching is normally carried out shortly after planting and may be repeated at different stages of the growth of the crop. This was deemed critical in creating a conducive environment for crop growth during the dry season, particularly, soil moisture retention, soil temperature regulation and improved soil fertility. The following comment from the farmer significantly backs this finding,

> *The rains have not been so kind to us in recent years, and the price of fertilizers is very high. Despite these challenges we need to be productive on land because our families depend on agriculture for food and survival in general. Most farmers now spend a lot of time making composts with different organic materials that are readily available in our households, farming systems and the surrounding environment. These include maize stalks and other crop residues from previous harvests, grass, leaves, kraal manure and ash remains from cooking. Considering the dry spells, we often experience during the farming season; a lot of farmers are now protecting their crops with compost mulch to reduce the rate of water evaporation from the soils and to increase soil organic matter. This farming method has promoted some notable crop yields increases in my household and I would like to believe for other as well* (Respondent 10, September 2022).

The study results further revealed the significant influence of social capital in the adoption of organic fertilisers among the subsistence farmers. Empirical literature has shown that collective social action and farmer-based networks positively impacts the choice of climate adaptation practices utilized by farmers (Deressa et al., 2009; Ubisi, 2016; Thamaga-Chitja & Tamako, 2017). Speaking to the findings

of this study, the use of compost mulch by rain-fed smallholder farming emerged to be a collective intervention practice against drought. Due to their inability to purchase fertilizers from the market in recent years, some farmers claimed that they began using organic mulch to improve their poor fragile soils into productive agricultural land after learning about its advantages through their trust-based social interactions with other farmers in their community.

> *Through m interactions with other farmers in this area, including my neighbours who have been involved in subsistence agriculture for many years, I, learned about the benefits of using organic mulch in this area where drought is a problem. I have been doing this for the last eight to ten years and I'm very happy to say that it has proved helpful to the crops. The only problem with organic mulch is that it attracts pests and worms, but not at all times. Besides, one can always inspect and treat the organic fertilisers before using them* (Respondent 6, September 2022).

As a result, as subsistence farmers in Mphego are faced drought and financial challenges in accessing modern synthetic fertilizers, organic fertilizer, which is a component of the subsistence farmers' indigenous farming practices, has been recognized as a viable method in boosting crop yields in dry season farming because it improves soil fertility and retains moisture. These results are consistent with a study conducted by Aniah et al. (2019) which found that smallholder farmers in the savannah agro-ecological zone in Ghana adapted to drought and declining soil fertility challenges using indigenous agronomic practices such as organic compost and manure. However, in this study, farmers had to be vigilant in pest and disease control because organic compost was seen to exacerbate crop and disease problems compounded by the drought.

Interestingly, the utilization of organic fertilizers as an alternative to synthetic fertilizers in climate change adaptation as seen among some subsistence farmers in Mphego, has been identified in literature as a climate smart adaptation pathway. Drawing from the FAO report of 2011, organic farming reduces the vulnerability of agrarian communities to climate change, while also mitigating anthropogenic climate change through the reduction of greenhouse gas (GHG) emissions. This entails that organic agriculture is a long-term drought adaptation strategy that encourages the development of sustainable rain-fed agricultural systems that allow subsistence households to meet their food requirements without jeopardizing the capacity of future generations to meet theirs (Brodt, 2011).

Intercropping

The study findings showed that ten of the thirteen interviewed subsistence farmers have adapted to drought through intercropping, where they grow a variety of crops on their small pieces of land to maximize crop yields and to improve soil fertility. Intercropping was found to be indigenous agricultural practice that is deeply embedded in the broader social and cultural context of the Mphego community. The subsistence farmers unequivocally proclaimed that the intercropping agricultural practice was used by their forefathers to adapt to the environmental constraints of their natural environment, and it continues to form an integral part of their farming activities after many generations of use. Through socialization of different normative and agricultural practices, subsistence farmers in Mphego have internalized the importance of intercropping practices as part of their farming practices and cultural heritage. They have over the decades conserved different indigenous crop varieties and diligently mastered crop combinations that are suitable in keeping agricultural production afloat in an environment where they operate on small sized infertile agricultural lands which are susceptible to pervasive droughts.

In this view, the embrace of intercropping as a drought adaptation strategy by subsistence households was greatly determined by a combination of the physical and human capital resources at their disposal. Farmers were able to complement their physical capital resources particularly the small plots of land and soil type available to them with their human capital i.e., their agricultural expertise to effectively implement the intercropping combinations that are tailored to sustain their livelihood and food security needs in the face of drought. As seen in figure **5.2.1** below, the intercropping technique that is dominant among subsistence households in the Mphego involves the growing of maize as the main crop along with other selected crop species, particularly leguminous crops such as groundnuts, round nuts, cowpeas and beans. Pumpkin leaves are at times added to the combination, depending on the farmer's preferences.



Figure 5.2.1. Intercropping practices by subsistence farmers in Mphego **(Source:** Fieldwork photos by researcher, March 2023)

Farmers in Mphego value the intercropping of these crops as opposed to mono-cropping (the growing of a single crop type of a piece of land). They argued that crop species diversification is endowed with the capacity to guarantee them with some good agricultural yields in the context of drought and are more efficient on their relatively small pieces of land of less than 2 hectares. As one farmer put it,

> *Our land is too small to focus on growing just one crop. I grow maize and round nuts on the same piece of land because both crops can live together and give us a steady harvest in this drought. Let's say one crop fails, I'm still going to get some yields of other crop. This provides my family with some food to eat, something which would be hard to achieve if I only focused on growing one of these crops* (Respondent 4, September 2022).

The study findings further revealed that intercropping was seen by farmers to be an environmentally sustainable farming practice vital in assisting them to sustain crop production in drought conditions with the minimal use of chemical fertilizers. In addition to improving crop harvests, the farmers pointed that another advantage associated with the intercropping of maize and legumes is promotion of soil fertility and favourable conditions for plant growth, due to observed increases in soil organic matter. Interestingly, a similar study by Kom (2020), which was also conducted in Vhembe district in Limpopo, revealed that mixed cropping was deemed essential by rural smallholder farmers in adapting to prolonged and unpredictable dry spells. This is because these crops are perceived to be "green manures" that increase soil fertility by fixing the nitrogen content in the soil (Kom, 2020, p. 90).

Adapting to rainfall variability using the intercropping method is also very popular among subsistence farmers in other SADC countries such as Malawi (Stringer et al., 2009).

In overall, the findings show that the intercropping of grass/cereal crop and legumes is a long-term and ecologically sustainable adaptation strategy. This is because it naturally minimizes agricultural risks associated with drought particularly low crop yields and limited soil infertility, thus improving security of vulnerable subsistence farming households in Mphego with the minimal use of carbon emitting synthetic fertilizers. Therefore, unlike mono-cropping which has been reported in literature to degrade soils, encourage high use of chemical fertilizers that pollute the environment and contribute to anthropogenic climate change (Slavikova, 2019), intercropping can enhance the resilience of rain-fed subsistence farmers in Mphego to future droughts given that it promotes an eco-friendly drought adaptation pathway.

Rainwater harvesting (RWH) methods

Macro-catchment (ex-situ) RWH techniques

Evidence from the fieldwork suggests that despite some efforts by the state in the implementation of water reform programmes in Mphego and surrounding villages through the construction of Nandoni dam, the transformation of a water infrastructure in this black dominated rural community remains a utopia or what Kemerink et al., (2011) refers to as the 'pipe-dream'. This clearly shows that water governance in post-Apartheid Africa continues to be skewed along racial lines even after almost three decades of democratic dispensation. The subsistence farmers reported that they do not benefit much from the Nandoni water plant because they lack access to a steady supply of water. They only get running tap water after every three to four days or even weeks, which significantly undermines their water dependent livelihoods. Drought has been seen to converge with this structural challenge to reproduce an additional water crisis among these rain-fed subsistence farmers in Mphego village.

Nonetheless, these subsistence farmers have been seen to defy these structural and ecological challenges to sustain the production of their crops and livelihoods. They have progressively implemented various macro-catchment (ex-situ) rainwater harvesting techniques as a long-term adaptation strategy to avert the pressures of intra-season dry spells and water scarcity on their rain-fed cropping activities. By definition, macro-catchment rainwater harvesting involves the collection of runoff water from roof tops, land surfaces and rock catchments etc. into storage reservoirs as a supplemental water source to sustain crop production (Biazin et al., 2012; Kiggundu et al., 2018).

Subsistence farmers in Mphego were found to be using electric powered borehole systems and free standing jojo tanks to harvest and store runoff water. These are modern industrially manufactured agricultural inputs that can only be accessed through markets. Hence, the farmers' financial capital greatly influenced the choice of macro-catchment water harvesting techniques they each adopted in adapting to and achieving a positive livelihood and food security status in the context of drought.

Four of the thirteen interviewed subsistence farmers with sufficient financial resources were found to have constructed an alternative self-supply electric powered borehole water infrastructure in their homesteads given the unreliable municipal water supply. These boreholes also allowed farmers to easily access and store the groundwater recharged by the rain in their tanks, thus providing them with a steady supply of water for crop irrigation and domestic use all year round especially when faced by mid-season dry spells. However, financial constraints resulted in one farmer sourcing their water directly from the drilled borehole pipes in their homesteads as shown in **figure 5.2.2** below.



Figure 5.2.2. Macro-catchment rainwater harvesting techniques by subsistence farmers in Mphego **(Source:** Fieldwork photo by researcher, September 2022)

On the other hand, nine of the farmers were found to be using Jojo tanks as a storage reservoir for water collected from distant water sources such community boreholes, streams, hot springs as well as rainwater harvested from roof tops. This technique has become increasingly popular among

subsistence farmers with limited financial resources to drill electric boreholes as it is cost-effective. It was observed during the field work that the tanks are strategically located close to the homestead garden. Water is fetched from using a bucket or a jerry can and ferried to the garden for irrigation or directly irrigated from the tank through horse pipe. This has proved beneficial to the farmers by providing them with enough water for supplementary crop irrigation especially during the dry spells, which according to the subsistence farmers has enhanced crop yields especially of horticultural crops that require a require a regular and steady supply of water. This finding thus corresponds with other studies by Biazin et al. (2012) and Kiggundu et al. (2014), which confirmed the use supplementary irrigation from ex-situ systems to a credible water source in improving agricultural output in rain-fed agricultural systems in SSA especially during inter-season and intra season dry spells.

Micro-catchment (in-situ) rainwater harvesting

Farmers were also found to be employing micro-catchment (in-situ) rainwater harvesting which involves the collection of rainwater in the cropping field to promote a prolonged concentration and infiltration of runoff water in the soil (Biazin et al., 2012, Kiggundu et al., 2018). The raised-bed in-situ RWH technique, also popularly known as the ridge and furrow planting was seen to be practiced by five of the thirteen interviewed subsistence farmers to facilitate the survival and growth of rain-fed crops during mid-season dry spells. The results obtained from Mphego indicated that raised-bed farming is likely a modern agricultural practice that is linked to colonial history of this society. The subsistence farmers indicated that they historically used the raised farming practice to facilitate the production of root crops such as sweet potatoes and potatoes that require adequate soil moisture. However, they have in recent years transformed the usage of this farming practice as they seek to improve crop yields in their drought prone agro-ecological zone.

The farmers reported the most common challenge associated with the drought is that it leads to the poor performance of all crop species leading to low yields and starvation. As such, they have exercised their agency and came up with rational steps to mitigate this challenge. These farmers alluded that they no longer practice the conventional flat planting. For them, raised bed farming, which involves minimum tillage is a better alternative with a promising breakthrough in upgrading and ensuring the survival of their crops during seasonal dry spells.

The subsistence farmers were seen to employ a combination of human and physical livelihood capitals in adapting the use of raised beds in their drought mitigation efforts. In terms of human capital, the farmers used their understanding of different crops, their soil types, landscape, climatic conditions in

which they operate in to adjust their farming practices and scale up the construction of raised beds in response to drought.

As seen in **figure 5.2.3** below, farmers have managed to adapt to the use of raised beds that can be watered and fertilized using organic and chemical fertilizers to other crop varieties they once grew using the conventional flat planting method. These include maize, tomatoes, beans, round nuts and ground nuts.

