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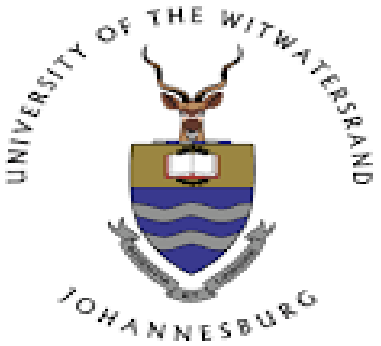
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Research Report for Masters of Arts



Climate change and food security: Exploring factors of food production in Mozambique and Zimbabwe (2001-2019)

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Dedication

This research is dedicated to the millions of community and subsistence farmers throughout Southern Africa who work tirelessly to feed their families and communities. Through extreme conditions of poverty and climate change, these members of our communities continue to provide a beacon of hope for a better inclusive future.

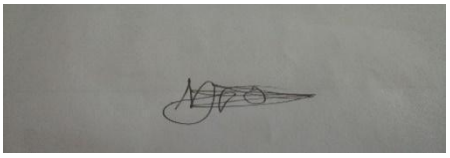
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Acronyms

AGRITEX	Department of Agricultural, Technical and Extension Services
AGRA	Alliance for a Green Revolution in Africa
AATF	Agricultural Technology Foundation
CIMMYT	International Maize and Wheat Improvement Centre
FAO	Food and Agricultural Organisation of the United Nations
FEWS NET	Famine Early Warning Systems Network
FRELIMO	Frente de Libertação de Moçambique (Mozambican Liberation Front)
FSI	Food Security Index
GDP	Gross Domestic Product
HDI	Human Development Index
IITA	International Institute of Tropical Agriculture
IMF	International Monetary Fund
IAI	Integrated Agricultural Survey
IPCC	Intergovernmental panel on climate change
MDG	Millennium Development Goals
NGO	Non-Governmental Organisation
NIS	National Institute of Statistics
ORCS	Office of the Regional Coordinator
RENAMO	Resistência Nacional Moçambicana (The Mozambican National Resistance)
SADC	Southern Africa Development Community
SDG	Sustainable Development Goals
STATS SA	Statistics South Africa
UN	United Nations
UNDP	United Nations Development Project
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WB	World Bank

WEMA	Water-Efficient Maize for Africa
WFP	World Food Program
WFS	World Food Summit
WHO	World Health Organisation
ZANU-PF	The Zimbabwe African National Union-Patriotic Front
ZIM STATS	Zimbabwean National Statistics Agency
ZIM VAC	Zimbabwean Vulnerability Assessment Committee

Abstract

Climate change has emerged as a severe security threat which has worsened poverty, inequality and more importantly sustainable development throughout the global south. Southern African countries have been especially susceptible to climate change with severe weather patterns such as drought, land degradation, flooding and severe tropical cyclones that disproportionately affect poor communities. The effects of the impact of climate change on development and poor communities is observed with stubbornly high levels of food insecurity throughout Sub-Saharan Africa and by extension Southern Africa. Changing climates have forced farmers to undertake drastic measures to produce food for themselves and their communities with limited external support. In Mozambique and Zimbabwe alone around 3.5 million and 1.5 million subsistence and smallholder farmers respectively, are responsible for more than 70% of total food production (FAO 2011, World Bank 2019, INE 2014). This study explores the impact of climate variation and climate change on food production and food accessibility throughout Mozambique and Zimbabwe through a person-centred human security approach . The study further complements the challenges of food security by assessing the response of small-holder farmers in adapting and reacting to climate change. This study relied substantially on secondary sources such as regional reports, bulletins and journal articles alongside publications from NGOs, government departments and international organisations. The data was analysed through thematic and content analysis. The findings suggest that Mozambique and Zimbabwe remain highly vulnerable to climate change negatively affecting food insecure communities. Furthermore, while small-holder farmers have desperately undertaken various methods of adaptation they are unable to cope with extreme weather patterns. The findings underscore the necessity for interventions aimed at enabling farmers and vulnerable communities to adapt to climate change or, at the very least, mitigate its effects. This is crucial for preventing recurrent food and humanitarian crises.

Chapter 1. Introduction

1.1 Study Background

At the start of the 21st century global food supply and distribution has improved significantly with major strides in limiting hunger and food security throughout developing communities. For many regions, the increase in food supply alongside economic, social, and political development has decreased the threat of food insecurity due to increased availability in global food stocks. Within the past two decades these strides in limiting global hunger and malnutrition have been overshadowed by declining food production due to failing environmental conditions caused by climate change (IPCC 2018). Climate variation and climate change are the largest existential threats to food security and supply. Climate change has increasingly been recognised as a catalyst for continued food and agricultural challenges throughout Sub-Saharan Africa. Rising temperatures caused by increased greenhouse gas emissions have led to global temperatures surpassing 1.2°C with concerns that it may reach 1.5°C by 2050. The response to these climate threats as observed by the Intergovernmental panel on climate change (IPCC) and various other multilateral institutions has raised the alarm that climate change is a real concern rather than an abstract existential threat (IPCC 2014, IPCC 2018).

The challenges of climate change have cemented changes throughout the globe with the northern hemisphere experiencing rising temperatures year-on-year records (IPCC 2018). In contrast, the global south, which struggles with underdevelopment and adaptation, has been experiencing severe changes in climate beyond individual weather events referred to as climate variation. The increase in global temperatures follows rising droughts, floods and severe climate patterns across the southern hemisphere unequally affecting small-holder farmers who produce food on small agricultural plots for income and subsistence. Within Sub-Saharan Africa, these small-holder farmers cultivate and provide 70% of the total food produced (AGRA 2017). The existence of vulnerable communities amid climate fluctuations has been particularly notable in southern Africa, where regional droughts and sporadic, devastating weather events have markedly intensified in severity and frequency from 2000 to 2019. (IPCC 2014).

1.1.1 Climate Variation and Food Security

Periodic climate events that shift beyond individual weather events, referred to as climate variation, are increasing in severity due to global changes in precipitation, wind conditions and overall temperature (Vermeulen et al 2012). The occurrence of climate variation due to

global climate change is more likely to increase in frequency and severity as global climate conditions worsen and atmospheric temperatures increase. Within the global south the increase in frequency and length of droughts, erratic rainfall, flooding and cyclones are the most impactful disasters affecting communities and individuals. A useful measurement to evaluate the scale and impact of climate variation, as noted by the IPCC, is short-term climate variant events in relation to decadal or long-term climate variant events (IPCC 2012). In summary, Short-term severe climate-related disasters are measured and compared to long-term disasters, highlighting a shift in the frequency and severity of climate variation. Throughout the southern hemisphere, these climate events have shifted from being decadal events to short-term events, which have manifested in climate events being more severe with higher frequency.

Southern Africa has emerged as an epicentre for climate variation caused by the rising temperatures coupled with the El Niño Southern Oscillation Phenomenon (Kolusu et al 2018). The decade-long patterns of climate variation have shifted from occuring once every decade to occuring on a yearly, and monthly basis. The impact of these events has disproportionately impacted underdeveloped communities and culminated with a set of recurring droughts between 2014-2019 (WMO 2019, FAO 2020, World Bank 2020, SADC 2020). The most prominent of these events is the extended 2014-2020 El Niño drought period. Throughout this period disastrous events severely threatened human capacity for survival with declining water supply leading to inhospitable conditions due to limited or restricted water access for agriculture and consumption. These challenges culminated in the ‘Day-Zero’ crisis in South Africa which was coupled with severe food insecurity and hunger across regional neighbours, Mozambique and Zimbabwe. IPCC predictor reports highlight that within the past decade, Southern Africa has been experiencing more frequent, severe, and prolonged climate variation and disasters impacting millions of agricultural producers who are reliant on stable climate systems for rainfall and irrigation (IPCC 2014). Throughout the region, the most obvious climate threat has been variating rainfall. Across Mozambique and Zimbabwe, rainfall throughout 2015-2017 decreased below 1000mm and 500mm respectively raising concerns for agricultural producers and equitable water access for vulnerable communities (WFP 2016, World Bank 2017, Ndlovu et al 20).

Food security as defined by the World Food Summit in 1996 is when individuals and communities have reliable physical and economic access to nutritious and healthy food (FAO 1996). The reliance on ensuring access to food security is based on the sustainability of food systems where the activities of production, distribution, consumption, and disposal of food products from agriculture are not compromised (FAO 2018, Vermeulen et al 2012). Throughout rural communities, food system activities such as distribution, consumption and production are centralised around small-holder agriculture. Small-holder agriculture refers to agricultural production undertaken on small-holdings usually below two hectares with cultivation occurring for self-consumption and to supplement household income. Small-holder farmers often occupy multiple factors of food systems through directly partaking in distribution, consumption, and production (Vermeulen et al 2012) Small-holder agricultural producers comprise up to 33 million individuals throughout Southern Africa alone and are responsible for more than 70% of the region's food production and availability (SADC 2020). The concept of food insecurity has emerged as a substantial threat to the livelihoods and integrity of food systems throughout Southern Africa as continued challenges of poverty and underdevelopment persist.

Food systems have been under severe strain following increasing climate variation. In relation to increased climate variation, vulnerable communities who rely on climate-dependent resources for nutrition are at threat as they rely on stable climate and rainfall to ensure sufficient food production and cultivation (FAO 2006, Schmidhuber and Tubelio 2007). Food system stability is vital in the maintenance and development of subsistence and small-holder agricultural producers reliant on stable production for local consumption and to supplement household income.When engaging with food systems, vulnerable communities and individuals embody a diverse array of interconnected interests, ranging from enhancing living standards to preserving personal and local nutritional levels to mitigate hunger and malnutrition.n (FAO 2018). Food system stability however is wholly reliant on sustainable climates where sufficient access to agricultural necessities, such as water, is not overshadowed by continuous climate variation threatening harvests and food supply chains.

The declining environmental and food conditions of rural smallholder farmers in ensuring and sustaining nutritional security throughout Southern Africa is however a unique

phenomenon. Southern Africa, while mostly arid and dry, has been largely food secure without significant famines or widespread food shortages during climate shocks and climate variation (SADC 2016). This is noted with rising production throughout South Africa, Botswana, and Zimbabwe from 1990 to 2002 in staple food crops. These accomplishments are attributed to a continual rise in food production following the establishment of international support systems, namely through the FAO, and co-operation between neighbouring states and regional organisations (SADC 2016, FAO 2018). This results in a distinctive trend within food systems in Southern Africa, wherein although much of the region enjoys food security, less developed countries like Mozambique and Zimbabwe consistently grapple with food insecurity. Food systems have become less stable throughout vulnerable communities and states following disastrous climate events. The most affected and vulnerable states are Mozambique and Zimbabwe due to the intensity of climate events such as droughts and continual floods. Mozambique is characterised as one of the most vulnerable states in terms of climate variation. Recurring droughts, cyclones and floods have challenged development and food production throughout Mozambique and Zimbabwe. The environmental challenges that arise are widely attributed towards changes in food production, availability and access following these events.

1.1.2 Vulnerability and Food Insecurity

Small-holder farmers who produce food for sustenance and income are vital in maintaining individual and community needs of nutrition and health. According to the World Health Organization (WHO), the decrease in locally produced food production is associated with deteriorating health conditions, resulting in a rise in malnutrition-related diseases like anaemia and kwashiorkor. (WHO 2020). A lack of healthy and sufficient food is often the primary cause for stunting which is an indicator of increasing food insecurity and overall human development. The focus on insecurity leads to addressing the needs of individuals and communities about state and regional needs. Individual needs are categorised as having sufficient resources and the basic means for survival entailing broad human development. Conversely, state needs pertain to macroeconomic, governmental, and nationwide policy-driven initiatives (UNDP 1994). These contrasting needs are characterised by different approaches and questions of vulnerability.

Vulnerable communities are communities that are at high risk of insecurity alongside social and economic insecurity following disastrous events such as climate shocks and conflict. In

Southern Africa, vulnerable communities are primarily defined by poverty and face a heightened risk of food insecurity in the aftermath of calamitous events, often lacking access to resources or support systems(FAO 2000). Southern Africa from 2015 to 2016 relied on 33 million subsistence and small-holder farmers to provide nutrition for developing communities (SADC 2016). Small-holder farmers who produce food for both nutrition and as a form of income are under severe pressure following prolonged drought periods. TThese farmers encounter substantial vulnerability, operating on small plots of cultivated land, typically less than 2 hectares, and relying on agriculture for income and fulfilling basic necessities (FAO 2002, Mutami 2016). Cultivation of these small-holdings is also largely for subsistence and as a basic source of income. The challenges that food producers experience with variant rainfall have widespread implications regionally, nationally, and locally. Individual needs arise from requiring healthy variant diets and enough food to maintain a healthy lifestyle alongside sufficient access to available food stocks (FAO 2006). Local needs are also impacted by droughts, as diminishing food reserves and reduced production hinder community access and development. This is significant considering that over 80% of rural populations across the SADC region depend on food production for income, employment, and sustenance. (SADC 2016). The impact of climate variation has also presented a challenge to state and regional needs as governments attempt to limit the humanitarian consequences of mass food shortages and restrictions following climate variant events.

1.4 Research Questions

The primary research question that this research report addresses is:

- What is the effect and impact of erratic rainfall, rising temperatures and variating climate conditions, on food systems and food production throughout Mozambique and Zimbabwe?

In conjunction with the primary research question several sub-questions are also addressed

- What is the different impact of droughts and climate shocks on subsistence and small-holder agriculture?
- How have rural food producers responded to climate variation?
- What impact has government and international programs had on food production throughout climate change disasters?

1.5 Research Rationale

The purpose of this study is to explore the impact climate variation has on food security by exploring food production and access during climate variant periods. In undertaking this study, the focus is largely attributed to small-holder food producers who are the primary food producers throughout Mozambique and Zimbabwe. This is because small-holder farmers are the most susceptible to fluctuating temperatures and changes in rainfall patterns(FAO 2016, INE 2014, SADC 2016).

1.6 Methodology

1.6.1 Research Design

The roadmap for the research addresses several themes in order of occurrence. In exploring the impact of climate variation on small-holder producers, and its effects on food security, the analysis of the aforementioned variables explore the predetermined themes of food production, food access and adaptation. In approaching the response from small-holder farmers the themes of conservation and climate-smart agriculture and water irrigation and rain-fed agriculture are utilised to provide a grounded approach in addressing the research questions. Production and access as a theme address the impact of climate variation on food security by exploring food availability, agricultural production and market access through imports and food pricing.

Conservation and climate-smart agriculture alongside water irrigation and rain-fed agriculture address the response from smallholder farmers on climate variation and how these communities approach food insecurity caused by climate variation and the impact on production and access.

1.6.2 Data Gathering and Analysis

This study undertakes a qualitative approach to exploring secondary sources. The secondary sources employed originate from government publications, journal articles, books, situation reports and visual documentaries. The primary sources utilised included situation reports from UN-affiliated organizations like the FAO, WFP, and regional offices, as well as government commissions and publications such as the Zimbabwean Vulnerability Assessment Committee and the Mozambican Vulnerability Assessment Committee. In gathering information, some statistical data through the CGAP Mozambican Smallholder Household Survey was employed in gathering information regarding production numbers and household cultivation in Mozambique. In terms of the smal-lholder household survey the CGAP undertook an annual survey of 3979 small-holder households throughout Mozambique

in 2015/2016. The gathering of data from the Small-holder household survey primarily focussed on the variables of homegrown agricultural cultivation. In analysing and interpreting the data from the surveys SPSS and STATA were used, respectively.