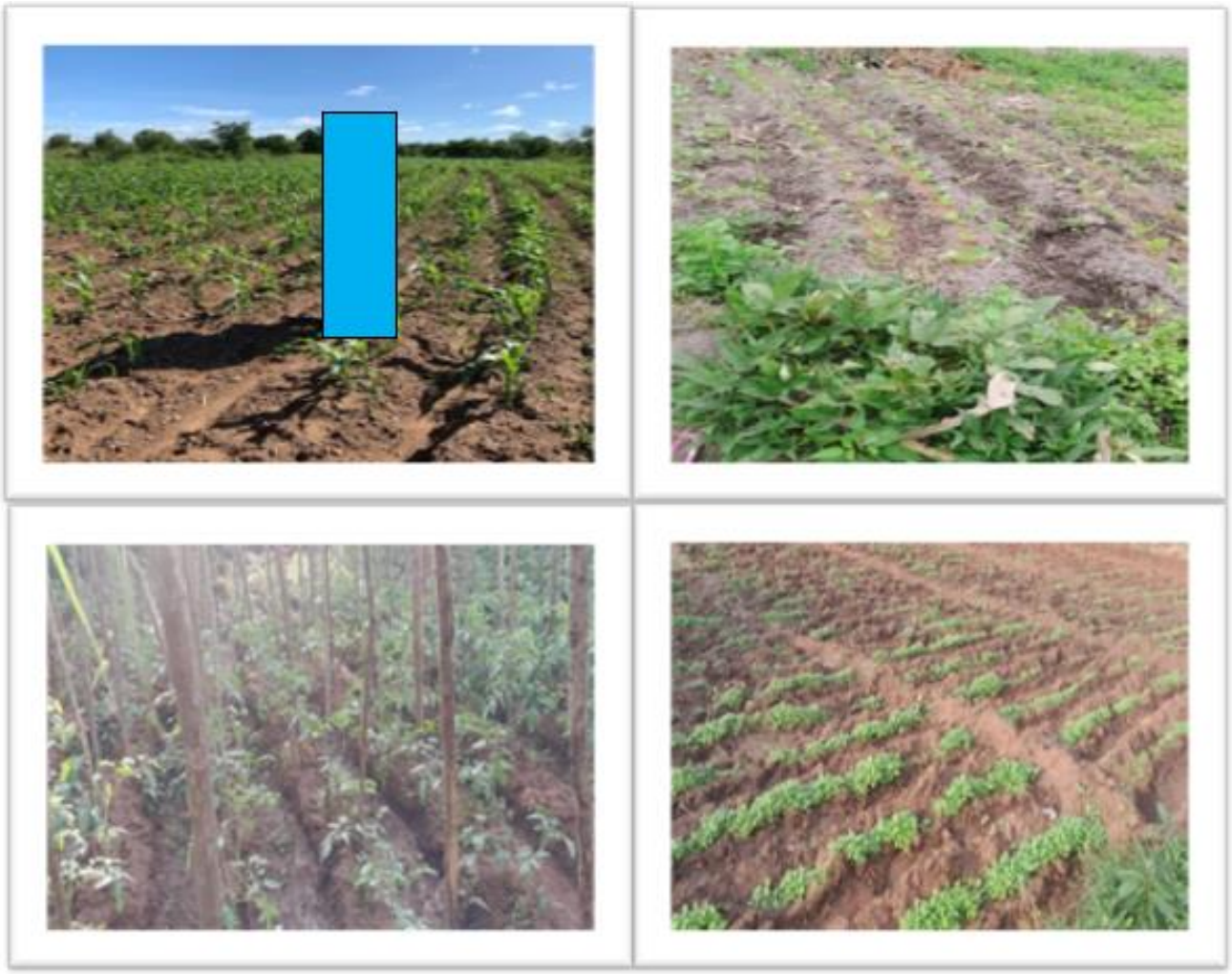


Figure 5.2.3. Raised bed farming practices by subsistence farmers in Mphego **(Source:** Fieldwork photos by researcher, January 2023)

The study found that the subsistence farmers' physical capital was necessary in the construction and maintenance of the raised beds. As farmers experience challenges in accessing tractors, they were found to be either use hand hoes or draught power to mount soil beds separated by furrows, all of which varied in size across farmers all depending on their preferences. The process of making and

maintaining the beds was reported to be labour-intensive. As such, farmers were seen to rely on workforce that encompasses family and wage labourers sourced from the community. The use of both family and wage labourers in implementing this in-situ RWH practice was seen to bolster social cohesion and also to build drought resilience among the subsistence farmers.

The farmers acknowledged that apart from the obvious benefits of raised bed farming i.e., preserving soil moisture for crops and particularly legumes that reproduce under the soil, it is also an innovative water retention technique that has crucially promoted higher yields other crop varieties they previously produced using conventional flat planting method. This is because during the rainfall season, the furrows on each side of the farming bed have an added advantage of collecting and preserving a considerable amount of rainwater – prolonging the periods of soil moisture availability in the farming beds, thus creating favourable conditions for plant growth when confronted with intra-season dry spells in the farming period. This was clearly explained by some of the farmers as follows,

> *In this area, rainfall is very low and unpredictable, and this is impacting our cropping activities. Raised-bed farming has helped me a lot. I mainly use this farming technique on maize, and it has boosted crop yields to eat and to sell in comparison to when I planted this crop on the flat surface. The trenches between the farming beds trap a lot of water when it rains, which provides a lot of soil moisture to the beds to sustain crop growth for a longer period especially when it stops raining for some time* (Respondent 8, September 2022).

This finding demonstrates that raised bed planting (ridge and furrow planting) is a significant micro-catchment rainwater harvesting technique that has helped some subsistence farmers in Mphego to address crop failures related to intra-season dry spells, something that was thought to be difficult to achieve using the conventional flat surface planting. As shown in the interview narrative, raised bed planting has been acknowledged to increase the annual yields of maize which is the staple crop of subsistence farming households as well as other crop varieties such maize, tomatoes, beans, round nuts and ground nuts. This has therefore provided them with enough food to supplement their dietary needs, while also ensuring some economic returns. This discovery corroborates with prior studies conducted by Ndlovhu et al. (2020) and Kruger et al. (2021) which revealed that adoption of the ridge and furrow in-situ RWH method significantly improved the food security and crop yields of smallholder farmers in Zimbabwe's drought prone district of Gwanda and semi-humid regions of the South Africa's Limpopo province and Eastern Cape.

Overall, this study revealed that less farmers used the raised-bed in-situ RWH method. The main reason being that some farmers perceived them to be labour-intensive. In this regard, there is a need for adequate external support from agricultural extension services in upscaling the implementation of in-situ RWH. If these practices are properly utilized by the farmers, they can surely sustain their livelihoods in their drought prone environment. This is because they hold a great potential to stabilize crop yields while also ensuring food security and economic returns among subsistence farming households.

Diversification of indigenous and hybrid crop varieties

This study confirmed that as rain-fed subsistence crop farming is greatly impacted by increased temperatures and unpredictable prolonged dry spells, seven of the thirteen interviewed subsistence farmers have been logically determined to improve and stabilize their crop yields by integrating the production of locally adapted indigenous crops with modern hybrid crop varieties. This finding corroborates with a study by Kurukulasuriya & Mendelson (2008) which revealed that African farmers adjust their crop choices in adapting to their local climatic conditions. From analysing the findings, it was established that youth subsistence farmers were the driving force towards the utilization of hybrid seeds to complement indigenous crops as a drought coping mechanism. This hypothetically informs us that young farmers by virtue of their age and high literacy levels have better access to information technology and are willing to take advantage of technologically advanced modern agricultural inputs. Importantly, these young have taken it upon themselves to educate the elderly farmers about the associated benefits of hybrid seeds especially in drought adaptation.

These new reflections coming from the youthful farmers have built on the indigenous farming practices that already exist in the community to advance a hybrid approach to drought adaptation. This clearly highlights the importance of age in social reproduction and the accumulation of human capital i.e., the transfer of knowledge and skills among farmers of different age groups in responding to challenges that threaten the subsistence agricultural economy including ecological ones. As such, both young and elderly farmers have been found to be now cultivating hybrid crop varieties together with some indigenous crop species that they have preserved for many years to increase production in the face of drought. So, we begin to witness some kind of evolution in the subsistence agriculture economy and a transfer of knowledge across the different generations.

The subsistence farmers generally agreed that indigenous crop varieties are tasty and nutritious but are low yielding and have implications on their household food security due to their high vulnerability to

heat stress and water scarcity. As such, key to their drought adaptation efforts and the quest to enhance their household food security, these subsistence farmers have supplemented the production of indigenous crop varieties with hybrid crops such as the Pan 53 and ZM401 maize varieties, orange-fleshed sweet potatoes (OFSP) as well as cabbage, cowpea and bean genotypes. This is attributable to their higher yielding performance and drought tolerance owing to their early maturation and less water requirements, which allows and enhances their adaptability to the shortened rainfall season. A similar study by Kom (2020) also found that rural smallholder farmers in Vhembe district, Limpopo are overcoming the impacts of drought through the growing hybrid crops because they provide a comparably greater yielding in comparison to traditional crops. Therefore, in this study, hybrid crop varieties were seen to provide farmers with twice the normal crop output with less water requirements compared to some indigenous crops. As some farmers put it,

> *Growing hybrid crops together with our indigenous is a good strategy. These crops have a higher chance of surviving drought conditions because they grow faster and require less water and a short rain season to produce compared to some of our indigenous crops. Hybrid crops have allowed me to prosper, I can safely say that I get two times the harvests of someone who only specializes in growing traditional crops. Even now you see that and some farmers who at first doubted hybrid seeds are now growing them because they do increase crop yields a lot* (Respondent 9, September 2022).

The results therefore suggests that the diversification of indigenous and hybrid crop varieties is important in reducing crop failure in rain-fed subsistence farming systems in Mphego, an agro-ecological zone with shorter rainfall season given their ability to withstand moisture and heat stress. Therefore, providing subsistence households with modest yields, thus buffering them against household food insecurity and income shortages. The idea of using drought resistant crops is popular in the SADC region. Vincent et al. (2013), confirmed that farmers in Zimbabwe are increasingly growing indigenous grains like sorghum, finger millet and rapoko, while cassava is becoming popular in Zambia because of its drought resistant qualities. The only difference with the findings of this study is that farmers are adapting to drought by also being receptive to hybrid crop varieties introduced as part of the fundamental production inputs to modern agriculture. In this context, Angula et al. (2012) established that climate change vulnerability among smallholder farmers can be reduced through adequate access to a wide range of appropriate technologies.

Crop pests and disease management

The findings have shown that subsistence farmers in Mphego have been regularly monitoring their agricultural activities and employing various control measures to reduce crop yield losses associated with pests and pest borne disease compounded by the prolonged drought on their rain-fed farming systems. The study findings clearly show that the subsistence farmers' urgent need to enhance food production through the eradication of crop pests on water and heat stressed crops has greatly triggered the use of industrially manufactured chemical insecticides among four of the interviewed farmers. This adaptation pathway is reflective of modern agricultural practices that hinge on chemical pest control measures in enhancing crop productivity (Altieri, 2011), as opposed to other pest management practices such as the use of bio pesticides. This result echoes a review by Opio (2021) who argued that climate change and variability has prompted the increased use of chemical pesticides among smallholder farmers in some countries in Sub Saharan Africa as a strategy to improve their resilience. This is the typical situation in Benin, South Africa's Limpopo province, Zimbabwe, Mauritius and Uganda (Fadina & Barjolle, 2018; Phophi, 2018; Zinyemba et al., 2020, Ramborun et al., 2020; Atube et al., 2021).

In this study, the farmers were seen to have devoted a considerable amount of financial resources towards the purchasing of insecticides and herbicides on the market. The most common insecticides used by farmers are Cyperfos 500 EC, Steward and Matador. Farmers were found to employ a 'timed application scheme' where they apply insecticides to their crops at regular intervals within a certain time frame. Nonetheless, the rate of application differed across subsistence farmers all depending on the availability of insecticides in each household as well as the severity of the pest and pest borne disease on their respective farmers. The majority of the farmers in Mphego said they favoured employing chemical pest and disease management techniques. The farmers claim that the use of insecticides has allowed for an improvement in agricultural yields owing to their greater ability to reduce the prevalence of harmful pests responsible for destroying their crops within a short period of time. This was aptly explained by some of the farmers as follows,

> *Our crops are being affected by pests because of this drought. Crop pests have always been there, but drought has made them worse. My vegetables are affected by aphids here we call them* ***nnda****. I apply Cyperfos 500EC to get rid of the aphids from the vegetables. I also use a pesticide called Steward to get rid of pests like the fall armyworm that mostly affects the maize crop. The main factor that determines the amount of pesticide that I apply on a particular crop is the population of the pest and the potential damage that it is likely to cause. I normally apply pesticides once in three weeks but*

> *given the increased population of pests as was the case in the past years and even now, I apply pesticides twice in three weeks. I apply these pesticides using a handheld spray or sometimes the sweeping method using a broom. This not only kills them but also removes them from the plant itself. Sometimes when the times are tough and I do not have enough money to purchase pesticides, I use vinegar. Yes vinegar. What I do is mix it 50/50 with water and we spray it on the crops, it works just like the pesticide from the store* (Respondent 11, September 2022).

This finding indicates that the application of synthetic insecticides as a drought adaptation strategy has greatly reduced the damage caused by pests on water and heat stressed crops. The farmers have acknowledged its pivotal role in improving their total crop harvests, thus benefiting these subsistence farming households in terms of food and monetary requirements. Despite the noted benefits associated with synthetic pesticides a further examination of the study findings reveal that these benefits are short term. As highlighted by the narratives from Mphego, some subsistence farmers are sometimes pressured to increase the frequency and dosage of insecticide application with the motive to boosting crop yields. This adaptation approach may result in maladaptation to future droughts because it undermines the promotion of sustainable and resilient agricultural systems, which is worrying because agriculture is a vital source of livelihood for subsistence farming households in the study area.

This finding is supported by a number of studies that found that the farmers' poor use, overreliance, and exploitation of synthetic pesticides disrupts the agroecosystem over time by fostering the development of pest and disease resistance, poisons delicate ecosystems, poses a threat to farmers' health due to exposure to toxins and contributes to anthropogenic climate change due to GHG emissions (Lundvist et al., 2008; Zinyemba et al., 2020). Owing to these observations, FAO reports including the recent one from 2023 has advocated for farmers to be educated about and empowered to adopt ecologically sustainable Integrated Pest Management (IPM) practices which is a combination of biological, physical, chemical and cultural methods, and minimize their overreliance on synthetic pesticides. In this study, this calls the need for agricultural extension officers to educate and provide sufficient training to smallholder farmers how they can effectively adapt to drought using eco- friendly pest and control measures, this is crucial in enhancing their adaptive capacity to future droughts.

Finally, evidence from the data shows that nine of the subsistence farmers are complementing synthetic insecticides with bio pesticides as a possible effective solution to minimize crop losses to pests. The use of organic insecticides to supplement synthetic pesticides emerged as a viable pest management option used by low-income farmers, who are severely constrained and cannot afford to purchase

expensive chemical pesticides from the market all year around. Natural capital was seen to influence this adaptation decision. Based on their interactions with nature, the subsistence farmers have accrued knowledge about the locally available, cheap and accessible plant extracts with pesticidal properties. These include chilli, ginger, garlic, aloe vera, onions (among others). Farmers have been using concoctions of these pesticidal plants to alternate with chemical pesticides to reduce crop losses to pests. This interchange shows that the farmers rely on hybrid practices, constitutive of both indigenous and modern pest management practices to adapt to the environmental pressures they experience. The following sentiments from one of the farmers form the base of this argument,

> *Drought increases pest outbreaks and diseases on our crops. So, I use different methods to reduce crop losses to pests. I sometimes buy pesticides from local sellers and use them at least once every two months to repel common pests. The pesticides do not usually last long because I have to cover a portion of land on a constrained budget. Sometimes, I cannot afford the chemical pesticides because the price is exorbitant. I have to supplement chemical pesticides with organic plant-based pesticides. I'm familiar with these organic ones too. When I was young, my father taught me how to mix different plants easily found in our farming systems to address crop diseases and pests. I mix plants such as aloe vera, garlic and onion which I apply on vegetables and maize either using a spray bottle or the sweeping method repeatedly every two weeks to control the spread of aphids on vegetables, red spider mites in tomatoes and army worm in maize. This pesticide may not be as effective as the chemical ones, but it helps a lot in managing these pests* (Respondent 6. September 2022).

The findings show the interchangeable use of chemical and organic pesticides, as an effective way of combating pest outbreaks and diseases for poor subsistence farmers in the Mphego. Conventional literature often presents modern pesticide management practices, which are centred on the use of chemical/synthetic pesticides, opposed to other control methods as the most preferred pest and disease control option by most subsistence farmers (see for example, Fadina and Barjolle, 2018; Phophi, 2018; Zinyemba et al., 2020, Ramborun et al., 2020; Atube et al., 2021). The divide between the two showcases the cultural differences between modern agriculture and indigenous practices that are centred on organic crop pest and disease management practices. However, evidence emerging from the Mphego community illustrates that organic pesticides are used by farmers interchangeably with the chemical pesticides, particularly in the face of market constraints. Therefore, the interchangeable use of chemical and organic pest and disease management practices on crops, indicates that the two

are complementary and can coexist to build a hybrid drought resilience strategy for poor subsistence farmers.

5.3. Chapter summary

The study findings clearly demonstrated that autonomous adaptation has enabled rain-fed subsistence farmers to build and strengthen their resilience to drought. They have managed to successfully implement different drought adaptation strategies, despite lacking adequate drought relief support from the state. These adaptation strategies include alteration of cropping calendar, (ii) natural and artificial soil conservation practices (i.e., use of chemical fertilizers, organic fertilizers and intercropping), (iii) Rainwater harvesting (RWH) techniques, (iv) pest and disease control practices and (v) the diversification of drought tolerant hybrid crops and indigenous crop varieties. The adoption of these adaptation practices varied across farmers all depending on the livelihood capitals at their disposal. Although the implementation of these adaptation practices came with many challenges, these subsistence farmers acknowledged that they have played a crucial role in improving their household food security in the face of drought. The following chapter is the conclusion chapter, it will summarize the key research findings of this study.

CHAPTER SIX

Conclusion and Recommendations

6.1. Introduction

This chapter summarizes the key research findings of the study based on each research objective. The thematic areas to be covered in section one of the chapter are, drought impacts on rain-fed subsistence cropping practices and its convergence with state orchestrated socio-economic constraints to reproduce the farmers' vulnerabilities. Section two provides an overview of the adaptation strategies employed by subsistence farmers to mitigate the impacts of drought on crop production and the livelihood assets that inform their choice of adaptation practices. The chapter concludes with an evaluation of the effectiveness of the adaptation practices employed by subsistence farmers in mitigating the nexus of drought and other political and socio-economic challenges that undermine subsistence agriculture in Mphego. A few policy recommendations were drawn from this evaluation. In addition, the limitations of the study were articulated, which also shed light on avenues for further research on this topic, leading up to the final conclusions.

6.2. Drought impacts on rain-fed subsistence cropping practices in Mphego

The first research objective of this study was to investigate drought impacts on rain-fed subsistence cropping practices in the rural community of Mphego. The study findings revealed that rain-fed subsistence crop production immensely contributes towards the food and income needs of subsistence farming households in the research area. Nonetheless, the consistent scourge of drought on rain-fed subsistence cropping practices has posed to be a threat to both the food and livelihood sources available to the farmers.

Seasonal droughts were seen to have resulted in a shift of planting dates. The subsistence farmers attested that drought has compounded regular uncertainties in rainfall patterns. These include delayed rains, episodic dry spells in between the rain season and early flight of rains towards end of rain season. In Mphego, the uncertainties posed by drought have propelled precarious cropping patterns and a late planting season. However, participating in this seasonal gamble, has allowed farmers to survive each rain season and its dilemmas.

Secondly, it was reported that regular droughts were undermining rain-fed subsistence cropping activities by amplifying problems such as soil infertility and aridity in the research area. This study

discovered that the bulk of the soils in Mphego are loam and sandy soils, and they show signs of exhaustion. Drought trends associated with low rainfall and high atmospheric temperatures were reported to have further impacted the water holding capacity of these already poor and fragile soils, leading to loss of biodiversity and low crop yields.

The findings obtained from Mphego showed the combination of low rainfall and high temperatures provided breeding ground for crop pests such as aphids, diamond back moths and fall armyworms (among others) that attack crops in the dry and hot weather conditions. These pests were seen to impact the overall growth of crops, through the spreading of various diseases that cause stunting and wilting of crops. Although some subsistence farmers reported to be using insecticides to control crop pests, they also pointed out the financial costs, which at times are beyond their means. Therefore, resolving this challenge using modern agriculture inputs was cumbersome for most subsistence farmers due to financial constraints.

In overall, drought was recognized as one of the biggest impediments towards the achievement of food security Mphego. The combined impacts of induced penalties on rain-fed cropping practices such as late planting, increased soil infertility and aridity and crop pests were found to reduce the annual yields of the crops that the farmers are specializing in. Few examples of crops grown in Mphego are maize, beans, pumpkins cabbage, spinach, cowpeas, ground nuts, round nuts sweet potatoes, tomatoes and onions. Much of these crops were recognized as drought sensitive crops, meaning any susceptibility to drought, coupled with ecological stresses, had familiar effects, which are to decrease crop yields and increase the vulnerabilities experienced by the poorly resourced subsistence farmers in Mphego.

6.3. The interplay of drought and state orchestrated socio-economic constraints

The study also explored the intersection of drought with existing politically engineered social and economic constraints experienced by subsistence farmers in Mphego in reproducing their vulnerabilities. The results of this study explicitly demonstrated that drought vulnerabilities experienced by subsistence farmers in the rural community of Mphego (a former homeland area in Venda) and South Africa broadly should not be treated independently. Rather, they ought to be understood in light of other deeply intertwined state orchestrated socio-economic constraints experienced by rural subsistence agriculturalists in former homeland areas. This is because these structural factors tend to intersect with ecological challenges to exacerbate the manifold vulnerabilities experienced by subsistence farmers in former homeland areas, and these have merged for the larger part of South Africa's history. In this study, the articulation of the political was largely tied to inherited

colonial state developmental initiatives and capitalist practices in Mphego and South Africa as a whole, that have contributed in producing and reproducing socio-economic structures of deprivation that exacerbate the vulnerabilities of rain-fed subsistence crop farmers.

Throughout Mphego's history, the state was seen to engineer various forms of socio-economic inequalities, through the maintenance of the dual agrarian structure and its preference for commercial agriculture over subsistence agriculture. The results emerging from Mphego solidified that despite twenty-eight years (1994-2022) of democratic dispensation in South Africa, the ANC-led government has failed to decolonize the agricultural sector as it continues to be largely shaped by the longstanding legacies of Apartheid's segregationist policies. The government has continued to promote neo-liberal policies whose resource provision largely favour and benefit the white dominated large scale commercial sector, while neglecting the needs of smallholder farmers who predominantly black and are largely concentrated in former homeland areas. Such is the plight of the subsistence farmers in Mphego village.

This study revealed that the continued exclusion of subsistence farmers in the rural community of Mphego by the state from accessing resources that are crucial for agricultural development has exposed them to socio-economic inequalities that increase the farmers' susceptibility to drought. The farmers were found to experience social constraints such as tenure insecurity and insufficient access to arable land as a result of the colonial history of land dispossession in South Africa. The limited progression of the state in adequately addressing this historical injustice through its land redistribution programmes has left these subsistence marginal plots of land with poor fragile soils. The study findings highlighted that as a former homeland area, Mphego is susceptible to demographic imbalances that pose a serious threat to the environment. In ways similar to other former homelands, the soils and natural vegetation in Mphego show enduring signs of depreciation, due to population and density pressures that leaves the subsistence farming susceptible to the impacts of drought and other ecological challenges. These farmers also lamented that their drought vulnerability has been amplified by the failure of the state in providing them with sufficient access to basic social services that are crucial in improving their drought resilience such public water infrastructures and extension programmes.