Analysing data from the aforementioned sources pertained to document and content analysis exploring several predetermined themes. The themes that the research presents are economic production and access trends, conservation (climate-smart) agriculture, crop diversity, water irrigation and rain-fed agriculture.

Economic production and access pertain to the production and pricing of food as measurements of availability and access. Conservation and climate-smart agriculture is measured through the usage and import of fertilisers, crop diversification and the use of seeds. Water irrigation and rain-fed agriculture refer to how water resources either through rainfall or irrigation systems are employed in relation to small-holder agricultural production.

In exploring the themes of access and availability, conservation agriculture, crop diversity, water irrigation and rainfed agriculture content and document analysis were employed. Document analysis is employed in identifying recurring structural and social themes through analysing policy reports, journal articles, situation reports books, and information-based articles. Data was gathered and analysed in order from food production and access linked to the follow-up themes of adapting to changing conditions.

1.6.3 Case Studies

In exploring climate change and food security the case studies of Mozambique and Zimbabwe are analysed. Case studies are defined as a detailed examination of a phenomenon or historical event to develop or test historical explanations that may be generalizable with differing events (George and Bennett 2005, Lamont 2015).

In addressing the historical phenomena of the 2015-2017 ENSO drought and rainfall phenomenon, Mozambique and Zimbabwe are the explored cases. The factors contributing to case study selection and analysis utilised a ‘most similar’ approach. The ‘most similar’ approach explores similar characteristics of each case and analyses it regarding an overarching event or phenomenon (George and Bennet 2005). Both cases are similar in experiencing widespread regional climate events, namely drought and flooding, alongside being highly reliant on small-holder agriculture for food production. Zimbabwe and Mozambique are also considered some of the most vulnerable Southern African states regarding both food security and climate variation (FAO 2016). These cases also experience

high levels of underdevelopment and informal employment leading to more small-holder agricultural reliance.

1.6.4 Variables and Measurements

Dependent Variable

The dependent variable that is identified is the occurrence of food insecurity through the limitations surrounding availability and accessibility within food systems. The variable of food security throughout the study is focussed largely on the production and accessibility of food however does consider sub-measurements of utilisation. The measurements of food security are as follows.

- Production and availability of food through agricultural tillage, food imports and crop production
- Access to food through pricing and market distribution.
- Utilisation in line with availability and access to food as an indicator which focuses on health issues that arise with a lack of access and availability such as developmental stunting.
- Stability of food systems through the livelihoods of individuals.

The main measurement this study focuses on is how production and production systems contribute to sustaining livelihoods and food security. Utilisation as a measurement is aimed at exploring factors and impacts of production. Accessibility is a secondary factor that needs to be measured as food markets and financial systems have a strong relationship and impact on production systems. The connection between financial systems and food markets is highlighted, particularly in terms of the significance of distribution and trade within food systems. These factors are interdependent, as highlighted throughout the literature presented. Therefore, when considering food security as a dependent variable, it is essential to explore these factors, while stability and utilization serve as secondary measurements.

Independent Variable

The independent variable that this report addresses is climate variation due to climate change. In measuring the independent variable, the following considerations were undertaken.

- Rainfall patterns and precipitation
- Periods of rising temperatures and dry spells
- Localised flooding and localised droughts
- Regional El Niño-related droughts

1.7 Report structure

The structure of the undertaken research focuses on an interrelated set of chapters and research with each using either a singular or combination of research elements as discussed. This leads to three primary components of the case study chapters namely production trends, market and economic access and adaptation and mitigation.

- Introduction and background: This chapter provides a background of the research report alongside outlining key concepts employed in the report. The chapter also assesses existing literature on food security, sustainability, human security, and the relationships with climate variation.
- Literature Review and Theoretical Concepts: This chapter outlines the framework of human security and aligns the theoretical concepts with food security and climate variation. This chapter outlines the framework of human security and aligns the theoretical concepts with food security and climate variation. The chapter further aims to link human security approaches with the concepts of food security and climate variation. The chapter also assesses existing literature on food security, sustainability, human security, and the relationships with climate variation.
- Climate Change and Food Security: The Case of Mozambique: This chapter presents and explores the findings of food production, access, and agricultural adaptation throughout 2015-2017 in Mozambique.
- Climate Change and Food Security: The Case of Zimbabwe: This chapter explores the case study of Zimbabwe from 2015 to 2017. This chapter addresses the impact climate variation has had on crop production and the response to climate variation.
- Summary, Conclusion and Recommendations: This chapter concludes the research report by comparing and analysing the findings of both case studies. The chapter also presents concluding remarks and future research recommendations.

Chapter 2. Literature Review and Theoretical Framework

2.1 Introduction

The concept of human security became prominent after the Cold War culminating in the 1994 Human Development Report where the UNDP developed a comprehensive approach to individual and community threats. The concept of human security arose within the context of various multidimensional humanitarian challenges which remained unaddressed affecting vulnerable communities. Recurring humanitarian crises such as continued hunger, poverty, rising ethnic conflict and economic challenges guided multilateral and national engagements with the well-being of marginalised and vulnerable communities. The Human Development Report established official guidelines and humanitarian challenges that non-state actors and international organisations need to explore in addressing humanitarian threats

. Throughout the 1990s as the military tensions of the Cold War subsided a wide array of conflicts and humanitarian crises erupted throughout the developing world followed by devastating economic and social challenges. Historically Sub-Saharan Africa has been highly susceptible to humanitarian threats exacerbated by the economic challenges that arose from the structural adjustment plans of the 1980s coupled with continent-wide underdevelopment and poverty (Jolly and Ray 2006, Axworthy 1999, Alkire 2003). Alongside conflicts, a wide array of different threats continuously pose a threat to human development such as severe poverty, food insecurity and environmental degradation. The period marking an increase in human centred multilateral engagements are coupled with various humanitarian crises namely the genocides in Rwanda and Yugoslavia. These underlying conditions introduced fresh challenges that extended beyond the traditional concepts of state security and sovereignty. Individual communities persist in grappling with issues such as persistent poverty, food insecurity, and underdevelopment, which jeopardize their sources of income and livelihoods..

The concept of human security provides a framework to address social, economic, and political insecurities beyond affixed borders by exploring the needs of communities and individuals struggling with insecurity. These needs are manifested in assessing human development through a people-centred approach where vulnerable individuals and communities are placed at the forefront of humanitarian crises. Therefore, a people-centered approach is necessary to comprehend the most effective ways to assist vulnerable communities, individuals, and underdeveloped states. Vulnerable communities and marginalised individuals frequently receive inadequate attention in responses to broader challenges such as escalating economic difficulties, poor governance, and the failure to

safeguard citizens from existential threats such as conflict, climate change, food insecurity, and economic instability.

The continuation of these security challenges and threats has led to a rising debate on whether the state is capable of dealing with challenges that threaten the basic rights of its population (UNDP 1994, Jolly and Ray 2006). Human security encompasses 7 key pillars namely: political, food, health, environmental, economic, personal, and community-based security. Given the close relations of human security and its pillar of food security the broader theoretical framework presented is highly interlinked. The linkage is largely attributed to the notion that in addressing human insecurity and food insecurity a human centred approach is required to understand individual and community needs and challenges.

This chapter outlines the concept and theoretical framework of human security and how it is applied through reviewing and discussing the pillar of food security. In engaging with human and food security, the chapter further includes discussions and an overview of the relevant literature. Lastly the chapter presents a practical application of human and food security by reviewing the concept of climate adaptation and resilience as a response to climate, food and human insecurity caused by rapidly changing climate conditions.

Three academic literature bodies were utilised to explore and address the connection between climate variation and food production and human security throughout the chapter. Specifically, the broader study delves into the pillar of food security ,under the umbrella of human security, sustainable livelihoods, and adaptation and mitigation. The multidimensional framework of human security prioritises the concepts of empowerment and protection, while addressing the complexities associated with development, food systems, and rapidly evolving environmental conditions, all within a people-centered approach. When delving into the fundamental principles of food security, the literature underscores the correlation between availability and access, especially in relation to the effects of climate variation. This correlation is further underscored by debates surrounding production and entitlements referring to structures of power and ownership of food production.

2.3 Defining and conceptualising human security.

The human security framework marks a shift from state-centric towards individual security. The UNDP defines human security as a “means of safety from such chronic threats as hunger, disease, and repression. Secondarily, it means protection from sudden and hurtful disruptions

in the patterns of daily life whether in homes, in jobs or communities" (UNDP 1994, 23). The definition provided by the UNDP prioritises pervasive threats that individuals and communities face regarding their livelihoods and existence. In the advent of addressing these threats, human security undertakes a person-centred approach. The attention of individuals and communities draws the focus of various institutions and organisations on human beings and away from existential state threats (Alkire 2003). The shifting focus to person-centred security aligns with ensuring cultural and economic rights that are addressed with the purpose of promoting human development where human well-being is considered as an end of development rather than as a means (Alkire 2003, Jolly and Ray 2006, UNDP 2016).

Key milestones that outline the person-centric developmental focus of human security are the establishment of the millennium development goals and its subsequent successor the sustainable development goals. These initiatives were developed with the aim to address severe threats that vulnerable individuals and marginalised communities often contend with. Some of the most notable goals aimed at shifting focus to the livelihoods and existence of individuals are the notion of decreasing poverty and halving hunger and starvation (Alkire 2003, UNGA 2000).

The challenges that arise with declining human development cannot be sufficiently addressed through state resources or policies alone. Thus, in breaking from the state-centric norm, human security aims to tackle challenges regarding the sustainability and protection of human lives and livelihoods and the actors that can promote these pillars (UNDP 1994). Any threat to human lives or livelihoods is considered urgent. In prioritising human well-being by any means necessary widespread identification of threats needs to be pervasive. These threats as argued by Alkire (2003) are identified as sudden or severe shocks that are all-encompassing and may arise again over time. The human security approach thus relies on engagement with affected communities.

The model of human security relies on assessing the needs of affected individuals and communities by engaging in people centred solutions through reviewing personal experience during periods of humanitarian crisis. In undertaking a human-centred approach solutions to humanitarian problems cannot be broadly applied without the inclusion of affected communities and individuals. In contrast to top-down approaches employed by developed states and multilateral institutions, the comprehension of human security revolves around how communities respond to humanitarian threats, often with minimal external assistance. To

tackle the mentioned threats effectively, institutions should concentrate solely on human development and livelihoods while being attuned to the unique context of these challenges. The focus should be on supporting communities in the best possible manner, rather than imposing conditions or dictating terms for humanitarian aid (UNDP 2016). Through the shift to a person-centred lens international institutions and actors engaging in hands-on support such as NGOs and regional organisations become more prominent in supporting individuals and communities. These relationships are due to the close interrelated relationships between vulnerable individuals and communities and non-state actors that provide developmental and humanitarian assistance (Alkire 2003, Axworthy 1999).

The process of empowering individuals and undertaking a people-centred approach is a unique phenomena which has shifted international focus to support developing countries and vulnerable communities (UNDP 2016, Axworthy 1999). In approaching existing humanitarian threats that threaten the livelihoods of communities and individuals' states have been inefficient in addressing human security issues. In assessing challenges in human security communities are at the forefront of both understanding the humanitarian crisis and needs of vulnerable individuals. Thus, in approaching human security threats a significant shift requires cooperative, participatory, and integrated inputs away from large scale policy and state support. This is accomplished through utilising international organisations namely through the United Nations and its affiliates alongside NGOs and civil society organisations that have a higher degree of community trust than state institutions (UNDP 2016, Jolly and Ray 2006, UNDP 1994).

In defining human security there is further need for engagement of various different pillars of human development and the causes of humanitarian crises. It is within this framework that several pillars of security are promoted aimed at addressing various multidimensional challenges relating to human security. The pillars that are central to the umbrella of human security are economic security, political security, food security, personal security, community security health security and environmental security.,

2.3.1 Human Security and Livelihood Sustainability

The most prominent authors on human security are developmental economists Richard Jolly and Deeyapan Basu Ray in their 2006 review of the human security debate. The report analyses UNDP reports of Afghanistan, Latvia, Macedonia, and Bangladesh to outline the various aspects of human security. The initial challenge that Jolly and Ray highlight as concerning is the interrelationships between different insecurities. Environmental insecurity

has the means to be a driving variable in food, health, and economic security. These widespread interrelationships allow for the framework of human security to address a variety of complex issues both on a macro level alongside in-depth exploration from individuals and communities (Jolly and Ray 2006).

Jolly and Ray (2006) in exploring human security within the presented case studies also note the broad spectrum of human development that human security is unable to address. Issues such as cultural and structured socio-economic inequities present serious security threats however are easily bundled with other humanitarian threats or ignored. Thus, human security cannot be effectively defined without the conditions of insecurity.

When examining the critiques surrounding human security, authors such as Sabina Alkire (2003) contend that the adoption of the concept necessitates the inclusion of the roles of states and governments and that their engagements remain crucial to promote security of individuals. The state is thus in a unique position to both provide support locally and drum up awareness regarding insecurity. These limitations of human security as argued by Jolly and Ray (2006) are the catalyst for sustainable livelihoods arguments that arose alongside human security. Sustainability ,as an alternative to a solely human security approach,is thus underutilised as a tool to explore insecurity (Jolly and Ray 2006).

In determining the use of sustainability throughout communities the literature mainly through the works of Serrat (2017) and Scoones (1998) concentrates on promoting on maintaining livelihoods of vulnerable communities. The initial argument is aimed at addressing vulnerability, which Serrat defines as insecurity of the well-being of individuals (Serrat 2017). Scoones expands the well-being argument by assessing vulnerability which he argues as external factors and shocks that threaten the well-being of individuals and communities. With these definitions of vulnerability, Serrat and Scoones present a key debate in terms of human security and sustainable livelihoods as they share various similar framework assumptions. Initially, in exploring poverty and development it is key to analyse the livelihoods approach of multi-stakeholder relationships between individuals, communities, and governmental actors. The general assumption throughout the literature is that poverty can be alleviated by both providing for and supporting the needs of the impoverished, who are presumed to have a better understanding of their own circumstances and requirements. (Serrat 2017). This is based on the consideration of poverty reduction through a person-centred approach. Scoones and Serrat argue that sustainability is achieved through

addressing interlinked social, political, and economic factors that arise with human insecurity. The most prominent source of various security challenges is noted widespread poverty that communities struggle with. Insufficient financial, social, and physical resources lead to vulnerability and increases insecurity throughout underdeveloped and impoverished communities (Scoones 1998). In addressing challenges of insecurity communities need the resources to adapt and have the means necessary to adapt to recurring crises. Scoones and Serrat inexplicitly, within the framework of sustainable livelihoods, present climate change as a core factor in ensuring that individual and community livelihoods are developed and able to adapt.

In applying the concept of human security and exploring sustainable livelihoods, Berry et al. (2014) in their piece *Food security and sustainability* assess the linkages between the human security pillar of food security and livelihood sustainability. In contrast to Scoones, Berry et al (2014), while contributing to the desirability of sustainability through the above-mentioned pillars of social, political, economic, and financial resources, argue that there is a dualist factor that ensures stability in relation to human security and changing climates. Individual human security is often attributed to the lack of state capacity leading to humanitarian responses centred around communities and support from multilateral organisations and NGOs. Berry et al (2014) argue that sustainability arguments are guided by state participation and state actors devolving from the individual and people-centred approach to human security.