The farmers were correct to point out that drought and other ecological vulnerabilities, have been amplified by state developmental initiatives that promote capitalist accumulation at the expense of peasant livelihoods. As the state has been facilitating the capitalist expansion of large-scale commercial agriculture in Mphego and bordering areas. This has left the subsistence farmers in Mphego and neighbouring areas exposed to both ecological and market volatilities. Given that the

majority of subsistence farmers in Mphego are unemployed and financially constrained. Their marginal position in the capitalist economy results in them being unable to invest in technologically advanced agricultural inputs such as irrigation infrastructures, tractors, hybrid seeds, chemical pesticides and compound fertilizers that could aid in cushioning them against drought. The lack of financial subsidies from the state has been seen to perpetuate the economic challenges experienced by these subsistence farmers by further excluding from accessing the aforementioned agricultural inputs, rendering them vulnerable to both market volatilities and drought.

From a theoretical standpoint, scholars that treat drought vulnerability as an independent variable are missing its linkage with the political, social and economic practices tied to state practices in a capitalist economy. As a result, the drought adaptation practices they recommend at both the theoretical and policy levels are one dimensional and bent on addressing the ecological consequences and not the background causes. Therefore, there is need for a much more holistic theoretical approach to understanding drought impacts in subsistence agriculture economies that are bedridden by capitalist expansion practices and state politics.

6.4. Drought adaptation strategies

The third objective of this study was split into two. Foremost, to identify the drought adaptation practices by subsistence farmers. Secondly, to evaluate the livelihood assets that shape farmers' adaptation strategies to drought. The findings showed that drought was a regular climatic condition that impacts rain-fed subsistence cropping in Mphego. The nexus of drought and subsistence agriculture was established to require urgent attention by the state. However, the state exhibited little interest in improving the adaptive capacity of rural smallholder farmers and to cushion them against drought. Lack of support from the state was seen to embolden farmers into exercising their own agency to cushion their crops from drought and other ecological disasters. From a theoretical and an empirical point of view, the study contributed to ongoing discussions on grassroots pathways to drought adaptation practices by subsistence farmers in developing rural communities.

Prior to the fieldwork, it was determined that an understanding of the drought adaptation practices, employed by the subsistence farmers in Mphego, was only possible through grasping how they (the farmers) perceive of the drought and the measures they need to come up with to off-set potential effects. Therefore, farmers' perceptions of their local drought conditions i.e., how they interpreted and understood drought trends in their immediate environment was crucial in their adaptation efforts. The most notable sign of drought mentioned by farmers was the change in seasonal rainfall patterns and

atmospheric temperatures. From these perceptions, they were able to socially construct short- and long-term adaptation practices to mitigate the impact of drought on rain-fed subsistence cropping practices, thus demystifying the idea of the skilled development practitioner having to be the one that maps out the climate change adaptation strategies in subsistence economies.

The drought adaptation practices employed by subsistence farmers in Mphego were found to be rooted in both modern and indigenous agriculture practices. As the farmers relied on their own agency in their drought adaptation efforts, this study found that the livelihood capitals that they possess served as the foundation for enhancing their adaptive capacity and informing their decisions for building resilience against drought. Hence, these drought adaptation practices were largely discussed in light of the sustainable livelihood framework and its forms of capitals that include: the human, social, natural, physical and financial capital. These were seen to enable farmers in Mphego to successfully undertake autonomous action in build sustainable food systems and livelihoods in the face of drought and other structural constraints that exacerbate their drought vulnerabilities.

The adaptation strategies that were reflective of the modern agricultural practices included the use of industrially manufactured chemical fertilizers to necessitate the boosting of soil fertility and crop yields. Ex-situ rainwater harvesting strategies using electric powered borehole systems and free standing jojo tanks as a means of supplementing rain-fed agriculture during periods of incessant dry spells as well. Lastly, the farmers were also found to be using chemical insecticides to reduce crop yield losses associated with pests and pest borne diseases compounded by the drought. As these technologically advanced modern agricultural inputs are highly capitalized, the farmers' financial capital proved to be a significant livelihood asset that necessitated their access to these farm inputs. Subsistence farmers who were able to invest in these modern agricultural inputs (particularly chemical fertilizers, electric powered boreholes and insecticides) were seen to obtain higher monthly earnings from their on-farm activities as well as off-farm financial sources (such as social grants, remittances and wages). This therefore revealed how the subsistence farmers' financial resource base has enabled them to build resilient food systems and enhance their household food security in their marginal rural setting where they confronted by drought.

The study findings further pointed that financial constraints and exorbitant market prices were the biggest obstacle for most subsistence farmers in Mphego when it comes to accessing modern agricultural inputs. As such, the subsistence farmers were seen to also rely on their indigenous agricultural practices to minimise drought impacts on their rain-fed cropping activities. The indigenous agricultural practices have been used by subsistence farmers in Mphego for generations and are deeply

embedded within their cultural structures. Examples of indigenous drought adaptation practices include the use of organic fertilizers such as animal manure, plant residue, charred ash and other natural wastes and intercropping practices for soil fertilization, as well and plant-based insecticides for pest control. These adaptation practices do not border on economic resources alone. As shown by the research findings, they encompass low external input sustainable agricultural practices centred on using locally available natural capital i.e., the stock their natural resources available to these subsistence farmers.

It was however revealed that there were no strict boundaries between indigenous and modern agricultural practices as they were seen to intersect and produce a hybrid approach to drought adaptation. For example, the study findings showed that subsistence farmers were complementing chemical insecticides with homemade plant-based pesticides to cushion crops from pests compounded by their local dry land conditions. This emerged to be a pest management practice utilized by the poorest farmers who cannot afford to purchase expensive chemical pesticides from market all year round. The adoption of this adaptation practice showed that livelihood capitals did not always function independently, rather there are instances where they interconnected as farmers engaged in their drought adaptation efforts. In this case, the farmers' natural capital was seen to function cohesively with the amount of financial capital they possess. The farmers were able to use cheap procurable plant extracts with pesticidal properties such as aloe vera, garlic, onion, ginger, chili, pepper that are locally available in their natural environment to complement chemical pesticides when faced with market constraints. This shows that the farmers have embraced using hybrid agricultural practices to adapt to pest outbreaks exacerbated by drought conditions.

6.5. Evaluating the effectiveness of the drought adaptation strategies

The study sought also to evaluate the effectiveness of farmer's adaptation practices in mitigating the nexus of drought and other converging politico-socio-and economic challenges that affect rain-fed subsistence crop production. An assessment of the drought adaptation practices that are being employed by subsistence farmers in Mphego revealed some positive outcomes when it comes to mitigating the different impacts of drought on rain-fed cropping activities. As the subsistence households in Mphego are faced with a precarious future as a result of their prolonged local drought conditions. Adapting to this ecological condition has been an avenue through which they have been able to remain relevant in the subsistence agricultural economy and to consistently meet the food and income needs of their families.

For instance, through adaptation strategies such as intercropping, crop diversification (hybrid and indigenous crop varieties) and macro-catchment and micro-catchment rainwater harvesting techniques (among others), these subsistence farmers were able to improve and maximize the annual yields of maize their crop, as well as other crop varieties such as such as beans, cowpeas, spinach, onions, tomatoes, groundnuts, round nuts and sweet potatoes etc. that constitute an integral part of their diets. This was seen to be providing them with enough food to supplement their dietary needs, while also ensuring some economic returns.

As a researcher, I was also able to draw that some of the adaptation strategies that are being utilized by these subsistence farmers are long term and ecologically sustainable. For example, soil conservation practices such as the use of natural composts and intercropping, as well as bio-pesticides for pest control emerged to be indigenous agricultural practices that are highly effective not only in mitigating the current impacts of drought on rain-fed subsistence crop production, but future droughts as well. These entail organic farming practices, which have been reported by FAO (2011) to be a climate smart adaptation practices that reduce the vulnerability of agrarian communities to climate change, while also mitigating anthropogenic climate change through the reduction of greenhouse gas (GHG) emissions. As such, these organic indigenous adaptation strategies were found to be crucial in encouraging the development of sustainable rain-fed agricultural systems that allow subsistence households in Mphego to meet their food requirements without jeopardizing the capacity of future generations to meet theirs.

However, since drought was seen to intersect with other existing politically engineered socio-economic factors that reproduce vulnerabilities experienced by farmers, it was noted that the farmers' agency alone may not be enough to mitigate the nexus of drought and the structural constraints that exacerbate the farmers' vulnerabilities. Even though these subsistence farmers are trying to adapt using their agency, they encounter socio-economic constraints with political implications that in most cases weaken their individual adaptive capacity. This therefore calls the need for state support in strengthening the drought resilience of these farmers. Based on this finding, several policy recommendations that are integral in sufficiently cushioning these subsistence farmers against current and future droughts have been made.

6.6. Recommendations

Financial capital was found to strongly the farmers' drought adaptation practices. It significantly improved the farmers' access to modern agricultural inputs such as chemical pesticides, fertilizers,

hybrid seeds and technologically advanced rainwater harvesting equipment. Since the majority of subsistence farmers in Mphego are poor and unemployed, the government should extend its financial support to these farmers and should consider collaborating with NGO's to assist with financial aid to improve the resilience of these rural subsistence to drought.

The policy makers should train and deploy more extension officers in Mphego to strengthen the social capital base of the subsistence farmers. The social networks between farmers and extension officers can potentially improve the farmers' drought adaptive capacity. It provides them sufficient access to information and relevant technologies that they can use to combat drought and other ecological challenges.

Moreover, the state should implement policies aimed at developing public water supply systems in rural households. It should also scale up the construction of communal water sources such as hand pumped and electric boreholes and strategically locate them in the proximity of the subsistence farming households for easy access. This is crucial in providing rural subsistence farmers with a steady supply of water they can use to supplement rain-fed agriculture during incessant dry spells

6.7. Limitations of study and suggestions for future research

This study was conducted over a short duration of two weeks. It focused on collecting rich anecdotal experiences using interviews, supplemented by observations made during data collection. Consequently, the study is a 'snapshot' into adaptation practices based on data gathered from Mphego over a short duration. Ideally, ethnographic observations made over a lengthy period have potential to provide longer-term observations, based on participation in the farmers' daily practices. This has potential to provide deeper perspectives about adaptation practices, and how they changed through time. Living in-situ gives the researcher an insider perspective about a people's agricultural practices and how they adapt to the ecological constraints of their local environments. However, these possibilities do not negate the validity of this study which was only concerned with understanding contemporary adaptation practices at Mphego. Future research may adopt a longer-term focused participant observation and ethnographic approach to broaden the range of conclusions possible.

Based on practical considerations, this study mainly focused on the views of farmers and excluded other stakeholders in the subsistence agriculture sector. Again, future research would widen the range and depth of observations by including more stakeholders in the research. Finding out how multiple stakeholders across categories such as traditional leaders, extension service workers, and among others,

agricultural specialists in government and Non-Governmental departments in Mphego and the broader Limpopo province has potential to increase knowledge of adaptation practices on the ground. Therefore, future studies should coordinate the efforts of different stakeholders.

REFERENCE LIST

Abaje, I. B., & Magaji, J. (2022). Farmers' perceptions of drought and adaptation strategies in Mashi Local Government Area, Katsina State, Nigeria. *Journal of Meteorology and Climate Science*, *21*(1), pp. 54-82.

Adger, W. N., Arnell, N. W., & Tompkins, E. L. (2005). Successful Adaptation to Climate Change Across Scales. In Global Environmental Change 15 (2), pp. 77–86. DOI: 10.1016/j.gloenvcha.2004.12.005.

AgriSA, (2016). A raindrop in the drought: Report to the Multistakeholder Task Team on the Drought – AgriSA's status report on the current drought crisis: Centurion: AgriSA.

Ajaz, A., Taghvaeian, S., Khand, K., Gowda, P.H. and Moorhead, J.E. (2019). Development and evaluation of an agricultural drought index by harnessing soil moisture and weather data. Water, 11(7), pp.1375.

Akinnifesi, F. K., Ajayi, O. C., Sileshi, G., Chirwa, P. W., & Chianu, J. (2010). Fertiliser trees for sustainable food security in the maize-based production systems of East and Southern Africa. A review. *Agronomy for Sustainable Development*, *30*(3), 615–629.