Berry et al. (2014) further justifies their argument regarding state support by delving into food security and recognizing both the global state-centric support and local community engagements are necessary to promote sustainability. They argue that the interconnections between these aspects emerge within the framework of food security and sustainability. In this framework, each component of food security, such as availability, is directly linked to its corresponding pillar of sustainability in which the state can provide financial support while local producers can best identify what kind of support is needed. With the inclusion of global observations and goals the political spectrum Berry et al (2014) present excludes the political aspect as throughout research into food security there is often a conflation between the political through the assumptions of poor governance or poor action plans with actual humanitarian crises. Thus, to separate the political a food security nexus, sustainable development needs to be explored as it pertains to the development of and promotion of food security.

2.4 Dimensions of Human Insecurity

Human security is frequently recognized and readily apparent in its absence. Without the dimensions of human security, interconnected threats to livelihoods and existence become challenging to discern (UNDP 1994). Conflict is frequently scrutinised as the primary cause of insecurity. However, various dimensions such as food, economic, and environmental security address crises at both the individual and community levels, encompassing more than solely political and conflict-related issues.

In undertaking a human-centred approach human security is largely identified by human insecurity. The threat of insecurity is identified by exploring several vital dimensions of livelihoods and individual interactions (UNDP 2016,). The dimensions of human security that are key in identifying and addressing threats are economic, food, health, environmental, personal, community and political security (UNDP 1994, Jolly and Ray 2006, UNDP 2016). These challenges have arisen as a response to what proponents of human security determine as an anachronistic system of sovereignty based on ideological divides regarding social, economic, and political systems. This would often lead to either the abuse of state power on individuals or unwillingness of the state to address the social well-being of its citizens (Alkire 2003). Thus, securitisation which often prioritises military and state security, shifts to address security threats that individuals face daily. These relate to the sustenance of individuals, ensuring equitable human development and purposeful existence. (Alkire 2003). Human security threats are interconnected to the livelihoods, existence, and sustainability of vulnerable communities. Human insecurity thus arises with threatening crises or events that paralyse the livelihoods or threaten the existence of individuals and vulnerable communities (Alkire 2003, Jolly and Ray 2006).

Table 2.1 Dimensions of Human Insecurity

Type of Insecurity	Root Causes
Economic Insecurity	Persistent poverty, unemployment, lack of access to credit and other economic opportunities Persistent poverty, unemployment, lack of access to credit and other economic opportunities
Food Insecurity	Hunger, famine, sudden rise in food prices
Health Insecurity	Epidemics, malnutrition, poor sanitation, lack of access to basic health care
Environmental Insecurity	Environmental degradation, resource depletion, natural disasters
Personal Insecurity	Physical violence in all its forms, human trafficking, child labour
Communal Insecurity	Inter-ethnic, religious, and other identity-based tensions, crime, terrorism
Political Insecurity	Political repression, human rights violations, lack of rule of law and justice

(Source: UNDP Human Security Handbook 2016, 7, UNDP 1994, Alkire 2003, Jolly 2003, Scoones 1998, Serrat 2017)

2.5 Addressing Human Insecurity

Through the adoption of Human security, two primary concepts arose in addressing the challenges presented by insecurity. Jolly and Ray (2006) argue through exploring various case studies in relation to development and security the shift from state to personal, communal, and individual security has presented a broader means of addressing insecurity and the occurrence of humanitarian crises. It is thus based on the human security framework developed through the considerations of empowerment and protection.

Empowerment refers to a bottom-up approach in which inclusive participatory processes support the roles of individuals and communities to promote development and the achievement of their freedoms (UNDP 2016, UNDP 1994). In promoting empowerment developmental assistance should develop individuals' capabilities to fully participate and shape events that affect their lives (UNDP 1994, Sen 1985). In empowering individuals and communities to address developmental threats and challenges social well-being becomes more prominent in community and individual responses.

Protection refers to the institutional, policy-oriented and organisational top-down approach to establishing comprehensive norms (UNDP 2016). Protection implies a top-down approach where developmental assistance should arise from the top to ensure that individuals and communities can shape and address their well-being without being limited or hindered through social, political, or economic limitations (UNDP 1994, Axworthy 1999).

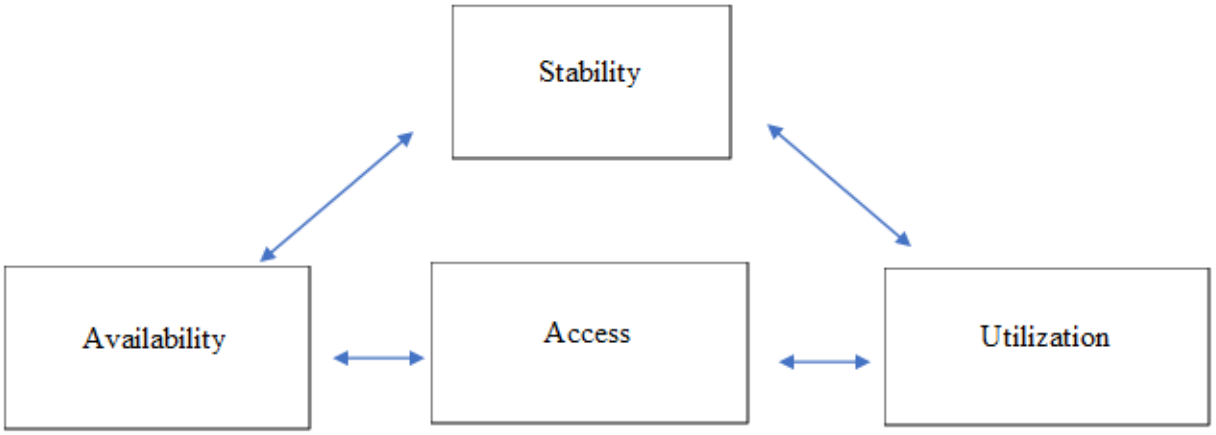
2.6 Food security

The FAO defines food security as a ‘‘situation that exists when all people, at all times have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life’’ (FAO 2002, FAO 1996). This definition of food security has however led to a substantial challenge raised throughout existing literature on the degrees of insecurity. The definition provided by the FAO encompasses a variety of factors that contribute to identifying and exploring food security. Inherently there is a wide array of definitions however the definition provided by the FAO presents a comprehensive framework for exploring food insecurity leading to the establishment of 4 primary interrelated pillars of food security namely availability, access, utilisation, and stability. The 1996 World Food Summit and the endorsed 2002 State of Food Security outline the key dimensions of global food systems and nutritional frameworks as availability, accessibility, utilisation, and stability. (FAO 1996, FAO 2002).

- Availability: This dimension relates to the overall ability of food systems through production means such as agriculture and fishing to produce and fulfill nutritional demands and acquire means to meet demand through production, imports, or food aid (FAO 2006, WFP 2009,).
- Accessibility: Covers access by individuals to adequate resources (entitlements) to acquire appropriate foods for a nutritious diet. In exploring access these arrangements from the means to acquire nutritious foods easily through entitlements. It is thus based on the ability to gain access to nutritious food that meets dietary requirements sufficiently and in proportion to the needs of the individual(FAO 2006)
- Utilisation: Utilisation of food through adequate diet, clean water, sanitation, and health care to reach a state of nutritional well-being where all physiological needs are met. This brings out the importance of non-food inputs in food security (FAO 2006, WFP 2009, Napoli 2011).
- Stability: Stability encompasses a multidimensional spectrum including sufficient access to food and required availability. Within the FAO policy briefs stability is often

defined as: "To be food secure, a population, household or individual must always have access to adequate food. They should not risk losing access to food because of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity). The concept of stability can therefore refer to both the availability and access dimensions of food security" (FAO 2006: 1).

Figure 2.1 Food Security Nexus



Source: Napoli 2011,19

The literature on food security predominantly addresses the pillars of food production and access. Within the concept and literature of food security there is notable emphasis on two closely related causal factors—climate change and climate variation—which are crucial for availability and access to food. The literature further stresses several key debates with production and entitlements at the forefront. Debates surrounding production and entitlements are often centred around the concepts of availability and access. In contrast to the food security debate there have been various arguments and criticisms aimed at discrediting the human centred approach of food and human security. These criticisms mainly emerge from the concept of food sovereignty which broadly argues that existing power structures and ownership of agricultural production is the primary cause for inefficient production, limited access and general insecurity.

2.6.1 The Emergence of Food Security

The concept of inclusive food security arose throughout the 1974 World Food Conference in response to increasing food prices throughout the developing world. It was a follow-up on the extreme instances of famine throughout the Sahel between 1972 and 75. These famines led to a crisis in various states with widespread hunger and malnutrition amidst high global supply

and production (Crankshaw 2015, Jarosz 2014, WFS 1974). With the advent of the Green Revolution of the 1970s initial approaches towards food security are focussed on production and national stockpiles undermined with high global production in relation to low local production. The increased demands would require more imports from developing states with declining local production.

Numerous critiques have been directed towards the formal establishment of food security as a concept to address malnutrition and hunger. These critics argue that such discourse formations fail to adequately tackle food inequities stemming from underdevelopment and poverty. (Crankshaw 2015, UN 1974, Sen 1981). These criticisms coupled with continued shortages of food due to poverty shifted the idea of food security from a macro-economic production-oriented concept to a human-centred inclusive concept. Amartya Sen (1981) argues that the availability of food does not constitute food sustainability as global stockpiles surpass global demand, however hunger and malnutrition continue throughout developing countries. Thus, food security threats do not solely encompass the export responsibilities of developed nations but to ensure local communities and impoverished individuals have access to nutritious food by addressing food inequities. Communities that do not have sufficient food access are thus also not able to address nutritional needs such as healthy diets with a focus on availability. In addressing health, poverty, and production the World Food Summit in 1996 outlined that in conjunction with accessibility and health, food security approaches should recognise the importance of sustainability through ensuring equal and sustainable food production, access, and utilisation by both governments and international organisations alongside vulnerable communities and individuals (FAO 1996, FAO 2002).

2.6.2 Food Security Approaches: Production versus Entitlements

Through the analysis and historical process of food security development, a key author is John D Shaw who in his 2007 publication *World Food Security: A History since 1945* outlines the logical progression of the food security shift from the initial green revolution to the adoption of accessibility and utilisation as core pillars to attaining food security. Throughout the book, Shaw identifies the inadequacy of adopting variant pillars from international organisations and donors leading to disharmonised policy engagements between multilateral institutions. Instead, the continued focus was based on Malthusian thoughts of overpopulation and famines being derived solely from the lack of food availability (Shaw 2007). The findings Shaw (2007) present is a large overview of the development of institutions such as the WFP and FAO as a means to address food insecurity however as

noted with the concept of human security Shaw (2007) argues that the sole development of international organisations is insufficient in managing food insecurity but rather it should include local production, access, utility, and stability as core concepts outside of the globalised responses. In his presentation of evidence, Shaw highlights the failure to address food security issues following the Green Revolution, during which production surpassed global demand.. However, Famine was still a severe threat throughout Sub-Saharan Africa and Southeast Asia (Shaw 2007). Therefore, in crafting a comprehensive framework aligned with human security during the 1990s, the fundamental pillars of accessibility, production, utilisation, and stability, along with promoting the well-being of individuals have been widely acknowledged as central avenues to achieve food security. There are several limitations however as Shaw highlights, these pillars do not sufficiently address the widespread complexity that is present within food security and in some cases are rather broad in determining the causes of food insecurity (Shaw 2007). A key theme that Shaw (2007) however argues in favour of is the continued outlook of production-oriented food security. Shaw (2007) argues that production is the primary variable that needs to be explored; however, it needs to be assessed in tandem with the promotion of equitable access to healthy food for everyone. To ensure this local food production is important within local and global value chains to address shortages and poor food quality. The lack of local food production is attributed to the rising inaccessibility of basic food crops.

In reviewing the disparities of food production Schmidhuber and Tubelio in their 2007 article *Global Food Security Under Climate Change* argue that in terms of food security, only production is routinely addressed regarding climate change (Schmidhuber and Tubelio 2007). In addressing production mostly, the rising question that Schmidhuber and Tubelio attempt to address is what role climate change has in global food security in relation to access, utilisation, and stability in relation to production. Schmidhuber and Tubelio conclude the discussion by outlining that climate change disproportionately affects poor communities in developing states as these communities are reliant on vulnerable agriculture as a form of nutrition and income.

Examining the diverse effects of climate variation on food security, especially beyond mere availability, highlights developmental issues related to access to food markets, as well as the health consequences of poor dietary habits. With the focus on production as the primary concern in exploring food security Schmidhuber and Tubelio through briefly exploring the impacts on the different pillars of food security argue for a comprehensive outlook including

access, utilisation, and stability. Climate variation has different impacts on each pillar from health conditions and health strains to poverty and lack of sufficient access to food. Access is predominantly approached as being indirectly impacted by climate change similarly with health conditions due to market and financial supply side constraints often limiting access to healthy foods during climate disasters. The factors contributing to restricted access and inadequate financial and market assistance are often linked to governmental inefficiencies and social and cultural issues. Meanwhile, Schmidhuber and Tubelio assert that climate variation's influence on production can also manifest in rising food prices and deteriorating healthcare services.

The leading author who delineates the disparities poverty imposes on food access, contrasting it with production, is Amartya Sen. Sen explores and analysis the core challenges pertaining to food entitlements and food production through his publications namely, *Poverty and Famines* published in 1981, alongside his pioneering essay titled *An Essay on Entitlement and Deprivation*. Across the book and its accompanying articles, Sen (1981) highlights the disparities and connections poverty has in relation to the incidence of famines, primarily by examining entitlements. Entitlements are determined by personal resources and the sets of commodities and products a person has access to (Sen 1981 434-435). Sen (1981) argues that individuals and starving communities lack 'entitlement' to food stockpiles due to economic and financial resource constraints. As global production increased rapidly throughout the Green Revolution the occurrence of famines was still inherently common throughout the global south which experienced extreme starvation and hunger conditions through the arising of food security debates (Sen 1981). The Sahelian famines between 1972 and 1974 outline this as various states such as Sudan had experienced increased crop yields but experienced immense famines and food insecurity. Sen in response to the Green Revolution provides an agro-economic framework of poverty as a variable to food insecurity. This is in contrast to the food production and availability approach, with Sen arguing that economic conditions are complex and the lack of access to food leading to starvation is the condition of poverty and a lack of entitlement. In critiquing the green revolution approach Sen (1981) indicates how the increase in global production follows a global increase in industrial and commercial agriculture however communities within developing states while also producing more food have insufficient access to entitlements that would improve production and access (Sen 1981). With low food stocks developing communities have to rely on imports and foreign aid to address low production. The economic inequality of food insecurity is clear in not just

production measurements but access to both food and the means to efficiently produce food (Sen 1981)

Sen (1981) addresses the issue of accessibility not within the framework of a traditional supply and demand chain where production holds primacy, but instead emphasises poverty and economic resources as the crucial prerequisites. The argument that Sen poses notes is that the recurring issue of hunger is described as: “the characteristic of some people not having enough food to eat. It is not the characteristic of there not being enough food to eat” (Sen 1981). Sen further explains that market-based approaches and food commodification are to blame for the recurrence of hunger. Sen's argument opposes challenges of availability chains of supply and demand but rather sufficient access and resources which the global market limits (Sen 1981). The disparities between poor communities and developed states is the condition of widespread poverty coupled with limited access and low production. Developing states in the framework presented by Sen are largely within climate-volatile regions where small-holder farming is prevalent alongside poverty which as Sen notes leads to insufficient access. In relation to the undertaken research, the exploration of climate change and food security is concentrated in the communities which Sen notes lacking entitlements. These communities dealing with high poverty and unemployment are in vulnerable regions where climate variation is more impactful and with low production following limited means of adaptation. The inequalities set out by Sen through focussing on the green revolution become more jarring with continued food insecurity but the declining rate of famines.

Thompson et al (2010) reaffirms the intrinsic economic and market-based connection between poverty, underdevelopment, and continued hunger. Thompson et al (2010) in reviewing the literature on food security argue for a structural approach. Food security as outlined by Thompson et al (2010) has been presented as a structural and policy issue where social, economic, and political factors hinder means of adapting to changing climate conditions. In exploring adaptation, Thompson identifies several gaps throughout the literature and addresses the concept of utilisation. In comparison to Sen (1981) and Shaw (2007) Thompson et al (2010) argues that predetermined focus of most food security research does not address utilisation which is often linked to health conditions. Poor diets also contribute to food insecurity and the challenges of low production and food-related diseases. In the discussion of their findings, Thompson et al (2010) argue that health conditions are vital in exploring food insecurity as developing states experience poor nutrition standards due to a lack of diversified diets. In exploring the conditions of food production and entitlements

the quality of food through utilisation is underutilised in identifying a lack of access or availability of food. The indicators that are used to identify food insecurity are attributed to macro-economic measurements such as production or in the case of entitlements income and poverty. Thompson et al (2010) challenge these claims and promote the use of health-based research to determine food security and thus address the gap of utility. Food quality is a condition that measures both food availability and food access. Food may be available however Thompson notes it may not be nutritious leading to serious health conditions.

2.6.3 Food Sovereignty.

Across the academic spectrum, a consensus has emerged that the distribution and production of food need to be more sustainable. The means of attaining these goals as argued by Shilomboleni (2017) are widely contested and unclear. Emerging from the unclarity in approaching food security two different approaches have become prominent in food security debates within the Global South. The African Green Revolution movement undertakes an institutional approach including governments, philanthropists in tandem with the private sector and food donors with high reliance on initiatives such as food aid to supplement food availability shortages. The institutional approach mirrors the purporting actors as the primary factors that are explored are trade, production, income, and market access.

The Food Sovereignty movement challenges traditional notions of food security by exploring structures of power and ownership. It prioritizes peasant social structures led by peasant unions and civil organizations, with a central focus on addressing market access and food inequality. (Shilomboleni 2017). Shilomboleni notes that the contentious debate is on how to address food insecurity sustainably in the context of widespread commercialisation and poverty. Discussions regarding how to tackle food insecurity often involve those who contest the concept of insecurity, advocating instead for food sovereignty as a means to address food inequality. Shilomboleni argues that food sovereignty addresses the social and economic inequalities that are tied to having limited access or availability to food. This stands in contrast to the initial solutions Shaw presents in providing aid and offsetting food deficits.

In opposition to Shaw and undertaking a disruptive approach to food security Satgar and Cherry argue for a comprehensive approach to a globalised neo-liberal food system (Satgar and Cherry 2019). In favour of the food sovereignty movement Satgar and Cherry argue that following continued climate crises throughout Southern Africa, food security responses centred around privatised aid and government policies are insufficient in addressing the inability to acquire and distribute food. Food availability and production is not considered as

a concern following the green revolution of the 1970s instead as argued by Satgar and Cherry (2017) the considerable challenge is food inequality that arises from corporatized food systems that shift capital away from agricultural producers. Reliance on exports and profits as a form of income places severe strain on vulnerable food producers who do not have access to agricultural products, seeds, or capital to maintain sustainable agricultural practices. Small-holder producers who produce more than 80% of local and regional food supplies throughout southern Africa are also considered as being highly vulnerable and within flux between spectrums of poverty (Satgar and Cherry 2019). Satgar and Cherry (2019) align with the arguments of availability and entitlements presented by Sen (1981) by arguing that food availability and access are determined by income and poverty levels. The vast inequalities within food systems, stemming from disparities among food producers, are exacerbated by adaptation inequalities. Small-holder agricultural producers encounter government and policy challenges in adapting, largely due to widespread reluctance to address food-related issues arising from climate change.

Throughout the research conducted by Crankshaw in exploring the agricultural role of food sovereignty, a key exploratory indicator arises through the G8 New Alliance for Food Security and Nutrition (Crankshaw 2015). The consideration and implication of challenges to climate as argued by Crankshaw is the significant economic and social power structures that limit access to sufficient resources namely through the lack of ownership and food sovereignty. With the rising climate production levels have decreased leading to rethinking food production systems. These systems are based on equity. and as noted with the G8 as argued by Crankshaw there is an opportunity to address the issues of climate change.

2.6.4 Literature response

The literature on food security is widely complex ranging from availability approaches to entitlements and sustainable livelihood approaches. In response to these debates, the idea of fixed food security as identified by the FAO through assessing availability, access, utilisation, and stability is largely attributed to policy, poverty, and governance inequities (FAO 2002, FAO 1996). As variables, these challenges and conditions insufficiently address the impact of climate variation on food security namely through assessing production trends amidst climate variation. The most notable argument presented is by Schmidhuber and Tubelio (2007) which note the varying impact that climate change could pose to vulnerable food systems. In addressing food challenges, a widespread agreement is that global food systems need to be sustainable. However as noted by various scholars the focus on addressing sustainability is

based on addressing government, social and economic shortfalls. These approaches such as the entitlements and food sovereignty approaches do not sufficiently address the role of climate variation. In a critique of food sovereignty approaches and entitlement capital and social inequities are disproportionately addressing economic and social factors that impact farmers. The lack of food availability and access is widely attributed to inequality and government inefficiencies however these approaches are unable to address key trends where food availability and access decreased following local and regional improvements in food access and equity. In comparison to the daily trial, farmers face decreasing production stocks and localised crop failure decreasing immediate supply and nutrition these approaches similarly provide brief overviews of how communities directly respond to the threat of climate variation on their livelihoods.

A key gap throughout the literature is the impact and activities that food producers utilise to offset food insecurity. The presented authors each identify serious challenges within food production systems ranging from production to income and distribution. In assessing food security, the human security debates do provide a framework for identifying the role of climate change and community response to food security issues that encompass elements from the different approaches to food security. Shilomboleni (2017) rightly notes that the debate and disagreement are largely based on how to achieve food sustainability. This research report addresses the gap by utilising human security as an approach to the impact of climate variation on communities by assessing the production and accessibility of food throughout climate shocks. Secondly, in undertaking a person-centred approach, this study explores how small-holder farmers have responded to climate variation and what role adaptation plays in adapting and mitigating the effects of climate variation.

2.7 Climate adaptation and sustainable livelihoods

Regarding human security, the concept of climate change and climate variation is aligned largely with promoting human development through adaptation and resilience based on the dimension of environmental security. By emphasizing adaptation and resilience promotion, international institutions aim to direct attention toward addressing threats through both prevention and empowering individuals to cope with environmental hazards, whether natural or man-made (IPCC 2014, IPCC 2018). Adaptation and resilience are key environmental conditions that are needed to address the challenges of insecurity and existential threats to the livelihoods of poor and vulnerable communities (Taylor 2013). Following the rise in extreme climate conditions a new set of interventions are needed to address human insecurity. Despite

its origins in human industrialisation and CO2 emissions the security dimensions of climate change are highly variable from addressing the root cause to mitigating its effects.

Human security scholars emphasise the need to empower individuals and communities in addressing existential crises and threats to the livelihoods of individuals and communities (Taylor 2013). Access to resources and support mechanisms are necessary within economic and socially vulnerable communities where prolonged weather and climate events directly impact their livelihoods. The livelihood threat is an interconnected spectrum affected by strained climate conditions (Scoones 1998, Taylor 2013). Climate variation is attributed to impacting the health of individuals through heat stress and nutrition availability. Similarly, the threat of climate variation on livelihoods is impactful as developing communities rely on climate-dependent resources as a source of economic activity and income (Scoones 2020, Taylor 2013). Thus, climate variation and climate change are a significant variable across the dimensions of human security encompassing the direct threat to individuals.

The most noticeable impact of climate variation is felt in accessing essential survival needs like clean drinking water and nutritious food. Insecurity becomes a significant concern in underdeveloped communities. Vulnerable communities and individuals experience economic, health, food, and environmental insecurity as climate variation targets the core needs of individuals. In relation to livelihoods and food security climate variation is impactful on communities where subsistence and small-holder farming provides opportunities for income, nutrition, and health (Scoones 2020).

With rising temperatures and variant climate conditions developments in agricultural and livelihood sustainability have focused on the capacity of food systems to absorb stresses and maintain their core functions to ensure the limiting of socio-economic, political and food-based collapse (Conway 2007, Conway and Barbier 2013, Thompson and Scoones 2009). The food system chain is disrupted largely at the production levels as food producers have to expend limited resources to absorb the stresses of climate variation. In absorbing these stresses individuals and communities need sufficient resources and the means to adapt to rapidly changing climate conditions.

The focus of international organisations and governments has been directed at closing the gap between the global North, which can mitigate and adapt to changing climates, in relation to the global South, where various developing states continue to experience climate extremities (Smit et al. 2001, Taylor 2013). This has led to a widespread debate regarding the rising need

to adapt to rapidly changing climate conditions to ensure the equitable well-being of vulnerable communities.

In responding to climate change the most prominent definition of adaptation and resilience is the ‘‘changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change’’ (Smith et al. 2001, p. 879). While there is an intense debate surrounding defining and identifying adaptation this study will focus on Smith’s definition as it is the most comprehensive and widely agreed-upon notion of adaptation that accounts for the complexities that the social, economic, environmental, and political spheres have on farmers.

Adaptability and resilience have emerged as a normative framework where the role of international organisations, NGOs and governments should be to ensure the well-being of vulnerable communities by promoting adaptation and developmental support (Taylor 2013). The UNFCCC outlines that all state and non-state parties must present, develop, facilitate, and implement national and regional programmes to measure and facilitate adequate adaptation towards climate change and climate variation that benefits the livelihoods of individuals in poor and underdeveloped communities (UNFCCC 1992 Art. 4.1b, FAO 2007). As regional temperatures rise adaptation and resilience as two concepts become interlinked with the severe strain that is placed on food systems and human development. The process of adaptation has two major spectrums which are autonomous and planned adaptation. Autonomous and planned adaptation are based on being either preventative in responding to climate shocks or reactionary (Easterling 1996). Autonomous adaptations are considered to be reactionary as the FAO (2007) notes:

“Autonomous adaptation is the reaction of individuals, for example, a farmer to changing precipitation patterns, in that s/he changes crops or uses different harvest and planting/sowing dates.” (FAO 2007, 5)

The other main factor of adaptation is planned adaptation. Planned adaptations are the result of policy-oriented responses recognising that conditions are changing, and that action is required to maintain or promote a desired state (Easterling 1996, Malik et al 2010). These adaptations could be national or regional crop substitution, systemic agricultural policies or specified selection of crops and irrigation methods (Easterling 1996). Planned adaptations are large macro plans and policies aimed at preventing food system strains. Through his research, Easterling presents the findings that conscious policy initiatives regarding food systems and

planned adaptation are preferable as they ensure sufficient adaptation alongside providing resilience through the occurrence of food crisis limiting the negative and humanitarian impacts that might arise (Malik et al 2010).

In contrast to Easterling's perspective, global climate variability has strained the efficacy of these plans aimed at fostering adaptation and resilience. This strain is exacerbated by social inequalities and the state-centric approach to security, which has curtailed developmental responses, resulting in widespread environmental vulnerability among marginalized populations (Taylor 2013). The framework and background of Easterlings (1996) research does not account for the rapidly changing conditions that might arise through climate change which threatens base capital assets (Scoones 2020). Throughout Sub-Saharan Africa, where more than 70% of inhabitants are reliant on climate-vulnerable sectors to maintain their livelihoods, the question of preventative adaptation becomes less appealing with recurring droughts and intense climate variation (AGRA 2017). Hence, communities in developing regions and states have emerged as autonomous responders, unable to adopt preventive measures due to insufficient resources and limited access to support systems. The sudden decline in rainfall, along with unusually high temperatures, has become a daily struggle for vulnerable communities. These communities have limited access to planned adaptation measures, such as formal irrigation systems and widespread crop rotations. Autonomous adaptation is preferable due to the low-cost entry barrier and short-term effects.

Autonomous adaptation has become the most widely adopted approach because it primarily revolves around short-term events and does not depend on large-scale state interventions. Farmers are able to selectively adapt to changing conditions based on their climate and production needs. Short-term adjustments within agricultural systems from farmers and agricultural producers are largely due to the localised nature of the occurring adaptation (FAO 2007, IPCC 2014). In undertaking a reactive approach autonomous adaptation aligns with contextualised threats. Rather than being prevention-oriented, autonomous adaptation within human security is comprehensive by including all necessary actors to directly respond to climate variation. The conditions that arise often require a desperate sense of protection from governments alongside the means of empowerment from communities reacting to severe climate threats (UNDP 2016, UNDP 2002)

In adopting autonomous adaptation, the impact and influence of government policy and institutional response are limited (FAO 2007). Taylor (2017) outlines that vulnerability

assessment through social and economic inequality is supportive of preventing or mitigating human insecurity. Thus, through developmental assistance individuals and communities would be able to address and adapt to changing conditions. The prevalence of autonomous adaptation among small-holder farmers does present challenges to addressing the severity of climate conditions. Autonomous adaptation is widely conducted under severe conditions and is less reliable than planned adaptation (Easterling 1996, Taylor 2013).

Chapter 3. Climate Change and Food Security: The Case of Mozambique

3.1 Introduction

Mozambique has been identified as being one of the worst affected Southern African states regarding climate variability. Mozambique has historically experienced extreme droughts, recurring floods and disastrous cyclones which has recently increased in severity due to prolonged climate disasters. The most notable weather and climate disasters posing significant threats to development and human security regarding Mozambique include the recurring cyclones, Hellen and Matthew in 2014 and 2016 alongside the El Niño-induced drought phenomena spanning 2015 to 2017. Mozambique ranks among some of the most susceptible countries to climate shocks due to climate change (World Bank 2020). In reviewing the case study, the chapter highlights a background to the case of Mozambique followed by production and access trends during the 2015-2017 drought period. Furthermore this chapter argues that adaptation has had a significant effect on food prices and food production which in some instances has mitigated the worst effects of climate disasters and in some cases has led to worsening conditions.

In response to the production trends, the chapter also explores how smallholder farmers have responded to these crises by analysing the usage of conservation agriculture and crop diversification alongside water irrigation and rain-fed adaptation across Mozambique.