Ala-Kokko, K., Nalley, L. L., Shew, A. M., Tack, J. B., Chaminuka, P., Matlock, M. D., & D'Haese, M. (2021). Economic and ecosystem impacts of GM maize in South Africa. *Global Food Security*, *pp. 1-10.*

Aliber, M. (2009). Exploring Statistics South Africa's National Household Surveys as sources of information about food security and subsistence agriculture. Institute for Poverty, Land and Agrarian Studies. Human Sciences Research Council, pp. 1-68.

Aliber, M., Baiphethi, M., De Satgé, R., Denison, J., Hart, T., Jacobs, P., & van Averbeke, W. (2009). Strategies to support South African smallholders as a contribution to government's second economy strategy. *Volume 1: Situation analysis, fieldwork findings and main conclusions. Research Report number* (14), pp. 1-90.

Aliber, M. & Cousins, B. (2012). Livelihoods after Land Reform in South Africa. *Journal of Agrarian Reform*, (13), pp. 140-165.

Altieri, M. (2011). Modern Agriculture: Ecological impacts and the possibilities for truly sustainable farming. Agroecology in Action. Accessed at http://agroeco.org/wp-content/uploads/2011/02/ecol_impact_modern_ag.pdf

Amadhila, E., Shaamhula, L., Van Rooy, G., & Siyambango, N. (2013). Disaster risk reduction in the Omusati and Oshana regions of Namibia. *Jàmbá: Journal of Disaster Risk Studies*, (5), pp. 1-9.

Anderson, R. (2007) Thematic Content Analysis (TCA): Descriptive Presentation of Qualitative Data.

Angula, M.N. & Kaundjua, M.B. (2016), "The changing climate and human vulnerability in North-Central Namibia", *Jàmba: Journal of Disaster Risk St*udies, 8 (2), pp. 1-7.

Aniah, P., Kaunza-Nu-Dem, M. K., & Ayembilla, J. A. (2019). Smallholder farmers' livelihood adaptation to climate variability and ecological changes in the savanna agro ecological zone of Ghana. *Heliyon*, *5*(4), pp. 1-24.

Anley, Y., Bogale, A., & Haile-Gabriel, A. (2007). Adoption decision and use intensity of soil and water conservation measures by smallholder subsistence farmers in Dedo district, Western Ethiopia. *Land degradation & development*, *18*(3), pp. 289-302.

Apraku, A. 2015. Assessing Risk Perceptions, Vulnerability and Asset Adaptation in the Context of Climate Change: A Study of Peri-Urban and Rural East London and Port Elizabeth, South Africa. D.Phil. thesis, University of Fort Hare, Department of Sociology, East London, South Africa.

Archer, E.R.M., Oettle, N.M., Louw, R., & Tadross, M.A. (2008). Farming on the edge in arid western South Africa: climate change and in agriculture marginal environments. Geography, (93), pp. 98-107.

Asfaw, S., & Lipper, L. (2011). Economics of PGRFA management for adaptation to climate change: a review of selected literature. *Commission on Genetic Resources for Food and Agriculture. FAO, Rome, Italy*.

Ashley, C., & Carney, D. (1999). Sustainable livelihoods: Lessons from early experience. London: Department for International Development, 7 (1), pp. 1-55.

Atkociuniene, V., & Zemeckis, R. (2015). Characteristics of Modern Farm. *Research for Rural Development, 2*, 230-236.

Atube, F., Malinga, G. M., Nyeko, M., Okello, D. M., Alarakol, S. P., & Okello-Uma, I. (2021). Determinants of smallholder farmers' adaptation strategies to the effects of climate change: Evidence from northern Uganda. *Agriculture & Food Security*, *10*(1), pp. 1-14.

Averbeke, W., & Khosa T.B. (2007). The contribution of smallholder subsistence agriculture to the nutrition of rural households in a semi-arid environment in South Africa, 33 (3), pp. 413-418.

Babu, S., Gajanan, S.N. & Sanyal, P. (2014). Food Security, Poverty and Nutrition Policy Analysis: Statistical Methods and Applications. Second Edition, pp. 1-615.

Backeberg, G.R., & M.F. Viljoen. (2003). Drought management in South Africa. Paper presented at a workshop of the ICID Working Group on "Irrigation under drought and water scarcity', August 13-14, in Tehran, IR of Iran.

Bagagnan, A.R., Ouedraogo, I. & Fonta, W.M. 2019. Perceived Climate Variability and Farm Level Adaptation in the Central River Region of The Gambia. Atmosphere, 10 (7), pp. 1-12.

Baiphethi, M. N., & Jacobs, P. T. (2009). The contribution of subsistence farming to food security in South Africa. *Agrekon*, *48*(4), pp. 459–482.

Bassey, N. (2018). The climate crisis and the struggle for African food sovereignty in, *The Climate Crisis: South African and Global Democratic Eco-Socialist Alternatives.* Edited by Vishwas Satgar, Published Edition, Wits University Press, pp.190-208.

Baudoin, M.A., Vogel, C., Nortje, K. and Naik, M. (2017). Living with drought in South Africa: lessons learnt from the recent El Niño drought period. *International Journal of Disaster Risk Reduction,* (23), pp.128-137.

Benhin, J.K.A. (2006). Climate change and South African agriculture: Impacts and adaptation options. CEEPA Discussion Paper No.21.CEEPA, University of Pretoria, South Africa.

Biazin, B., Sterk, G., Temesgen, M., Abdulkedir, A., & Stroosnijder, L. (2012). Rainwater harvesting and management in rainfed agricultural systems in sub-Saharan Africa- A review. Physics and Chemistry of the Earth, Parts A/B/C, (47), 139-151.

Bikam, P., & Chakwizira, J. (2014). Involvement of traditional leadership in land use planning and development projects in South Africa: lessons for local government planners. *International journal of humanities and social science*, *4*(13), pp. 142-452.http://www.ijhssnet.com/journals/Vol_4_No_13_November_2014/17.pdf

Bizikova, L., Bellali, J., Habtezion, Z., Diakhite, M., & Pinter, L. (2009). Vulnerability and Impact Assessments for Adaptation to Climate Change. An Integrated environmental Assessment and Reporting Training Manual. UNEP.

Blamey, R.C., Kolusu, S.R., Mahlalela, P., Todd, M.C., & Reason, C.J.C. (2018). The role of regional circulation features in regulating El Niño climate impacts over southern Africa: A comparison of the 2015/2016 drought with previous events. International Journal of Climatology, 38(11), pp. 4276 - 4295.

Bogale, A., Thamaga-Chitja, J.M., Kolanisi, U. & Maxwell, M. (2014). Assessment of food security in southern Africa. In Pittock, J., Grafton, R.Q., & White, C.(eds). Water, Food and Agricultural Sustainability in Southern Africa. Melbourne: Tilde University Press, pp. 9 - 29.

Boven, K. and Morohashi, J. (2002), Best Practices Using Indigenous Knowledge, UNESCO/MOST, The Hague, The Netherlands; Nuffic and Paris.

Boyce, C., & Neale, P. (2006). Conducting in-depth interviews: A guide for designing and conducting in-depth interviews for evaluation input. Watertown, MA: Pathfinder international, pp. 1-12.

Braun, V., & V. Clarke. (2006). "Using Thematic Analysis in Psychology." Qualitative Research in Psychology, 3(2), pp. 77-101.

British Sociological Association, (2017). Statement of Ethical Practice, pp. 1-10.

Brüntrup, M. & Heidhues, F. (2002) Subsistence Agriculture in Development: Its Role in Processes of Structural Change, Discussion Paper 01/02, Institute of Agricultural Economics and Social Sciences in the Tropics and Subtropics, University of Hohenheim, Stuttgart, Germany.

Bryceson, D. F. (2002). The Scramble in Africa: Reorienting Rural Livelihoods. *World Development*, *30*(5), pp. 725–739. https://doi.org/10.1016/S0305-750X(02)00006-2

Byg, A., & Salick, J. (2009). Local perspectives on a global phenomenon-Climate change in Eastern Tibetan villages. Global Environmental Change, 19, 156–166. Campaign Response. *Globalizations*, *17*(2), pp.1-21.

Chineka, J. (2020). Conservation Agriculture as an adaptation strategy to drought in Chivi District, Zimbabwe. Doctoral dissertation, University of Venda.

Chinnakali, P., Upadhyay, R. P., Shokeen, D., Singh, K., Kaur, M., Singh, A. K., & Pandav, C. S. (2014). Prevalence of household-level food insecurity and its determinants in an urban resettlement colony in north India. *Journal of health, population, and nutrition*, 32(2), pp. 227-236. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4216959/

City Facts, (2019-2020). Mphego village. Accessed at https://www.city-facts.com/mphego-limpopo

Coombes, A. E. (2003). History after Apartheid: Visual Culture and Public Memory in a Democratic South Africa. Duke University Press, pp. 1-384.

Cornish, G. (1998). Modern irrigation technologies for smallholders in developing countries.

Cornish, G. (1998). Modern irrigation technologies for smallholders in developing countries. Intermediate Technology Publications Ltd (ITP), pp. 1-90. ISBN 1853394572, 9781853394577.

Creswell, J. (2003) Research Design: Quantitative, Qualitative, and Mixed Methods Approaches, (2nd Edition) Sage Publications, Thousand Oaks, California. Accessed at http://isites.harvard.edu/fs/docs/icb.topic1334586.files/2003_Creswell_A%20Framework%20for%20Design.pdf

Cudjoe, G. P., Antwi-Agyei, P., & Gyampoh, B. A. (2021). The effect of climate variability on maize production in the Ejura-Sekyedumase Municipality, Ghana. *Climate*, *9*(10), 145. Accessed at https://www.mdpi.com/2225-1154/9/10/145

Dai, M., Huang, S., Huang, Q., Leng, G., Guo, Y., Wang, L., & Zheng, X. (2020). Assessing agricultural drought risk and its dynamic evolution characteristics. Agricultural Water Management, 231, 106003.

DeJonckheere, M., & Vaughn, L. M. (2019). Semistructured interviewing in primary care research: A balance of relationship and rigour. Family medicine and community health, *7*(2), pp 1-8.

Denzin, N. K., & Lincoln, Y. S. (2000). The discipline and practice of qualitative research. *Handbook of qualitative research*, *2*(1), pp, 1-20. Accessed at .https://www.sagepub.com/sites/default/files/upm-binaries/40425_Chapter1.pdf

De Vaus, D. A. (2001). Research design in social research. SAGE Publications.

De Villiers, A. (1995). Land Management and Rural Development Research Programme: Occasional Paper 1. Development Information of the Northern Province. Polokwane: University of Limpopo.

DFID, (1999). Sustainable livelihood guidance sheets. London: DFID Publishers.

DFID, (2000), Sustainable Livelihoods Guidance Sheets. Department for International Development. Accessed at http://www.livelihoods.org/info/info_guidancesheets.html (Accessed 15 October, 2017).

Drennan, J. (2003). Cognitive interviewing: Verbal data in the design and pretesting of questionnaires. Journal of advanced nursing, 42(1), pp. 57-63.

Deressa, 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(2), pp. 248-255.

Dulal, H., Brodnig, G., Onoriose, C. & Thakur, H. (2010). Capitalizing on Assets: Vulnerability and Adaptation to Climate Change in Nepal. Social Development Working Paper 121. Nepal: The World Bank.

Ellis, F. (2000). The Determinants of Rural Livelihood Diversification in Developing Countries. Journal of Agricultural Economics, 51(2), pp. 289-302.

Ellis, F., & Mdoe, N. (2003). Livelihoods and Rural Poverty Reduction in Tanzania. *World Development*, *31*(8), pp. 1367–1384.

Engelbrecht, F., Adegoke, J., Bopape, M.-J., Naidoo, M., Garland, R., Thatcher, M., McGregor, J., Katzfey, J., Werner, M., Ichoku, C., & Gatebe, C. (2015). Projections of rapidly rising surface temperatures over Africa under low mitigation. *Environmental Research Letters*, 10(8), pp. 1-16.

Ericksen, P. (2008). Conceptualizing Food Systems for Global Environmental Change Research. Global Environmental Change-human and Policy Dimensions (1), pp, 234-245. DOI:10.1016/j.gloenvcha.2007.09.002

Factory Farming Awareness Coalition, (2021). Intensive Agriculture: Examples, and Why is it Bad? Accessed at Intensive Agriculture: Characteristics, Examples, and Why Is It Bad? | FFAC (ffacoalition.org)

Fadina, A. M. R., & Barjolle, D. (2018). Farmers' adaptation strategies to climate change and their implications in the Zou Department of South Benin. *Environments*, 5(1), pp. 1-17.