3.2 Case Background

Mozambique is in a unique position in comparison to its neighbours, namely that it has a large coastline with climate vulnerability followed by conditions of intense drought and increased food production (FFSSA 2004). Alongside ecological challenges, Mozambique is classified as an underdeveloped nation with a national poverty rate of 46%. The poverty rate is exacerbated by continued climate phenomena that threaten a majority of Mozambicans such as extensive droughts, destructive cyclones and floods which limit or hinder vital production systems such as widespread pastoralism, fishing, and forestry. These humanitarian risks originate from intensified climate variations, which affect the 3.5 million small-holder farmers as regional temperatures rise and rainfall patterns become increasingly erratic. Small-scale farmers play a crucial role in sustaining 95% of Mozambique's agricultural production, with the remaining 5% attributed to the 400 commercial farmers. (FAO 2020, INE 2014). Mozambican agricultural production contributes 23.4% towards the total GDP and is the largest formal and informal employer (INE 2014). The reliance on small-holder

farming for nationwide food security has been at the forefront of the challenges Mozambique contends with.

Mozambique has been a conflict-ridden state since its independence in 1975 from Portugal. What followed was immense destruction and continued humanitarian crises with intense combat between FRELIMO and RENAMO (FFSA 2004). With the end of the conflict, Mozambique like many other African states throughout the 1990s experienced a wave of democratisation and exponential economic growth alongside local and international prospects of increased living standards. Throughout the period between 1990-2010, Mozambican GDP growth peaked at an average above 5% annually followed by rising food production and declining food insecurity (World Bank, 2020). This peak in economic activity was followed by the easing of tensions between former warring factions FRELIMO and RENAMO. The trends of growth and democratisation correlated with the continental trend of adhering to developmental strategies and goals outlined by UN institutions and regional organisations. A key milestone that is worth noting as an indicator of progress is the adherence to the Millennium development goal of halving hunger by 2015 alongside decreasing chronic poverty from 80% in 1990 to 45% by 2015 (World Bank 2015).

Mozambique throughout its recovery from a destructive civil war managed to adhere to the goals set out at the 1996 World Food Summit and the Millennium Development Goals by both halving nationwide hunger and decreasing chronic poverty from 80% to 46% (WFP 2015). However, with the 1986 World Bank Report on food insecurity and the latter World Food Summit, the key concepts that have arisen is that food insecurity is a complex interconnected process between rural sustainability through food production and climate variation through rapid disasters such as flooding or prolonged droughts.

With increased cereal production with the advent of the new millennium a combined effort from the Mozambican government, international aid agencies and local nutritional programs led to this goal being met (US AID 2017). Scholars commonly assume, within traditional aid structures, that increased employment leading to higher food production, reduced incidence of food-related diseases such as Kwashiorkor and anemia, and economic growth would facilitate climate change mitigation and adaptation within the agricultural community. This scenario would seemingly apply to Mozambique, especially in meeting the Millennium Development Goals during the 2000s.(WHO 2020). The following decade would provide the contrary with rapidly rising temperatures and varying climate conditions leading to an

increase in the severity of droughts alongside a stabilisation of economic and social growth Mozambique has been thrust into extreme humanitarian conditions following a increase in climate shocks. This is noted with the recurrent El Niño drought of 2015-2017 alongside a slew of devastating cyclones namely Cyclone Idai and Kenneth (Emerton et al 2020).

The rapidly changing climate has significantly hampered nutrition production rates followed by the severity of climate-related disasters such as cyclones Matthew, Idai, and Kenneth alongside the regionwide El Niño droughts of 2015-2017. The frequency and severity of these disasters have led to declining living standards and declining production as noted throughout 2016 where average food security through production declined up to 50% (Emerton et al 2020) While these background accomplishments are key in exploring food systems several crises did arise threatening food security within Mozambique.

The most significant impact on food security and production arose throughout two significant periods. The initial regional climate crisis was in 2001-2003 when a combination of extreme floods and serious droughts placed most of Southern Africa, including Mozambique, at risk of a severe humanitarian crisis (FFSSA 2004, World Bank 2020, Crush and Frayne 2011). The second crisis was a set of seasonal droughts following the 2015-2017 El Niño period which threatened the majority of Southern Africa with extreme heat conditions coupled with extreme water shortages. Mozambique throughout this period was at extreme risk of dramatic food insecurity with declining production of food products ranging from pastoral-based products to crops and fisheries. With the general decline of food production various concerns and measurements of food insecurity have arisen throughout Mozambique. This is noted with rising cases of anaemia between women of the ages of 15-49 breaching 50% in 2014 and increasing significantly during drought years (World Bank 2016). Essentially, these patterns reveal a consistent trend: the occurrence of food-related diseases has historically been prevalent in Mozambique during drought periods, with the notable exception of cyclones Kenneth and Idai.

In assessing the relationship between climate change, variation, food security and food production throughout Southern Africa, Mozambique as a case study presents unique insights. The aforementioned relationships correlate with the phenomena of rapid economic growth averaging above 5% per annum alongside early increased food security from 2001 to 2009 namely staple foods of cassava and Maize (SADC 2020). The phenomenon of the Mozambique achieving one of the objectives established in the Millennium Development

Goals, namely halving hunger, has been short-lived. Mozambique remains at high risk of humanitarian crises due to rising cases of nutrition-based diseases, frequent and disastrous climate variations, and declining food production and agricultural income. However, even with the promotion of food security and sustainability malnutrition continued to be relatively high with an estimated 2.1 million people considered food insecure amidst drought periods and conditions (FAO 2016, USDA 2016, US AID 2017, FEWS NET 2017)

3.3 Food and Agricultural Production Trends.

From 2015 to 2017 average rainfall precipitation varied heavily across Mozambique. The national average indicated that throughout the 2016/2017 harvest period where maize, cassava and sorghum were the primary harvests, the national rainfall average decreased below 800mm in comparison to the norm of 1200-1600mm year-on-year (OHCR 2016). In contrast to the national average of rainfall regional rainfall differed substantially impacting different forms of production. Regionally provinces such as Gaza, Sofala, Maputo and Inhambane experienced the largest decline in rainfall while in comparison Tete and Niassa experienced abnormal increases in rainfall following higher food production (OHCR 2016). The food crops that Mozambican farmers widely produce and are reliant on for nutrition are a combination of cassava, roots and tuber, and maize. The key observation throughout 2015-2017 is that despite the regular shift in rainfall patterns from La Niña to El Niño rainfall precipitation was far below average rainfall patterns. The severity of declining rainfall is most impactful on the agricultural sector which provides most of the food production and income for rural producers in the aforementioned provinces.

3.3.1 Cassava, Roots, and tubers

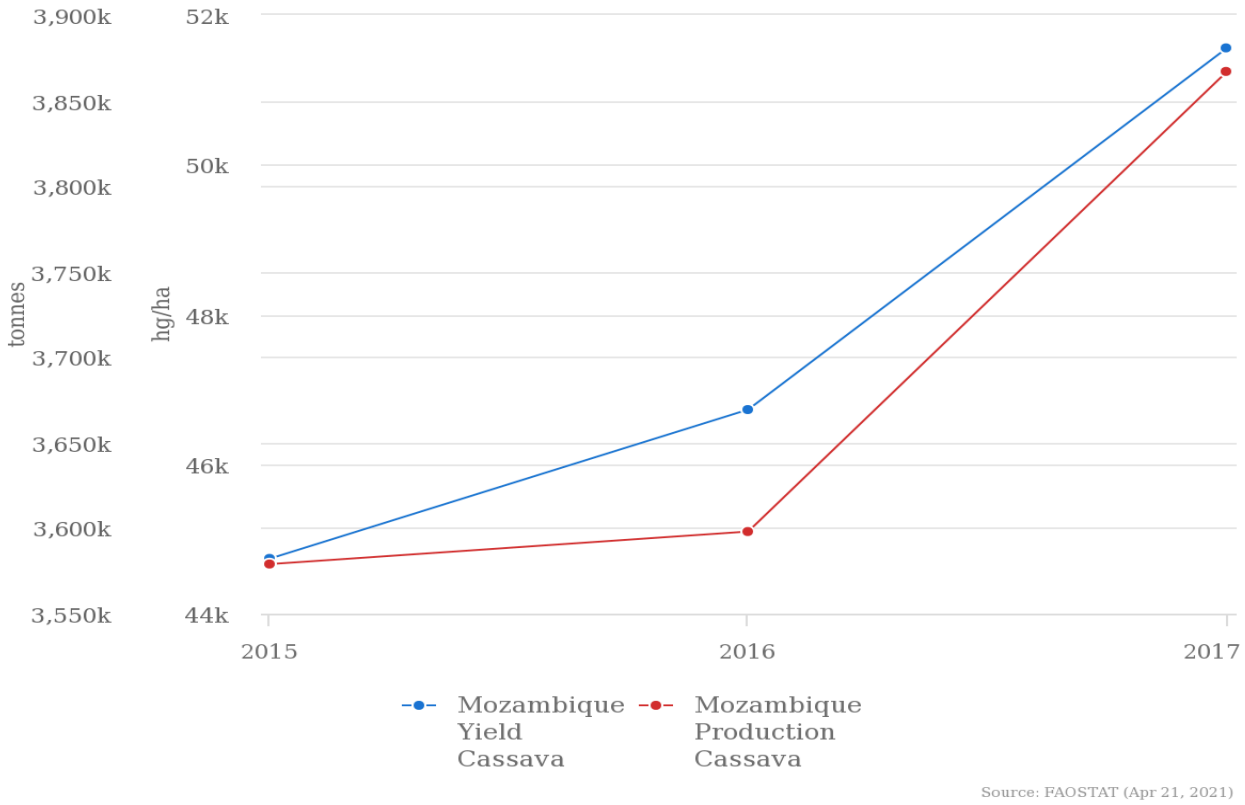
Cassava is the most produced and consumed staple crop across Mozambique with production cultivation concentrated throughout Zambezia and Nampula alongside the southern coastline provinces of Maputo and Gaza (Costa 2019). The production of Cassava is widely mixed with maize in local diets and is produced as a staple food due to being highly resistant to drought conditions that often threaten production chains. Within the initial stages of drought in Mozambique during the harvest season of 2015, cassava was produced by an estimated 58% of households for both nutrition and as a form of income (CGAP 2015). The production of cassava is largely concentrated throughout Northern Mozambique namely Cabo Delgado.

Throughout the 2015-2017 period following regional rainfall precipitation varying between 800-1000mm per annum cassava production has declined significantly throughout the period. The average production of cassava before 2015-2017 was above 4, 100k tonnes per annum

with variation across cyclones and disasters (FAO STATS 2020). The scale of the impact of rainfall is noted through the overall decline in rain across Mozambique decreasing by as much as 800mm per annum throughout the 2015/2016 harvest period. In Nampula and Zambezia where cassava is widely cultivated the ORCS reports that throughout the region excessive flooding has occurred which is in line with abnormal increase in rainfall precipitation limiting cassava production due to soil saturation and the halting of growth (ORCS 2015). Regarding flooding in Nampula and Zambezia, the provinces most susceptible to heavy rainfall, the ORCS (2015) study noted a decrease in production due to crops becoming saturated and unable to be harvested due to heavy mud and crop failures.. The saturation of crops is the advent of roots and tubers which gestate underground in comparison to maize which grows out. Decreasing rainfall, while promoting cassava due to its drought-resistant properties, leads to less arable land viable for cassava cultivation. The decreasing cultivation of cassava is noted with decreasing harvested areas steadily declining below 800 000 hectares of harvested land between the period of 2015-2017 (FAO STATS 2020, WFP 2016). Cassava cultivation and crop failures would lead to higher cultivation to offset production; however, regarding cassava production less land was cultivated, and cassava yields increased alongside cassava production (See Figure 3.1).

The decline in cassava production is however more influenced by recurring droughts than floods. Regardless of the cultivation of cassava due to its ability to withstand drought, the impact of climate variation throughout 2015-2017 is indicative of both increasing cassava production but also of cassava imports and access (Costa 2019, FAO 2016). Throughout the 2015/2016 harvest season ,where floods were limited, the area harvested and production quantity differ immensely from the previous 2014/2015 season. Low production yields reflect higher levels of crop failures. This stands in contrast with the increased production of cassava throughout the period by regions that received above 1000mm rainfall such as Zambezia. The strain in cassava production is that with highly variable rainfall patterns cassava yields are low with mass crop failures and individual farmers unable to increase production (OCR 2016, FAO 2016). In areas experiencing increased rainfall, there was a simultaneous increase in production, effectively compensating for low yields.

Figure 3.1 Cassava: Production and Yield within Mozambique 2015-2017



Source: Analysis from FAOSTAT 2021; Accessed 21 April 2021.

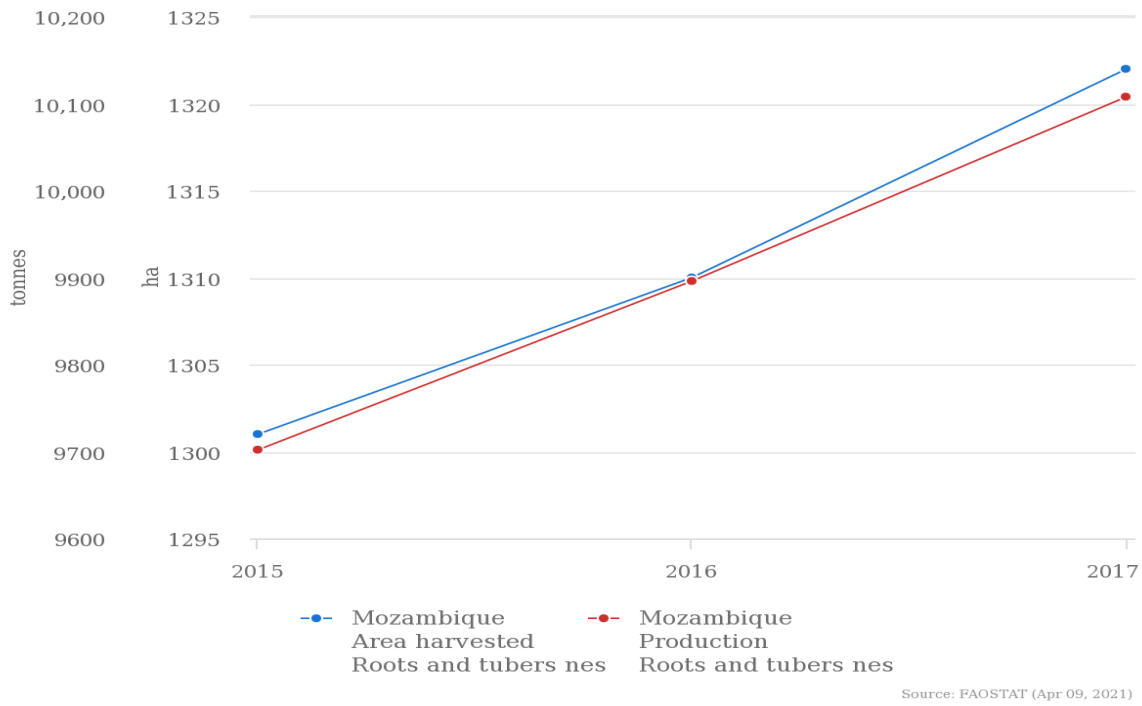
Throughout the drought of 2015-2017, the key trends as noted in Figure 2 reveal that cassava yields were exceptionally low in 2015. In comparison as rain precipitation slowly increased in 2016 the overall cassava yield increased slightly. Despite facing drought conditions, Mozambican smallholders persisted in cultivating cassava, as evidenced by the overall yield compared to the total production. Hence while cassava production was low with a slow recovery farmers continued to cultivate the crop as a means to both maintain nutritional standards and to mitigate the overall impact of severe drought conditions. As indicated throughout the Mozambican Household Survey the majority of rural and urban agricultural producers cultivate cassava for nutrition and income. The trends are thus indicative of concerning climate conditions leading to higher adoption of cassava which is more drought resilient than other crops such as maize.

In comparison to cassava different roots and tubers are largely produced based on shorter gestation periods and are cultivated as substitution crops. Maize planting arises throughout October and November and is harvested in April. Contrastingly, different root crops and tubers like beets and cassava are harvested intermittently, both between and during the

traditional planting and harvest seasons, resulting in higher production and turnover periods. These conditions lead roots and tubers to be highly popular among smallholder farmers as noted with widespread cultivation (Costa 2019, WFP 2016). With declining harvests and rainfall, the production of roots and tubers has noted a substantial increase throughout drought and flood periods. Within the 2015/2016 harvest season while maize and cassava production declined the area of roots and tubers being cultivated, harvested, and produced has increased from below 1300 hectares in 2014 to above 1320 hectares (FAO STATS 2020, World Bank 2017).

In relation to drought conditions, more crops are noted to fail throughout the drought period leading to more land being cultivated with roots and tubers to offset crop failures as noted by low yields. This constant trend is noted with the declining area being harvested as rainfall improved in 2017.

Figure 3.2 Roots and Tubers: Production and harvest area within Mozambique 2015-2017



Source: FAOSTAT 2021, accessed 9 April 2021

Throughout the drought period, both production yields and production quantities of roots and tubers increased following declining maize production. While including roots and tubers the diversification of crops is a strong response to failing cassava yields leading to beets and other roots and tubers to be produced to offset low cassava yields. Roots and tubers have recovered from the initial drought period in 2015 evenly up until the peak of 2017 following

the return of seasonal La Niña rains. The increase in cultivation and production of roots and tubers as noted in figure 3.2 is indicative of smallholder farmers attempting to offset high reliance on cassava and maize as sole cultivated crops. The cultivating of roots and tubers has thus emerged as a key emergency response by small-holder farmers which throughout 2016-2017 increased overall availability of roots and tubers for consumption. While cassava remained a key crop in terms of farmer yields, the increase in roots and tubers production is indicative of smallholders diversifying their crops in order to maintain food access and food availability. Roots and tubers have emerged as a sustainable alternative to cassava and maize and the higher cultivation reflects that more smallholders are cultivating various roots and tubers to address rising food prices and to maintain adequate food stocks amidst struggling cassava and maize cultivation.

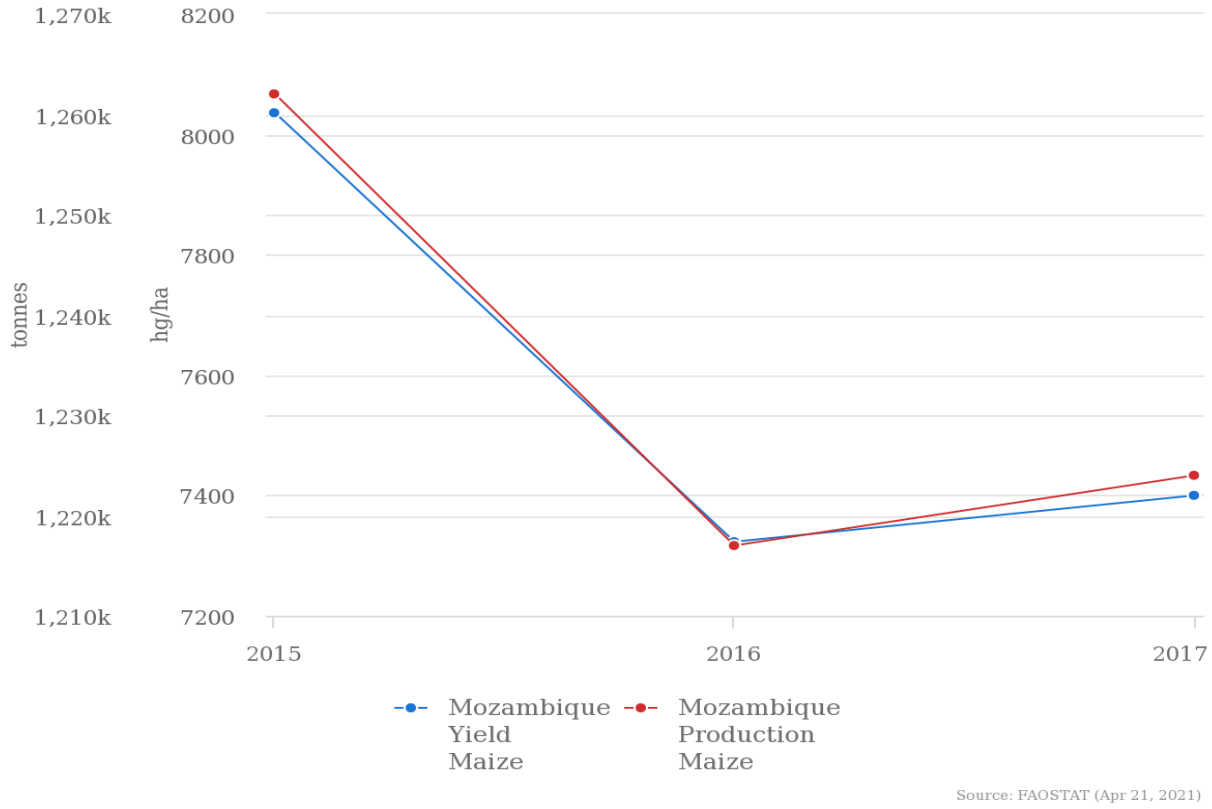
In comparison to staple crops such as maize and cassava, the average production of roots and tubers far outpaces that of maize. However, with the widespread availability of roots and tubers which are largely grown as supplementary crops in non-planting or non-harvesting seasons what becomes evident is the continued food insecurity that arises when conditions for these crops deteriorate with low rainfall (FAOSTAT 2020). The importation of roots and tubers signifies a notable deficiency in accessing these commodities for nutrition, despite increasing production rates. Nonetheless, market indicators reveal a dependence on subsistence foods during dry periods. Exports of roots and tubers are still overshadowed by rising food imports concentrated by maize imports and reliance on cassava production (TEC 2020, World Bank 2017). However, in terms of availability, the necessity of roots and tubers for nutritional value arises with variations in climates. Throughout 2014 Mozambique experienced the highest rate of root and tuber production alongside exportation peaking at 1 320k tonnes at the end of 2017. However, throughout the intense climate variation that arose through El Niño droughts and floods, these exports decreased significantly (FAOSTATS 2020. TEC 2020). While roots and tubers continue to represent some of the most produced commodities throughout Mozambique subsistence farmers are still highly reliant on cassava and maize as a form of income and nutrition with consumption rates surpassing minor roots and tubers as 60% of farmers indicate in mixing cassava within their meals rather than substitute roots and tubers (CGAO 2016).

3.3.2 Maize

Maize is the second most produced crop throughout Mozambique behind cassava and the most widely cultivated (CGAP 2016). This is noted with maize often being produced and mixed alongside cassava to a lesser extent.

Regarding maize production, similar trends in relation to cassava and roots and tubers, indicate that production and harvest area declined throughout 2015-2017. The most notable shift in maize production arose throughout the 2015/2016 harvest season which experienced the largest production slump of maize.

Figure 3.3 Maize: Production and Yield within Mozambique 2015-2017



Source: FAOSTAT 2021, accessed 21 April 2021

Maize production has been particularly affected by continued drought. Maize cereals are highly reliant on stable rainfall throughout rural Mozambique and is the second most cultivated and consumed crop behind cassava. Maize has been severely impacted throughout the drought period as figure 3.3 notes from 2015-2016 maize production and maize yields declined exponentially. Production was particularly affected with maize production decreasing from 1,27 million tonnes in 2015 to less than 1,22 million tonnes in 2016. The decrease was followed by a slight increase in 2017 indicating the volatility of maize

cultivation and production throughout tumultuous climate disasters. Decreased production and cultivation can also be attributed to higher production of roots, tubers and cassava to offset the impact of drought conditions on maize. Small-holder cultivation of maize is however not spread equally. Maize consumption and cultivation is much more prevalent throughout drier central states such as Inhambane and Tete. Throughout the low of 2016 the availability of maize as a staple cereal has been severely threatened as noted with lower cultivation and production. The concern within these trends is the shift away from a balanced diet consisting of maize and other crops to more climate secure crops.

Maize cultivation is widespread across Mozambique as a sustainable seasonal crop. Maize is the largest seasonal crop utilised for cultivation. The small-holder household survey notes that out of 3979 respondents 87% of households who undertook the survey cultivated maize (CGAP 2016). The high cultivation of maize and seasonal variation indicate the volatility of maize production. Maize production unlike cassava is widespread and grown across all regions. The widespread cultivation of maize does correlate with high production volatility throughout 2015-2017 with the most notable regions affected being Nampula, Inhambane and Gaza. Maize production declined as national rainfall decreased below 1000mm however in regions which experienced higher rainfall such as Niassa the declining maize production is attributed to recurring flooding threatening crop production and maintaining low yields and production amidst crop destruction (WFP 2017)

Maize is highly sensitive to erratic rainfall conditions and thus is highly susceptible to recurring droughts. These susceptibilities are observed in small-holder maize cultivation in Southern Mozambique. Southern Mozambique is largely arid in comparison to central and northern districts and provinces. Between 2015 and 2017 the heavy reliance on maize production noted an average decrease of above 40% in maize production throughout Gaza and Inhambane (FEWS NET 2017)

3.4 Food Availability and Food Access

3.4.1 Availability and Food Production.

In correlation with declining overall production, USAID indicates that 2 million inhabitants were food insecure with 2 million more at risk of food insecurity due to declining food stocks and production (USAID 2017). The availability of food has been on a steady decline throughout Mozambique as noted with rising food imports to fulfil demand. The increase in food insecurity and risk increases with erratic rainfall patterns. Throughout 2015/2016 food insecurity rose as limited access and production led to increased imports to fill demand.

Facing crop failures and lower production, Mozambican farmers relied more on imported food through local markets or international aid (USAID 2017)

Table 3.1 Food Import Aggregate: Mozambique (Tonnage)

Measurement year	Food Import aggregate
2015	37392
2016	53208
2017	69223

(Sources: FAO STATS 2020)

Food imports gradually increased as stocks declined. In alignment with declining maize and cassava production food imports drastically increased within the lowest production season between 2016 and 2017. The peak of imports is noted throughout the 2016/2017 harvest season peaking at more than 53k tonnes. The import aggregate mirrors the declining and erratic rainfall patterns and food imports as maize imports increased with primary suppliers originating from South Africa and Zambia (ORCS 2016)

Table 3.2 Mozambican Maize import aggregate (Tonnage)

Measurement Year	Food Import Maize (Tonnage)
2015	119122
2016	138409
2017	94455

Source: FAO STATS 2020, World Bank 2020[1]

Regarding Maize, similar trends to food imports are observed. As noted in table 3.2 maize imports increased from 119k tonnes to 138k tonnes between 2015-2016. Given that maize is primarily mixed with cassava the increase is indicative of higher demand throughout Mozambique. When climate variation affects local supply, higher demand is often indicative of decreasing food security and food conditions. The rise in maize imports suggests that local markets are trying to mitigate shortages by engaging in regional and global trade.

Regarding cassava production, it is noted that declining stocks of cassava align with climate variation as nationwide rainfall precipitation variated between 800 mm-1000 mm per annum.

[1] Food import Aggregate is calculated through the importation of other foods defined by the FAO as trade crops and livestock code 1894.

What is also key to note is the declining stocks and production were also affected throughout Northern Mozambique and across the coastline where flooding impacted drought-resistant crops like cassava (ORCS 2015). In Northern Mozambique, the heightened rainfall during 2015-2016, which resulted in widespread flooding, is linked to decreased maize cultivation production. Meanwhile, in Gaza, Inhambane, and Sofala, severe dry conditions have led to delayed planting and harvesting, as well as reduced productivity during harvests (ORCS 2015, FEWS NET 2017). Contrary to the assertion that droughts pose a greater risk of productivity insecurity, it has been observed that regions experiencing flooding due to changing rainfall patterns were also negatively affected with lower yields and production. In regions like Niassa and Zambezia, which typically receive higher average rainfall, there was a temporary decrease in production (ORCS 2015). However, these areas experienced stabilization in crop yields during harvest periods (ORCS 2015). Regions that experienced above 1000mm rainfall were at lower risk of food insecurity as indicated by high national production and these provinces' contribution to retaining production. These regions namely Niassa and Zambezia also noted price stabilisation of items such as maize while provinces such as Nampula and Gaza are the most insecure with severe water shortages and droughts (WFP 2017). The inequities that are identified are that climate variation exacerbates the availability of food.

The discrepancies in food availability and pricing are most notable in comparing rural versus urban areas. Throughout rural areas where the largest crop production occurs 46% of households experienced stunting among adolescents due to unavailability (USAID 2018). Whereas within markets where food is more available due to imports ,such as Maputo, stunting was lower at 35% (USAID 2018). In attributing the lack of food availability, the reason as indicated by local agricultural producers is limited access to food markets due to distance and low income (CGAP 2016).

The prevalence of at-risk individuals at the start of the 2015 El Niño drought season revealed that Gaza Inhambane, Sofala and Niassa experienced extreme conditions of food insecurity following a decline in production whereas throughout Zambezia and Maputo alongside national indicators note that more than 500 000 people were considered at risk of being food insecure. Drought conditions impacted the Southern Provinces of Maputo, Gaza and Inhambane with higher rainfall variation than tropical provinces such as Zambezia (ORCS 2015).

The key trend that is observed with extreme rainfall variation and the availability of food is the higher cultivation of substitute crops and increased imports. Declining rainfall followed with rising cultivation of roots and tubers alongside cassava to offset declining maize stocks.

3.4.2 Market Access and Food Prices

The consideration of low production throughout the initial period of July 2015 – January 2016 also noted a higher reliance on market-based food rather than locally produced (ORCS 2015, FEWS NET 2017). During July 2015-January 2016 widespread reliance on market acquisitions of cereals excluding Manica and Tete increased which is reflected by increasing imports of cereals and higher consumption peaking at 40% of household purchases in 2016 (CGAP 2016) These pressures arise from the significant dependence on imported food to sustain available stocks (FEWS NET 2016). Between 2015-2017, the aggregate food import increased significantly in comparison to previous harvest seasons. The reliance on market-based transactions for food is supported by declining availability and production. This is noted with rising imports throughout the 2015-2017 drought periods with the most significant increase throughout 2016-2017 by 16015 tonnes (FAO 2020).

Market access for food stocks experienced drastic shifts in pricing amidst climate variation as food systems were placed under strain.The prices of food and commodities varied between seasonal harvests with an overall year-on-year increase. Maize price indicators are highest within rural areas such as the Chokwe district where prices reached as high as $1,26 per kilogram throughout the 2016/2017 harvest period (FEWS NET 2017). In comparison, urban areas such as Beira have maize prices stabilising at $0,90 per kilogram of maize from October to March during the 2016/2017 harvest season (FEWS NET 2017).