FAO, (1983). World food security: a reappraisal of the concept and approaches. Rome: Food and Agriculture Organization of the United Nations.

FAO, (2003), Part 1. Conceptual approaches to food security and trade (Rome).

FAO, (2006). Policy Brief for Food Security. Accessed at https://www.fao.org/fileadmin/templates/faoitaly/documents/pdf/pdf_Food_Security_Cocept_Note.pdf

FAO, (2008). Climate Change Adaptation and Mitigation in the Food and Agricultural Sector. Technical Background Document from the Expert Consultation held in Rome (5-7 March 2008), pp. 1-16. Accessed at https://www.fao.org/3/au034e/au034e.pdf.

FAO, (2015). Climate change and food security: risks and responses. ISBN 978-92-5-108998-9. Accessed at https://www.fao.org/3/i5188e/I5188E.pdf.

FAO, (2020). Empowering farmers and their organizations through the creation of social capital - Bond learning guide for trainers. (Rome), Accessed at https://doi.org/10.4060/cb1423en.

FAO, (2021). Small Family Farms produce a third of the world's food. (23 April Rome). Accessed at https://www.fao.org/news/story/en/item/1395127/icode/

FAO, (2023), How to practice Integrated Pest Management? Accessed at https://www.fao.org/agriculture/crops/thematic-sitemap/theme/spi/scpi-home/managing-ecosystems/integrated-pest-management/ipm-how/en/

Fawzy, Z, F & Shedeed, S, I. (2020). Subsistence Farming Towards Sustainable Economic Agriculture of Small Farmers in Developing Countries. *NASS Journal of Agricultural Science,* (2), pp. 1-3.

Gandure, S., Walker, S., & Botha, J. J. (2013). Farmers' perceptions of adaptation to climate change and water stress in a South African rural community. *Environmental Development*, (5), pp, 39–53. Accessed at https://doi.org/10.1016/j.envdev.2012.11.004.

Garschagen, M. (2014). Risky Change? Vulnerability and Adaptation Between Climate Change and Transformation Dynamics in Can Tho City, Vietnam. Stuttgart: Franz Steiner Verlag.

Growth Employment and Redistribution (GEAR) macroeconomic Strategy, (1996). Accessed at https://www.treasury.gov.za/publications/other/gear/chapters.pdf

Gebretsadik, Y. H., Teklemariam, B. T., & Gebru, H. N. (2020). Effect of livelihood diversification on rural households' poverty reduction in Central Zone of Tigray regional state, Ethiopia. Adrigat University College of Agriculture and Environmental Sciences, pp. 1-18. Accessed at https://assets.researchsquare.com/files/rs-16923/v1_covered.pdf?c=1631831678

Gibberd, V., Rook, J., Sear, C. B., & Williams, J. B. (1995). Drought risk management in southern Africa. The potential of long lead climate forecasts for improved drought management. Technical Report, Natural Resources Institute Chartham, UK, (1), pp. 1-43.

Grothmann, T. and Patt, A. (2005). Adaptive Capacity and Human Cognition: The Process of Individual Adaptation to Climate Change. In Global Environmental Change (15), pp. 199–213.

Hagenlocher, M., Meza, I., Anderson, C.C., Min, A., Renaud, F.G., Walz, Y., Siebert, S. & Sebesvari, Z. (2019). Drought vulnerability and risk assessments: state of the art, persistent gaps, and research agenda. Environmental Research Letters, 14(8), p.083002.

Hall, R. (2004). A political economy of land reform in South Africa. *Review of African Political Economy*, *31*(100), pp. 213-227.

Haradhan, M. (2018). Qualitative Research Methods in Social Sciences and Related subjects. Assistant professor, Premier University, Chittagong, Bangladesh.

Hart, T., & Vorster, H. J. (2007). African Indigenous Knowledge Systems in Agricultural Production. Publisher: Department of Science and Technology, South Africa, pp. 1-77. ISBN: 978-1-919966-02-1. Accessed at https://www.researchgate.net/publication/340829283_African_Indigenous_Knowledge_Systems_in_Agricultural_Production

Hornby, D., Vanderhaeghen, Y., Versfeld, D., & Ngubane, M. (2016). A harvest of dysfunction: Rethinking the approach to drought, its causes and impacts in South Africa. *Report for Oxfam South Africa; Oxfam South Africa: Johannesburg, South Africa*.

Hughes, K, A, (2004). Comparing Pre-testing Methods: Cognitive Interviews, Respondent Debriefing, and Behaviour Coding. US Bureau of the Census, Statistical Research Division, Washington D.C, Research Report Series, Survey Methodology, pp. 1-20.

Huho, J. M., Ngaira, J. K., Ogindo, H. O., & Masayi, N. (2012). The changing rainfall pattern and the associated impacts on subsistence agriculture in Laikipia East District, Kenya. *Journal of Geography and Regional Planning*, 5(7), pp. 198- 206.

IFAD/ GEF, (2008). Partnership on climate change: Fighting a global challenge at the local level. Accessed at https://www.uncclearn.org/wp-content/uploads/library/ifad38.pdf

IPCC, (2001). *Climate Change Synthesis Report*. Contribution of Working Groups I, II and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change, pp. 1-409.

IPCC, (2007). *Summary for Policymakers*. *In: Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, pp. 7-22.

IPCC, (2007). *Climate Change: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, pp. 1- 976.

IPCC, (2018). Global warming of 1.5° C: An IPCC special report on the impacts of global warming of 1.5° C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press, pp. 1-616.

IPCC, (2022). Climate change: a threat to human well-being and health of the planet. Taking action now can secure our future, Berlin. Accessed at https://www.ipcc.ch/2022/02/28/pr-wgii-ar6/

Jiri, O, Mafongonya, P, & Chivenge, P. (2017). Contextual vulnerability of rainfed crop-based farming communities in semi-arid Zimbabwe: A case of Chiredzi District. International Journal of Climate Change Strategies and Management 9(1), DOI:10.1108/IJCCSM-03-2017-0070.

Kaczan, D., Arslan, A., & Lipper, L. (2013). Climate-Smart Agriculture? *A review of current practice of agroforestry and conservation agriculture in Malawi and Zambia*. Accessed at https://doi.org/10.22004/ag.econ.288985.

Kemerink, J., S, Ahlers, R., & Van Der Zaag, P. (2011). Contested water rights in post-Apartheid South Africa: The struggle for water at catchment level. Water SA (37) 585-594. https://doi.org/10.4314/wsa.v37i4.16.

Khumalo, J. (2021). Adaptation strategies of smallholder maize farmers to drought in Buffalo City Metropolitan Municipality, Eastern Cape, South Africa. Master's dissertation, University of the Free State, pp. 1- 103.

Kiggundu, N., Wanyama, J., Mfitumukiza, D., Twinomuhangi, R., Barasa, B., Katimbo, A., & Birungi Kyazze, F. (2018). Rainwater harvesting knowledge and practice for agricultural production in a changing climate: A review from Uganda's perspective, 20 (2), pp. 19-36.

Kom, Z. (2020). Assessing the impacts of climate change and adaptation strategies on smallholder farming in the Vhembe District, South Africa. Doctoral dissertation, University of Venda, pp. 1-200.

Kruger, A.C. and Sekele, S.S. (2012), "Trends in extreme temperature indices in South Africa: 1962-2009", International Journal of Climatology, 33 (3), pp. 661-676.

Kvale, S. (1996) Interviews: An Introduction to Qualitative Research Interviewing, CA: Sage, Thousand Oaks.

Lahiff, E. P. (1997). Agriculture and rural livelihoods in a South African 'homeland': A case study from Venda. University of London, School of Oriental and African Studies (United Kingdom), pp. 1-334

Lema, M. A., & Majule, A. E. (2009). Impacts of climate change, variability and adaptation strategies on agriculture in semi-arid areas of Tanzania: The case of Manyoni District in Singida Region, Tanzania. *African Journal of Environmental Science and Technology*, *3*(8), 206-218.

LDA, (2012). The Mapping of Agricultural Commodity Production in the Limpopo province, South Africa, 2012.

Lobell, D. B., Burke, M. B., Tebaldi, C., Mastrandrea, M. D., Falcon, W. P., & Naylor, R. L. (2008). Prioritizing Climate Change Adaptation Needs for Food Security in 2030. *Science*, (319), pp. 607–610.

Luiz, J. M. (1998). The Evolution and Fall of the South African Apartheid State: A Political Economy Perspective. *Ufahamu: A Journal of African Studies*, pp. 49-72. Accessed at https://escholarship.org/uc/item/7qs6h7fx

Maake, S. M., Manamela, M. G., & Meso, K. K. (2016). South Africa's Spatial Arrangements and Land Reform Issues Traversed. Polokwane. University of Limpopo, pp. 125-131.

Machete, M. (2020). The Contribution of Subsistence Farming to Rural Household Food Systems: A Case Study of Mamokgadi Village. Master's dissertation, University of Venda, pp. 1-81.

Madzwamuse, M. (2010). Drowning voices: The climate change discourse in South Africa. *Policy Brief*, *5*(8), pp. 1-8.

Makhura, M.T. (2001). Overcoming the Transaction Cost Barriers to Market Participation of Smallholder Farmers in the Northern Province. Unplished PhD degree. University of Pretoria.

Mashamaite, K. A. (2014). The contributions of smallholder subsistence agriculture towards rural household food security in Maroteng village, Limpopo Province. Master's dissertation, University of Limpopo, pp. 1-115.

Maxwell, S. (1996). Food security: a post-modern perspective. Food Policy 21(2), pp. 155-170.

Maxwell, S., & Slater, R. (2003). Food Policy Old and New. *Development Policy Review*, *21*(5–6), 531–553. Accessed at https://doi.org/10.1111/j.1467-8659.2003.00222.x.

Maxwell, S., & Smith, M. (1992). Household food security: a conceptual review. Household food security: Concepts, indicators, measurements, (1), pp. 1-72.

Meza, I., Rezaei, E. E., Siebert, S., Ghazaryan, G., Nouri, H., Dubovyk, O., & Hagenlocher, M. (2021). Drought risk for agricultural systems in South Africa: Drivers, spatial patterns, and implications for drought risk management. *Science of the Total Environment*, pp. 1-14.

Moeletsi, M.E., Mellaart, E.A.R., Mpandeli, N.S. & Hamandawana, H. (2013). The use of rainfall forecasts as a decision guide for small-scale farming in Limpopo Province, South Africa. *The Journal of Agricultural Education and Extension*, (19), pp. 133-145.

Mongi, H., Majule, A. E., & Lyimo, J. G. (2010). Vulnerability and adaptation of rain fed agriculture to climate change and variability in semi-arid Tanzania. *African Journal of Environmental Science and Technology*, *4*(6), pp. 371-381. DOI:10.5897/AJEST09.207

Monsalve, C, & Watsa, K. (2020). Human capital and climate action: Outcomes that deliver for people and the planet. Accessed at https://blogs.worldbank.org/climatechange/human-capital-and-climate-action-outcomes-deliver-people-and-planet

Morton, J. F. (2007). The impact of climate change on smallholder and subsistence agriculture. Natural Resource Institute, University of Greenwich, Vol 104 (50), pp. 19680–19685.

Moser, C. (1998). The Asset Vulnerability Framework: Reassessing Urban Poverty Reduction Strategies. World Development, 26(1), 1-19.

Morse, S., McNamara, N., & Acholo, M. (2009). Sustainable Livelihood Approach: A critical analysis of theory and practice. Geographical Paper No. 189. *Geography, The University of Reading*, pp. 1-67.

Mougou, R., Mansour, M., Iglesias, A., Chebbi, R. Z., & Battaglini, A. (2011). Climate change and agricultural vulnerability: a case study of rain-fed wheat in Kairouan, Central Tunisia. *Regional Environmental Change*, (11), pp. 137-142.

Mpandeli, S, & Maponya, P. (2013). The use of climate forecasts information by farmers in Limpopo province, *South Africa. Journal for Agricultural Science*, 5 (2), pp. 47-55.

Mpandeli, S. and Maponya, P. (2013). Coping with climate variability in Limpopo Province, South Africa. *Peak Journal of Agricultural Sciences*, (1), pp. 54-64.