Cassava prices in relation to maize prices have been much more varied and severe in poor communities. In utilising cassava households to convert and purchase cassava flour for nutrition the pricing however of cassava flour throughout the 2015/2016 agricultural season shifted from $0.53/kg to $0.63/kg within Nampula province (FEWS NET 2016). The situation in Nampula highlights the disparities and impacts of the drought on impoverished regions, as prices were lower in Maputo and Southern Mozambique. In comparison, the most affected market by variating prices is Nacala city in Nampula which in a break from provincial pricing experienced a low of $0.35/kg of cassava flour in 2015 however in 2016 with rising environmental conditions and declining production experienced a high of $1.17/kg (FEWS NET 2016, WFP 2016).

Mozambican households have also increased their expenditure on consumption with the increased prices however drought-prone regions have experienced lower food consumption on average (CGAP 2016). The effects of food price increases are most pronounced in impoverished northern regions like Cabo Delgado and Tete, where over 50% of household expenses are allocated to the acquisition of food and food-related items (Baez et al 2018). Within these regions, high consumption rates based on food purchases are undertaken by small-holder subsistence farmers who throughout drought periods purchase food to offset production and availability. Small-holder farmers and poor households are more sensitive to food price changes in maintaining access to available food stocks. Household expenditure mirrors these challenges as 60% of total daily and monthly budgets are expended on food within drought-prone and poverty-vulnerable regions (Baez et al 2018).

3.5 Conservation Agriculture and Crop Diversification

The use of conservation agriculture through crop diversification and irrigation conservationist agriculture is widely employed by small-holder farmers throughout Mozambique with the primary focus on cultivating a variety of crops. The majority of small-holder and subsistence farmers rely on generational traditional knowledge in adapting to climate change with changing irrigation systems, shifting planting and harvesting seasons and planting a variety of subsidiary crops to avoid pests and promote crop diversification (Grabowski and Kerr 2014). To cope with the threats of recurring droughts, cyclones and floods half of all surveyed agriculture-producing households in the MSG survey indicated using drought-resistant seeds and crops such as cassava while supplementing their food supplies with different roots tubers and maize (CGAP 2015).

The fluctuation of the usage of conservation agriculture is tied to the price of cultivated crops. This is reflected with maize production. When maize prices declined the usage of conservation declined as well. Similarly, when maize prices increased so did access to conservation technologies such as improved seeds and fertilizers from maize-producing farmers (Thierfelder et al 2016). In varying contexts of use, it is observed that cassava and maize producers have gained increased access to capital and have been better able to adopt climate-smart agricultural practices such as fertilisation during high harvest seasons. However, concerning climate change, the main challenge that emerged was the inability to obtain capital from harvests to implement conservation agricultural practices..Following poor harvests maize prices increased across Mozambique. However, the usage of conservation technologies declined as farmers had a lack of access towards drought-resistant seeds and

market-based fertilizers. While these can be offset by government intervention and NGO support.

3.5.1 Fertilisers

Several less consistent methods of conservation arise through the use of fertilisers and manure. Widespread use of cattle manure has been implemented in response to degrading soil conditions. The response from farmers to using livestock manure arises from the lack of financial access to acquire top-range fertilizers (FAO 2006, MSG 2017). The use of manure as a fertiliser substitute does however act as an efficient adaptation method in managing degrading soil due to a lack of rain. The usage of manure however is limited due to the limited soil nutrient qualities leaving improved fertilisation to occur through compost fertilization.

Nationwide usage of market-based compost fertilization to augment production is rather low with 3.8% of fertiliser usage by small-holder farmers (Zavale et al 2020). The low use of fertiliser, but high use of manure as noted by Zavale et al (2020), reveals that small-holder farmers are unable to effectively use compost and soil-enhancing fertilisation to the extent of manure fertilization. In adapting to drying soil fertilisers have become essential to crop cultivation. Regarding maize production, the application of fertilizer resulted in an increase in yields. In 2015, maize yields rose from 1090 kg/ha without the use of any fertilizers to an upward trend of 1321 kg/ha with fertilization. (Zavale et al 2020). Concerning small-holder farmers, Tete province stands out, with 10.8% of them employing non-manure fertilisation. In contrast, only 3.8% of small-holder farmers used inorganic fertilizers with manure fertilization promoted above market or industrial fertilizers throughout 2014-2015 (Zavale et al 2020). The industrial use of high-quality fertilizers have been largely utilised in sugarcane production and commercial agriculture. Sugarcane fertilization accounts for 80% of all fertilizers used in the agricultural sector, underscoring the reliance of smallholder producers on limited cultivation tools and mechanisms to adapt to changing environmental conditions. The widespread use of fertilizer increased between 2015 and 2017 with total fertilizer usage increasing from 4.5kg/ha to 5.1l kg/ha (World Bank 2020). The rise in usage suggests that agricultural producers are gradually embracing market fertilisation. However, the low usage per hectare indicates that small-holder farmers are not primarily adopting fertilization as a method of adaptation.

Technological change through advanced conservation agriculture has varied across Mozambique due to the question of utilisation that arises when measurements of production (land, labour, and capital) are sufficient allowing for ease of access. The adoption of basins and mulch is central in traditional seeding and adaptation. Within their research on conservation agriculture regarding land-hoe farmers, Grabowski and Kerr (2014) note how farmers use varying forms of cultivation to make sure that soil does not degrade. This is undertaken through the consistent use of compost fertilisation or manure fertilization. Manure and compost fertilization in comparison to market-based fertilisation have been much more effective with higher yields in provinces which experience higher rainfall precipitation. Throughout semi-arid regions, however, soil degradation was worsened as noted with higher crop failures in Gaza and Maputo (FEWS NET 2017). In comparison regions impacted by cyclone Dineo experienced severe soil erosion due to localised flooding decreasing harvests and yields (FEWS NET 2017)

3.5.2 Crop Diversification and Seeding

The use of conservation agriculture through crop diversification and irrigation conservationist agriculture is widely employed by small-holder farmers throughout Mozambique with the primary focus on cultivating a variety of crops. The majority of small-holder and subsistence farmers rely on generational traditional knowledge in adapting to climate change with changing irrigation systems, shifting planting and harvesting seasons and planting a variety of subsidiary crops to avoid pests and promote crop diversification (Grabowski and Kerr 2014). To cope with the threats of recurring droughts, cyclones and floods half of all surveyed agriculture-producing households in the MSG survey indicated using drought-resistant seeds and crops such as cassava while supplementing their food supplies with different roots, tubers and maize (CGAP 2015).

Technological change through advanced conservation agriculture has varied across Mozambique due to the question of utilisation that arises when measurements of production (Land, Labour, and Capital) are sufficient allowing for ease of access (Leonardo et al 2015). This adoption of using basins and mulch as a means to maintain soil integrity is highly applicable within traditional systems. Within their research on conservation agriculture surrounding land-hoe farmers Grabowski and Kerr (2014) note how farmers utilise variant and diverse crops as a means to both provide short-term sustenance but also as a means to improve soil conditions and conserve existing water sources. Crop diversification within Mozambique is promoted to substitute the negative effects of climate variation. Nationwide

crop diversification and its impacts are observed with continued high production of substitute crops in relation to fixed seasonal crops. The most prominent indicator is the brief surveys Grabowski and Kerr undertook. Above 50% of respondents indicated cultivating a larger variety of crops throughout drought periods (Grabowski and Kerr 2014)

The fluctuation of the usage of conservation agriculture is highly reliant on the price of crops. This is most noted with the outline of maize which is one of the primary crops for Mozambique. When maize prices decline the usage of conservation declines as well. Similarly, when maize prices increase so does access to conservation technologies such as improved seeds (Thierfelder et al 2016). However, concerning climate change the primary challenge that arises is the inability to acquire capital through harvests to adopt conservation agricultural practices. Following poor harvests maize prices increased across Mozambique. However, the usage of conservation technologies declined as farmers had a lack of access towards drought-resistant seeds as reported by Grabowsky and Kerr (2014). While these can be offset by government intervention and NGO support.

Thierfelder et al (2016) within their research regarding central Mozambique draw similar conclusions towards Grabowsky and Kerr (2014) however note that the low cultivation of farmland, due to the lack of access to wide tracks of land alongside labour shortages and limited the long-term opportunities and benefits of conservation agriculture. These measurements of conservation align with variations in climate conditions that lead to decreasing living standards. Following extreme droughts, the inability to access climate-smart technologies leads to limited production.

Mozambican farmers adopted a wide array of drought-resistant crops in addition to diversified supplementary crops such as fruits, vegetable roots and tubers (FAO STAT 2020, OCR 2015, Steenberg 2019). While cassava is the most produced crop among households, alternatives are simultaneously cultivated alongside cassava as noted with the high production, maize and roots and tubers are also widely cultivated. However, as noted with production trends while both crops experienced a significant decline in production the high levels of production in multiple crops eased the effects of severe drought conditions. Maize is considered to be extremely drought-sensitive however production was largely stable in relation to declining cassava production. In adaptation, the hypothesis that diversified crops provide stability in year-on-year harvests is observable within Mozambique. Throughout 2016 while imports of food increased there was less of a crop production failure leading to

above 50% crop production reduction. Inherently while cassava and maize saw an annual decline their production levels were more stable and resistant and reformed after 2017 (Renard and Tilman 2018). The primary dips are in correlation with climate-related events when dried soil declines overall fertility.

The 25th of September scheme aimed at supporting farmers through irrigation experienced high crop diversification to offset limited water resources from the scheme. Throughout rural communities, in Maputo, more smallholder farmers adopted the cultivation of sorghum and drought-resistant crops alongside maize and cassava. Small-holder farmers generally increase crop diversification as a means to maintain soil quality and to offset either crop failures or rain-reliant crops (Sousa et al 2017). While within the study range presented by Sousa et al (2017) and the CGAP (2016) the primary crop was maize a large portion of respondents indicated cultivating more than one crop including maize with a higher focus on drought-resistant crops such as cassava. 68% of respondents noted growing a variety of crops beyond maize and cassava. In comparison, 53% of farmers nationwide adopted drought-resilient crops to offset crop failures (CGAP 2016, Sousa et al 2017). Through the focus groups, interviews and surveys conducted by Sousa the key outline that is noted throughout the initial drought period is that:

"According to focus group discussions and the short surveys, the main advantage of diversification is to reduce the risks associated with market fluctuations, pests and diseases, post-harvest losses and climatic uncertainties" (Sousa et al 2017. 709)

The adoption of crop diversification due to its low barrier of entry is widely adopted among small-holder households. In exploring maize and cassava production 58% of households indicated that they cultivate both to limit the impact of environmental strains (CGAP 2016). As Sousa et al note (2017) Crop diversification is much more accessible due to its interlinkages with standard subsistence agriculture. The ease in adopting diversification is thus because of widespread access to different seeds and pre-existing practices of cultivating resistant and substitution crops. Acquiring fertilisers, digging basins, and using genetically resistant crops through diversification have a low barrier for entry and present the opportunity for low cost-effective diversification of crops.

Seed access outlines how farmers address climate variation. Within seed usage farmers and communities that utilised modified seeds produce above 1 tonne per hectare while farmers who do not utilise improved seeds produce 919 kilograms per hectare (IAI 2015, Zavale et al

2020). In conjunction with fertilisers modified seeds produce above 3 tonnes. Modified seeds are widely adopted among vulnerable farmers however in relation to total production Zavale et al (2020) note that general use of improved seeds is rather limited due to limited resource access. The integrated household survey also noted that limited capital led to decreasing seed and fertiliser usage even though more than half of the respondents indicated a desire to utilise fertilisation (IAI 2015)

Throughout Mozambique, 20 companies actively breed and affect seed genetics for improvement while there are a total of 63 registered seed suppliers. Seed production varies between the crops cultivated and seed demand. The most widely formally produced seeds are maize, rice and cowpeas which account for an estimate of 90% of the formal seed trade (Mabaya et al 2017). In reaffirming Mabaya et al (2017), Zavale et al (2020) illustrates how the widespread availability of improved seeds can limit the impact of late-season floods due to early gestation periods. The widespread production and distribution of modified and improved seeds through crops is noted by recurring floods throughout Zambezia and Niassa. Although these regions experienced flooding, maize production was rather stable. The challenge in widespread seed availability is concentrated seed production focussed on maize and access (Mabaya et al 2017). Informal seed trading remains highly prevalent indicating that crop diversification using modified seeds is limited. This is noted with less than 10% of small-holder households utilising formal or modified seeds (Mabaya et al 2017)

3.6 Irrigation systems and rain-fed agriculture

Mozambican food producers are largely reliant on rain-fed agriculture with more than 80% of food-producing households indicating that they rely on seasonal rains to cultivate crops (MSG 2017). This has emerged as a significant challenge in adapting to climate change following drought conditions. With low access to irrigated water adapting to droughts has become more severe as riverbeds dry up.

Irrigation equity throughout Mozambique is concentrated throughout Southern Mozambique mainly Maputo and Gaza. Within these provinces existing irrigation schemes and small-scale irrigation coverage are spread out over 40 000 hectares with the Chokwe irrigation scheme covering 30 000 hectares (Sousa 2017). The unequal distribution of irrigation is evident, with disparities and increased crop failures observed in Northern Mozambique compared to Southern Mozambique.

The largest formal irrigation scheme within Mozambique is the Chokwe irrigation scheme (CIS) which spans 33 000 hectares of irrigated land servicing 12 000 farmers. The scheme aims to supplement local farmers as the district maintains an annual rainfall of 530mm.

Mozambique has the largest potential for water irrigation in Southern Africa with an estimate of 3 million hectares of viable irrigated land however throughout 2015-2017 only 90 000 hectares of land has been irrigated (Sousa 2016). With low access to irrigation systems such as dams the means of maintaining crops are addressed by local pumping mechanisms from rivers while the majority of small-holder farmers plant and rely on seasonal rainfall. These methods are highly reactive following drought periods where rainfall does not meet water demands.

The most innovative response to climate variation through employing traditional knowledge arises within Manica province where local farmers use mountains and terrain irrigation to funnel water towards their crops rather than relying on rain-fed or irrigation systems for support (MASA 2016). In their examination of water irrigation at Wageningen University, Steenberg presents findings from interviews indicating that farmers utilise gravity-based mechanisms to access water from areas more prone to rainfall. (Steenberg 2019). These practices are largely predominant by small-holder farmers to conserve soil fertility through reduced tillage and crop rotation. The gravity rain system as noted in Steenberg's research relies on rainfall in high terrain where precipitation is higher and funnelling it towards small-holder farmers in low-lying areas where precipitation is highly variable. The alternative to these methods of adaptation is accessing widespread water irrigation systems which are most prevalent throughout the Maputo and Gaza provinces (Veldwisch 2016). These adaptation systems work well with geographical areas that have a downward slope. The challenge that arises is that these systems are still reliant on some form of rainfall to be sustainable which has dipped below 1000 mm in 2016.

Chapter 4. Climate Change and Food Security: The Case of Zimbabwe

4.1 Introduction

Zimbabwe is one of the most vulnerable Southern African nations to climate variation. With low household income coupled with rising inflation and currency crisis the challenges Zimbabwean farmers experience are attributed to maladministration causing worsening poverty. During the case period of 2015-2017, an estimated 4 million people were at risk of food insecurity (USAID 2017, WFP 2016). The seriousness of food insecurity emerges as rainfall decreases, dropping below 500mm nationally.. These challenges arose under the moniker attributed to Zimbabwe as being determined the “breadbasket of Africa” following the high production of maize in 2006.