Mpandeli, S., & Maponya, P. (2014). Constraints and challenges facing the small-scale farmers in Limpopo Province, South Africa. *Journal of Agricultural Science*, Published by Canadian Center of Science and Education; 6 (4), pp. 135-143.

Murphy, S. (2010). Changing perspectives: Smallscale farmers, markets and globalisation. London: International Institute for Environment and Development (IIED); The Hague: Hivos. Accessed at http://pubs.iied.org/16517IIED.

Mutero, J., Munapo, E., & Seaketso, P. (2016). Operational challenges faced by smallholder farmers: a case of Ethekwini Metropolitan in South Africa, (7), pp. 40-51.

Muthelo, D. (2018). Perception and adaptation strategies of smallholder farmers to drought in the Free State Province, South Africa. Master's dissertation, University of the Free State, pp. 1- 119.

Myeni, L., Moeletsi, M., Thavhana, M., Randela, M., & Mokoena, L. (2019). Barriers affecting sustainable agricultural productivity of smallholder farmers in the Eastern Free State of South Africa. *Sustainability*, 11 (3003), pp. 1-18.

Ncube, B. (2020). Small holder farmer drought coping and adaptation strategies in Limpopo and Western Cape provinces- *Report to the Water Research Commission*. Cape Peninsula University of technology, pp. 1-58.

Ndlovu, S., Mathe, B., Phiri, K., & Nyathi, D. (2020). Factoring water harvesting into climate change adaptation: Endogenous responses by smallholder farmers in Gwanda district, Zimbabwe. *Cogent Social Sciences*, *6*(1), pp. 1-16.

New, M., Hewitson, B., Stephenson, D. B., Tsiga, A., Kruger, A., Manhique, A., Gomez, B., Coelho, C. A. S., Masisi, D. N., Kululanga, E., Mbambalala, E., Adesina, F., Saleh, H., Kanyanga, J., Adosi, J., Bulane, L., Fortunata, L., Mdoka, M. L., & Lajoie, R. (2006). Evidence of trends in daily climate extremes over southern and west Africa. Journal of Geophysical Research, (111), 1-11. D14102. https://doi.org/10.1029/2005JD006289.

Ngumbi, E. (2019). Becoming Drought resilient: Why African Farmers must consider drought tolerant crops. Accessed at https://reliefweb.int/report/world/becoming-drought-resilient-why-african-farmers-must-consider-drought-tolerant-crops

Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014). Africa. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (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 University Press, Cambridge, pp. 1199–1265.*

Ntsebeza, L. (2007). Land redistribution in South Africa: The property clause revisited. In Ntsebeza, L. & Hall. R. (eds). The Land Question in South Africa: The Challenge of Transformation and Redistribution. Cape Town: Human Sciences Research Council (HSRC), pp. 107 – 131.

Ocheni, S., & Nwankwo, B. C. (2012). Analysis of colonialism and its impact in Africa. *Cross-Cultural Communication*, 8(3), pp. 46-54.

Odhiambo, J. J., & Nemadodzi, L. E. (2007). Soil fertility management practices by smallholder farmers in Vhembe District, Limpopo Province. *South African Journal of Agricultural Extension*, *36* (1), pp. 53-61.

OECD, (2010). Recognition of Non-formal and Informal learning pointers for policy development. Directorate for Education, Education and Policy Training Division. Accessed at https://www.oecd.org/education/innovation-education/44870953.pdf

Oestigaard, T. (2016). 13 Rainfed Agriculture, Drought and Hunger in Tanzania. A History of Water: Water and Food, (3), pp. 31- 332.

Okunlola, A., Ngubane, M., Cousins, B., & du Toit, A. (2016). Challenging the Stereotypes: Small-scale farmers and private sector programmes in South Africa. Published by Institute for Poverty, Land and Agrarian Studies, School of Government, Faculty of Economics and Management Sciences, University of Western Cape. Report Research (53), pp. 1-61.

Oni, S. A., Nesamvuni, A. E., Odhiambo, J. J. O., & Dagada, M. C. (2012). The study of agricultural industry in the Limpopo Province (Executive Summary), pp. 1- 57.

Opioh, E. (2021). Climate change fueling harmful pesticide use. Sci Dev Net. Published (28 January), accessed at https://www.scidev.net/sub-saharan-africa/news/climate-change-fuelling-harmful-pesticide-use/.

Parry, S., Prudhomme, C., Wilby, R & Wood, P. (2016). Drought termination: Concept and characterization. Progress in Physical Geography, 40 (6), pp. 743-767. DOI 10.1177/0309133316652801.

Pauw, P. (2013). The Role of Perception in Subsistence Farmer Adaptation in Africa enriching the Climate Finance Debate. *In International Journal of Climate Change Strategies and Management*, 5 (3), pp. 267-284.

Pereira, L. (2017). Climate Change Impacts on Agriculture across Africa. Oxford Research Encyclopedia of Environmental Science. Oxford University Press. Accessed at https://openaccess.city.ac.uk/id/eprint/21175/12/

Phophi, M. (2018). Emerging and new pests under climate change in Limpopo Province, South Africa. Doctoral dissertation, University of Kwa-Zulu Natal, pp. 1-147.

Pinstrup-Andersen, P. (2009). Food security: Definition and measurement. Food Security, 1(1), 5–7. https://doi.org/10.1007/s12571-008-0002-y.

Radimer, K. L., Olson, C. M. and Campbell, C. C. (1990). Development of indicators to assess hunger. J. Nutrition, (120), pp. 1544–1548.

Rahman, A., & Westley, J. (2001). The Challenge of Ending Rural Poverty. *Development Policy Review*, 19(4), pp. 553–562. https://doi.org/10.1111/1467-7679.00152.

Ramborun, V., Facknath, S. & Lalljee, B. (2020). Moving toward sustainable agriculture through a better understanding of farmer perceptions and attitudes to cope with climate change. Journal of Agricultural Education and Extension, 26(1), pp. 37-57.

Rankoana, S. A. (2022). Indigenous knowledge and innovative practices to cope with impacts of climate change on small-scale farming in Limpopo Province, South Africa. *International Journal of Climate Change Strategies and Management*, 14 (2), pp. 180-190.

Reconstruction and Development Programme (RDP), (1994). Accessed at https://www.gov.za/sites/default/files/governmentgazetteid16085.pdf

Reardon, T., Berdegué, J., & Escobar, G. (2001). Rural Nonfarm Employment and Incomes in Latin America: Overview and Policy Implications. *World Development*, 29(3), pp. 395–409.

Riessman, C. K. (1993). Narrative Analysis: Qualitative Research Methods Series, No. 30. Newbury Park: SAGE.

Rockström, J., Kaumbutho, P., Mwalley, J., Nzabi, A. W., Temesgen, M., Mawenya, L., Barron, J., Mutua, J., & Damgaard-Larsen, S. (2009). Conservation farming strategies in East and Southern Africa: Yields

and rainwater productivity from on-farm action research. *Soil and Tillage Research*, 103(1), pp. 23–32.

Rosenberg, N. J. (ed.), (1980). Drought in the Great Plains: Research on Impacts and Strategies, Water Resources Publication, Littleton.

Rouault, M & Richard, Y., (2003). Spatial extension and intensity of droughts since 1992 in South Africa. Water SA , (29), pp. 489-500.

Ruel, M. T., Garrett, J. L., Morris, S. S., Maxwell, D. G., Oshaug, A., Engle, P. L., Menon, P., Slack, A., & Haddad, L. J. (Eds.). (1998). Urban Challenges to Food and Nutrition Security: A Review of Food Security, Health and Caregiving in cities.

Sam, A.S.; Padmaja, S.S.; Kächele, H.; Kumar, R.; Müller, K. (2020) Climate change, drought and rural communities: Understanding people's perceptions and adaptations in rural eastern India. Int. J. Disaster Risk Reduction. (44), pp. 1-11.

Sánchez, N., González-Zamora, Á., Martínez-Fernández, J., Piles, M., & Pablos, M. (2018). Integrated remote sensing approach to global agricultural drought monitoring. Agricultural and forest meteorology, pp. 141-153.

Satgar, V. (2018). The climate crisis and systemic alternatives in, *The Climate Crisis: South African and Global Democratic Eco-Socialist Alternatives.* Edited by Vishwas Satgar, Published Edition, Wits University Press, pp.1-28.

Satgar, V. (2018). The anthropocene and imperial ecocide: Prospects for just transitions in, *The Climate Crisis: South African and Global Democratic Eco-Socialist Alternatives.* Edited by Vishwas Satgar, Published Edition, Wits University Press, pp.47-68.

Satgar, V., & Cherry, J., (2019). Climate and Food Inequality: The South African Food Sovereignty Campaign. 17(4), pp. 1-21. Routledge Taylor and Francis Group. DOI:10.1080/14747731.2019.1652467.

Schlenker, W., & Lobell, D., (2010). Robust negative impacts of climate change on African agriculture. https://doi.org/10.1088/1748-9326/5/1/014010

Scoones, I. (1998). Sustainable Rural Livelihoods: A framework for Analysis. IDS Working Paper 72 Brighton. London: Institute of Development Studies.

Scoones, I. (2009) Livelihoods perspectives and rural development, The Journal of Peasant Studies, 36 (1), pp. 171-196, DOI: 10.1080/03066150902820503

Seyoum, H. (2015). Perceptions, Vulnerability and Adaptation to Climate Change in Ethiopia: The Case of Smallholder Farmers in Sidama. PhD thesis, University of East London.

Seneviratne, S., Nicholls, N., Easterling, D., Goodess, C., Kanae, S., Kossin, J., Luo, Y., Marengo, J., McInnes, K., Rahimi, M., Reichstein, M., Sorteberg, A., Vera, C., Zhang, X., Alexander, L. V., Allen, S., Benito, G., Cavazos, T., Clague, J., & Zwiers, F. W. (2012). *Changes in climate extremes and their impacts on the natural physical environment*, pp. 109–230.

Sharmake, M. A., Sultan, K., Rehman, R., & Hussain, A. (2022). Decadal Impacts of Climate Change on Rainfed Agriculture Community in Western Somaliland, Africa. Sustainability, 15(1), pp. 1-17.

Shikwambana, S., Malaza, N., & Shale, K. (2021). Impacts of Rainfall and Temperature Changes on Smallholder Agriculture in the Limpopo Province, South Africa. *Water*, (13), pp. 1-16.

Siphesihle, Q., & Lelethu, M. (2020). Factors affecting subsistence farming in rural areas of Nyandeni local municipality in the Eastern Cape Province. *South African Journal of Agricultural Extension*, *48*(2), pp. 92-105.

Slavikova, S, P. (June 16, 2019). Advantages and Disadvantages of Monoculture Farming. Published (16 June) accessed at https://greentumble.com/advantages-and-disadvantages-of-monoculture-farming/

South African Weather Service. (2022). Monthly Drought Bulletin, pp. 1-8. Accessed at https://www.weathersa.co.za/Documents/Climate/nr_drought.pdf

Spinoni, J., Barbosa, P., De Jager, A., McCormick, N., Naumann, G., Vogt, J.V., Magni, D., Masante, D. and Mazzeschi, M. (2019). A new global database of meteorological drought events from 1951 to 2016. Journal of Hydrology: Regional Studies. Accessed at https://www.sciencedirect.com/science/article/pii/S2214581818303136

Steffen, W., Grinevald, J., Crutzen, P. and McNeill, J., (2011). The Anthropocene: conceptual and historical perspectives. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, pp.842-867.

Stringer, L. C., Dyer, J. C., Reed, M. S., Dougill, A. J., Twyman, C., & Mkwambisi, D. (2009). Adaptations to climate change, drought and desertification: Local insights to enhance policy in southern Africa. *Environmental Science & Policy*, 12(7), pp. 748–765.

Strydom, H. & Venter, L. (2002). Sampling and sampling methods. *In: De Vos, A.S., Strydom, H., Fouché, C.B. & Delport, CSL. Research at grass roots:* For the social sciences and human service professions. Pretoria: Van Schaik Publishers, pp. 197-211.

Svotwa, E., Baipai, R., & Jiyane, J. (2009). Organic farming in the small holder farming sector of Zimbabwe. *Journal of Organic Systems*, 4(1), pp. 8-14.

Thamaga-Chitja, J. M., & Tamako, N. (2017). Does social capital play a role in climate change adaptation among smallholder farmers for improving food security and livelihoods? *Journal of Consumer Sciences*, 2 (1), pp. 16-27

Theodory, T. F. (2016). Dealing with change: Indigenous Knowledge and Adaptation to Climate Change in the Ngono River Basin Tanzania. Faculty of Mathematics and Natural Sciences of the Rheinische Fredrich – Wilhelms University of Bonn, pp. 1-235.

Thorpe, J., Ayele, S., & Naes, L.O. (2020). Written Evidence (ZAF0042) submitted the Institute of Development studies. Accessed (17 April). https://committees.parliament.uk/writtenevidence/2460/pdf/

Thornton, P. K., Jones, P. G., Owiyo, T., Kruska, R. L., Herrero, M. T., Kristjanson, P. M., Notenbaert, A. M. O., Bekele, N., & Omolo, A. (2006). *Mapping climate vulnerability and poverty in Africa* [Report]. International Livestock Research Institute. https://cgspace.cgiar.org/handle/10568/2307.

Tonukari, N. J., & Omotor, D. G. (2010). Biotechnology and food security in developing countries. (Accessed 22 November, 2012).

Trautmann, N. M., Porter, K. S., & Wagenet, R. J. (1985). Modern agriculture: Its effects on the environment.

Traditional Cooperative Governance and Traditional Affairs Department, (2020). Profile, Vhembe District Municipality, LP. Profile and Analysis District Development Model, pp. 1-35.

Turpie, J., & Visser, M. (2013). The impact of climate change on South Africa's rural areas. Submission for the, (14), pp. 100-162.

Tyson, P., & Preston-Whyte, R, A. (2000). The Weather and Climate of Southern Africa, Oxford University Press Southern Africa, Cape Town. pp Xii – 396.

Ubisi, N. R., Mafongoya, P. L., Kolanisi, U., & Jiri, O. (2017). Smallholder farmer's perceived effects of climate change on crop production and household livelihoods in rural Limpopo province, South Africa. *Change and Adaptation in Socio-Ecological Systems*, 3(1), pp. 27-38.

Ubisi, R. (2016). Smallholder farmers' perceptions and adaptation to climate change interventions and support systems in Limpopo province, South Africa. School of Agricultural, Earth and Environmental Sciences (SAEES) College of Agriculture, Engineering and Science University of KwaZulu-Nata, pp. 1-124.

UNFCCC, (1992). United Nations, pp. 1-33. Accessed at https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf

UNFCCC, (2006). *Key Adaptation Concepts and Terms*: Draft Paper Agenda Document 1, pp. 1-33.

Unganai, L. S., & Murwira, A. (2010). Challenges and opportunities for climate change adaptation among smallholder farmers in southeast Zimbabwe. *In 2nd International Conference: Climate, Sustainability and Development in Semi-arid Regions,* Ceará Convention Center, Fortaleza, pp. 1-20.

Van Averbeke, W., Denison, J. and Mnkeni, P.N.S. 2011. *Smallholder irrigation schemes in South Africa:* a review of knowledge generated by the Water Research Commission. Water SA, (37), pp.797- 808.

Van Loon, A.F.V., Stahl, K., Baldassarre, G.D., Clark, J., Rangecroft, S., Wanders, N., Gleeson, T., Van Dijk, A.I., Tallaksen, L.M., Hannaford, J. & Uijlenhoet, R. (2016). Drought in a human modified world: reframing drought definitions, understanding, and analysis approaches. Hydrology and Earth System Sciences, 20(9), pp.3631-3650.

Van Rooyen, J. (1995). Overview of DBSA' s Farmer Support Programme, 1987-93. In Singini, R. & van Rooyen, J. (eds). Serving Small-scale Farmers: an evaluation of the DBSA's farmer support programmes. DBSA: Halfway House.

Vhembe District Municipality (VDM) (2014). The status of Agriculture in Vhembe District, Limpopo Province, Integrated Development Plan.

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.

Von Loeper, W., Musango, J., Brent, A., & Drimie, S. (2016). Analysing challenges facing smallholder farmers and conservation agriculture in South Africa: A system dynamics approach. *South African Journal of Economic and Management Sciences*, 19(5), pp. 747-773.

Walker, C. (2005). The limits to land reform: Rethinking 'the land question'. *Journal of Southern African Studies*, 31(4), pp. 805-824.

Warrick, C. O. (2011). Local Voice, Local Choice? Vulnerability to Climate Change and Community-Based Adaptation in Rural Vanuatu. PhD Thesis. University of Waikato, New Zealand.

Water Research Commission, (2015). Background to current drought in South Africa. Accessed at https://www.gov.za/sites/default/files/gcis_documents/dourght-background-wrc.pdf

Water research Commission, (2022). Youth and Agriculture. Understanding the challenges first: the rural youth and rainfed small holder farming, pp. 22-25.

Wetende, E., Olago, D., & Ogara, W. (2018). Perceptions of climate change variability and adaptation strategies on smallholder dairy farming systems: Insights from Siaya Sub-County of Western Kenya. *Environmental development*, (27), pp. 14-25.

Wiggins, S. (2004). Agriculture, hunger and Food insecurity, London: Department for International Development.

Wiggins, S., Kirsten, J., & Llambí, L. (2010). The future of small farms. World development, 38(10), pp. 1341-1348.

Wilhite, D.A., & Glantz, M.H. (1985). Understanding the drought phenomenon: The role of definitions. Water International (10), pp. 111-120.

Woetzel, J., Pinner, D., Samandari, H., Engel, H., Krishnan, M., McCullough, R., Melzer, T., & Boettiger, S. (2020). How will African farmers adjust to changing patterns of precipitation? *McKinsey Sustainability*. https://www.mckinsey.com/business-functions/sustainability/our-insights/how-will-african-farmers-adjust-to-changing-patterns-of-precipitation.

World Bank, (2013). An action for agenda transformation: unlocking Africa's agricultural potential. Sustainable development series, Washington, DC. Accessed at https://documents1.worldbank.org/curated/en/795321468191670202/pdf/769900WP0SDS0A00Box374393B00PUBLIC0.pdf

World Bank, (2021). Climate Change Adaptation and Economic Transformation in SSA. A product of office of Chief Economist for African Region, Volume 4, pp 1-90.

WMO, (2021). Updated 30-year reference period reflects changing climate. Published (5 May). Accessed at https://public.wmo.int/en/media/news/updated-30-year-reference-period-reflects-changing-climate

WMO, (2022). More bad news for the planet: greenhouse gas levels hit new highs. Published (26 October). Accessed at https://public.wmo.int/en/media/press-release/more-bad-news-planet-greenhouse-gas-levels-hit-new-highs

Yang, Q., Li, M., Zheng, Z. & Ma, Z. (2017). Regional applicability of seven meteorological drought indices in China. Science China Earth Sciences, 60(4), pp.745-760.

APPENDIX A

Participation information sheet

Dear Potential Participant

RE: Information sheet for rain-fed subsistence crop farmers.

My name is Nokutenda Ntuli. I am a master's student in Development Sociology at the University of the Witwatersrand, Johannesburg. My supervisor is Dr Tatenda Mukwedeya. I am conducting research on the adaptation strategies employed by rain-fed subsistence farmers to minimise the impacts of drought on crop production. The study title is: Adaptation strategies against drought: The case of rain-fed subsistence crop farmers in Mphego village (Vhembe district Municipality, Limpopo). Please take time to read the following information carefully and discuss it with others if you wish.

You are invited to take part in an interview for my research study that will be conducted in Mphego village. Questions will be asked on, the impacts of drought on rain-fed subsistence crop production and the adaptation strategies being employed to cope with this challenge. If you decide to take part in this research study, the interviews will last for 45 minutes to 60 minutes. You do not have to answer any questions that you might find sensitive. I'm fully aware of the risks of undertaking in person interviews during COVID 19. Hence, all participants of this study should fully observe COVID 19 regulations i.e., the wearing of masks, sanitisation, and social distancing during the interviews. However, in cases where you do not have masks and sanitisers of your own, I will take the responsibility of providing them to you as this is vital in protecting everyone during the research process. Please keep in mind that participation in this study is voluntary. You will not receive any form of reward for taking part in this study. You are also free to withdraw your participation from this research at any given point in time.

The interview will be anonymous and confidential. It will be recorded only if you have consented to it. Your name or any other form of information that could lead to your re-identification will not be included in the findings of this study. Other researchers studying this topic may only use data collected from this research with your permission, your identity and any personal information will not be disclosed. To avoid unauthorized access of the data, it will be stored in a password protected computer.

This data will be preserved for a period of 2 years, and I will be the only person with access to that information.

This research study will be written up as a research report. This report will be available on the Wits University library website. If you would like to get a summary of this report, I would be happy to send you.

Should you have any queries about this research (during or afterwards) feel free to contact me via email at 1889081@students.wits.ac.za, alternatively you can call me at 063 002 7319. If you have any concerns or complaints about the ethical procedures of this research study you are welcome to contact the University Human Research Ethics Committee (Non- Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Yours sincerely,

Researcher:
Nokutenda Ntuli, 1889081@students.wits.ac.za, 062 002 7319

Supervisor:
Dr Tatenda Mukwedeya, tatenda.mukwedeya@wits.ac.za, 079 096 8803

APPENDIX B

Consent form

Adaptation strategies against drought on: The case of rain-fed subsistence crop farmers in Mphego village (Vhembe district Municipality, Limpopo)

University of the Witwatersrand

Nokutenda Ntuli

I ……volunteer to participate in this research study.

I consent to the following:

(Please circle the relevant options below)

1. The research study was explained to me. I understand what this research is all about.

   YES/NO

2. I agree that my participation will remain anonymous (my name will not be used).

   YES/NO

3. I agree that direct quotation from my interview/focus group/other activity may be used by the researcher in their research project.

   YES/NO

4. I agree that the interview/focus group/other activity may be audio recorded.

   YES/NO

5. I agree that the other researchers may use the information I provide in my interviews/focus group/other activity (depending on their own ethics clearance obtained) but my name and personal information will not be used or passed on.

   YES/NO

6. I agree to fully observe COVID 19 regulations i.e., the wearing of masks, sanitising and social distancing during the research process.

YES/NO

…… (signature)
…… (name of participant)
…… (date)

……. (signature)
…….. (name of researcher)
…… (date)

APPENDIX C

Research instrument: Semi-structured interviews

Interview Guide

Main Research Question: How are subsistence farmers in Mpehgo village adapting to the prevailing impacts of drought on agricultural production?

Interview number: .....

Interviewer: .....

Language interview conducted in: .....

Interview questions

1. Participants demographic particulars

What is your gender?

Male Female

What is your age group?

18-20 years 41- 45 years

21-25 years 46-50 years

26-30 years 51-55 years

31-35 years 56-60 years

36-40 years 61-65 years

Above 65 years

What is your marital status?

Single

Married

Co-habiting

Divorced

Widowed

What is your highest level of education?

No formal education Primary education

Secondary education Tertiary education

1. Rain-fed subsistence cropping practices

What are the reasons for your involvement in rain-fed subsistence agriculture?

For how long have you been a subsistence farmer?
(participants should provide the years of their expertise in subsistence agriculture and whether they gained this experience through informal or formal learning experiences)

What kind of crops are you specializing in? and why?

What farming equipment are you using for crop production? and why?

How often do you access extension services?

2. The farmers awareness and perceptions of drought

What is your understanding of drought?

How has drought been like over the past 30 years?

Do you think drought has been occurring frequently than expected? If yes, please explain your answer.

How has drought affected your cropping practices?

(planting dates, crop yields, soils, water sources etc)

Are you receiving any support from the government or extension officers to cushion yourselves against these impacts?

3. Drought adaptation

What adaptation strategies are you employing to mitigate the effects of drought on your cropping practices?

Which of the following livelihood assets influences your choice of adaptation strategies:

- **Human capital** *(age, farming experience, education, drought awareness, gender)*
- **Social capital** *(number of household members, farmer-based networks, agricultural extension services)*
- **Financial capital** *(household income, off/non-farm income, credit)*
- **Physical capital** (*farming equipment, electricity)*
- **Natural capital** *(farm size, access to water and other natural resources)*

Explain why?