This chapter outlines the findings surrounding production systems and accessibility towards food within Zimbabwe. Secondly, the chapter presents the findings on how local small-holder farmers respond to declining food production and whether it has benefitted their livelihoods in adapting to climate variation.

4.2 Case Background

In contrast to Mozambique, Zimbabwe started the 21st century with abundant food availability, high accessibility, and broader food system stability. This was due to increasing food production and a thriving agricultural sector, earning the nation the moniker "the breadbasket of Africa." Notably, maize yields reached a peak of over 2.3 million tonnes in 2006. (FAO 2016). However, following a devastating drought throughout 2002-2003 the food systems of Zimbabwe have become severely strained with continuous decrease in food production even during non-drought periods coupled with immense political instability following the 2008 elections and worsening economic conditions for smallholder farmers. The challenges that threaten Zimbabwe’s food systems have also been exacerbated by climate variations from cyclones in the east of Zimbabwe to recurring floods and extreme droughts.

In Zimbabwe, the issue of food security has evolved beyond traditional production concerns, as various challenges related to food security, such as the price of maize and crop diversification have emerged. Zimbabwe, unlike its neighbours, has experienced a rapid decline in economic conditions from a disastrous currency crisis to a 90% unemployment rate (FFSSA 2004, Richardson 2007, Richardson 2005, World Bank 2020, IMF 2017). These challenges have led to the sole economic reliance of more than 1.5 million small-holder farmers to provide nutrition for local communities with extreme limitations to arable land. While the initial land reform program was aimed at increasing access to arable land most

subsistence and small-holder farmers have little to no access to sufficient land and thus deal with declining soil quality worsened by severe droughts. These conditions have severely impacted food security with stunted development and underweight conditions (FAO 2020). In conjunction with the regional El Niño drought of 2002 Zimbabwe's' food crisis was largely attributed to poor governance and mass evictions of white agricultural producers. These government programs and the land reform program are largely attributed as being the causal reason that throughout the drought period, Zimbabwe experienced extreme food insecurity followed by a state of emergency being declared by the ZANU-PF government.

From 1980 to 1998 Zimbabwe has experienced a significant increase in production, utilisation, and access to nutrition with a growing agricultural sector, rural livelihoods experienced stability and a decrease in nutrition-based challenges such as declining healthcare conditions (FAO 2017). However, with the establishment of the land reform program, which was widely considered to be an agricultural disaster, food production declined significantly. This has been attributed to the lack of resources and support for resettled farmers aimed at providing nutrition and opportunities for vulnerable communities (Richardson 2007). However, in exploring the factors of food production the extreme decline cited by a variety of scholars is arranged and mixed with significant declines in food security occurring throughout intense dry spells and declining rainfall. This is noted with peak food production in 2005 (FAO 2006). Although land reform programs have negatively impacted agricultural communities, the significance of climate variation has been overlooked in understanding the challenges faced by small-holder producers. These challenges include maintaining a sustainable standard of living by selling crops and ensuring adequate nutrition for themselves and their communities. The above mentioned challenges are observed through the rapidly rising food prices pegged at rapid inflation above a staggering 484% inflation rate thus hindering access to food from the most vulnerable communities (SADC 2020).

In the realm of production, the implementation of the land reform program, coupled with extensive country-wide drought conditions, necessitated government intervention during the periods of 2002-2003 and 2015-2017. As a result, rural Zimbabwean communities face a severe risk of food insecurity due to insufficient availability and access to adequate utilisation.. Zimbabwe alongside its land reform program has had little agricultural variation with an extreme reliance on maize as a nationwide crop (SADC 2020)

4.3 Food and agricultural production trends,

Zimbabwe up until 2005 was branded as a success story based on its peak production of 2.3 million tonnes in maize production upholding its status as "the breadbasket of Africa" from 1990 up until 2008 (FAO 2016). The term was also supported by Zimbabwe becoming a net exporter of maize offsetting crop and food imports (FAO 2016). However, throughout 2015-2017 production of food declined substantially. The decline in food production is most pronounced with the production and consumption of maize and groundnuts which are the largest produced food and cereal crops among small-holder and subsistence farmers.

4.3.1 Maize

Zimbabwean small-holder and subsistence farmers are overly dependant on maize as a form of nutrition and income. This is noted with 90% of the total population partaking in agricultural practices. In assessing household variability, the Zimbabwean Vulnerability Assessment Committee notes that throughout 2015/2016 84% of households produced maize as a primary crop for nutrition and income (ZIM VAC 2016).

Maize is the primary crop produced throughout Zimbabwe with 84% of households producing maize as a primary form of nutrition and income throughout 2015/2016 (ZIM VAC 2016). With recurring droughts, the peak of the El Niño season between 2016/2017 household cultivation of maize increased (ZIM VAC 2016). The production of maize throughout Zimbabwe is widespread due to the strong agricultural production output between 1990-1999 where average annual production increased by 50%. As a form of income generation maize is highly reliable and consistent in production throughout non-drought periods as noted with significantly high overall year-on-year production throughout 2006-2013 (FAO 2016).

In 2016 the WFP released a situation report on droughts and disasters appealing for aid indicating that throughout Masvingo 75% of maize crops in the province have been written off as either failed harvests or nutritionally insufficient (WFP 2016). A similar plea arose surrounding Matabeleland where 65% of crop cultivation failed or was nutritionally insufficient (Zim Gov 2015, ZIMVAC 2016, ZIMVAC 2017). Following these declines under ZIMVAC it was determined that 80% of households surveyed produced maize as a primary form of both nutrition and income with an average total production of above six hundred thousand subsistence maize crops produced throughout the 2016 drought period highly insufficient for the 1.8 million required. Zimbabwean households also reported that agriculture is their primary form of income. These declining harvest statistics are in line with

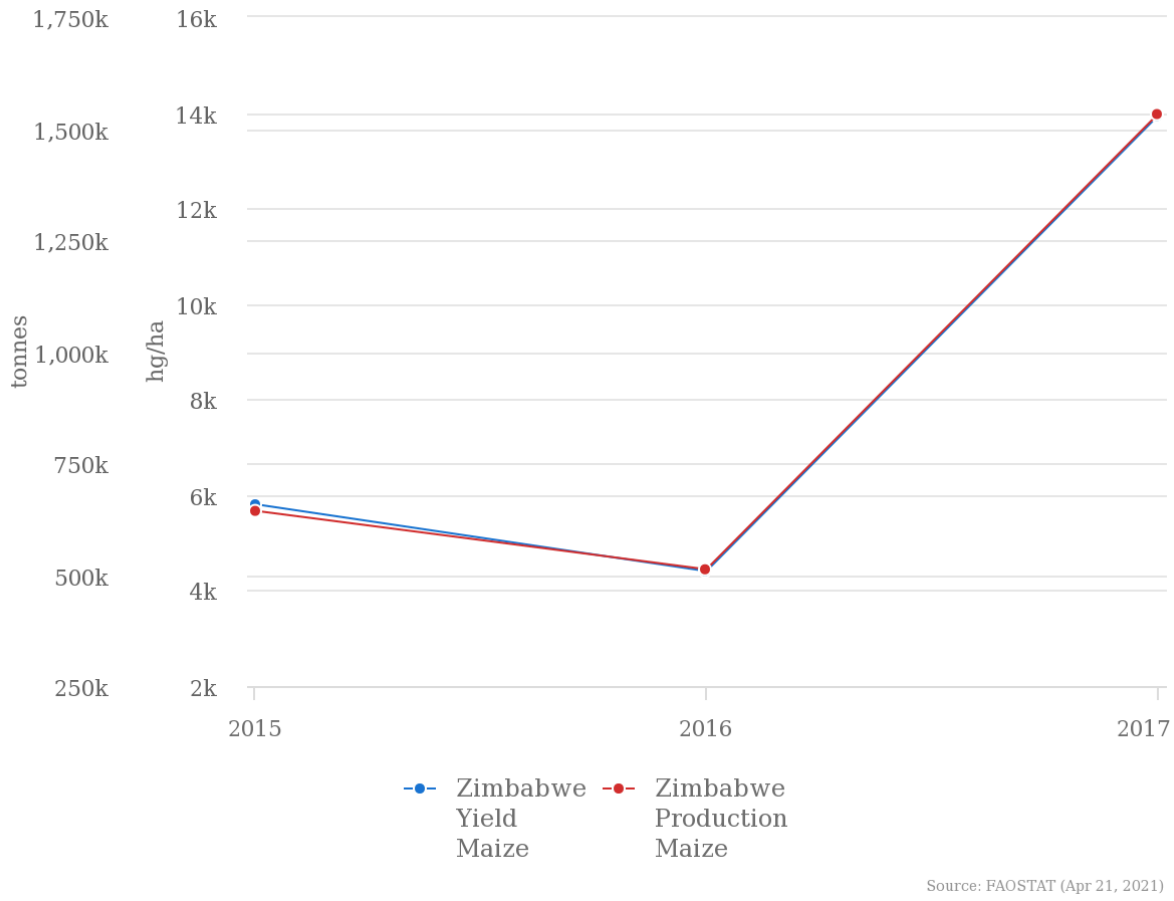
erratic rainfall below 300mm annually rainfall predominantly throughout Matabeleland North, Matabeleland South, Masvingo and even traditionally food-secure provinces such as Mashonaland (Zim Gov 2015, Dube and Guveya 2016). These challenges to food security are attributed to the increasing droughts and dry spells nationwide with the decline in production. With little variation in the climate differentiation, the production of maize and millet which are the backbone has been placed under severe market strains with worsening production conditions based on a lack of access to water sources and poor irrigation. Throughout the initial stages of the drought period originating in 2015, Zimbabwean crop production larger tracts of land were harvested with above 1,100 hectares of harvests throughout 2015. In comparison, while yields per hectare were larger, overall production declined significantly throughout the drought period to below 700 000 tonnes of production (FAO STATS 2020). The low production is extremely impactful in relation to 2014 which was already considered a low production year.

When assessing maize production as a commodity, a prominent theme emerging alongside production challenges is the fact that maize serves as the primary staple food, with minimal food production diversity beyond maize. This factor links food availability directly to the reliance on maize stocks, maize prices and maize production. However, with the escalation of drought conditions and the Zimbabwean government's declaration of severe dry spells resulting from a lack of access to water for irrigation, there was a corresponding sharp decline in production metrics (See Figure 4.1). The production measurements worsened throughout the provinces of Masvingo and the Southern Midlands where, throughout the 2016 harvest period, the availability of cereals throughout all districts was merely enough supply for three months with households reporting limited availability of maize and grain stocks used for consumption (ZIMVAC 2016, WFP 2016). Overall cereal production throughout 2016 in relation to the 2015 harvest noted a 30% decline culminating in barely above 700 000 tonnes of production in maize and cereals combined (See figure 5 WFP 2016).

The household-level production system poses significant challenges amid the emergency unfolding in drought-stricken rural regions of Zimbabwe. A significant factor indicating vulnerability in food production concerning climate change is the dependence on susceptible food crops, exemplified by the prevalent household cultivation of maize as a staple crop. Throughout production systems, 84% of crops produced by households for local consumption were maize alongside groundnuts at 43% of household production (ZIMVAC 2016, ZIMVAC 2017). The key correlation that is observed through the considerable production decline

throughout Zimbabwe in 2016 is noted with the number of households attempting to diversify food production. Smallholder farmers and households which produce 70% of total food stocks throughout Zimbabwe have decreased the planting of maize as a primary staple from 88% during the 2013/2014 harvest season to 84% throughout 2016 (ZIMVAC 2016, ZIMVAC 2017).

Figure 4.1 Maize Production/Yield Zimbabwe 2015-2017

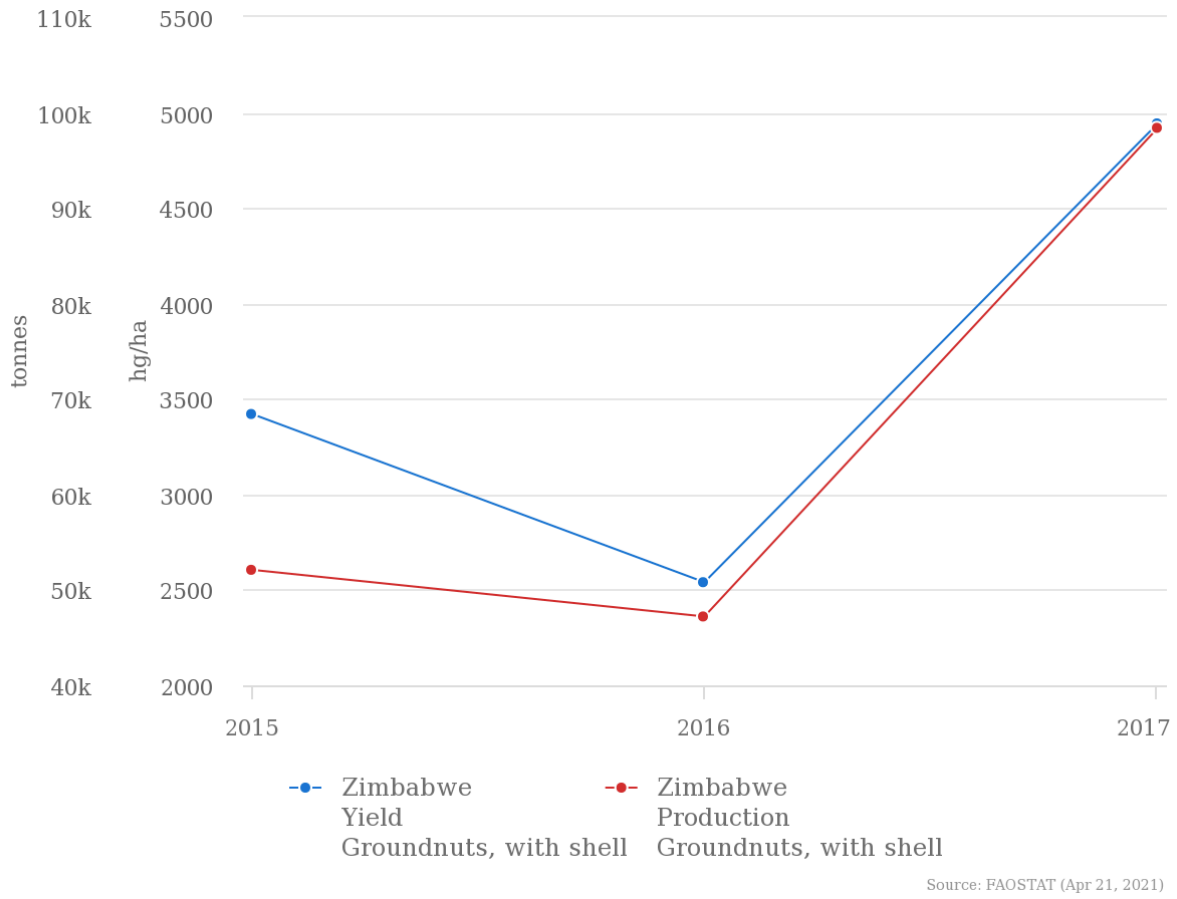


Source: FAOSTAT 2021, accessed 21 April 2021

4.3.2 Groundnuts

Groundnuts have emerged as a significant alternative to maize. As an alternative groundnuts, are more resistant towards extreme weather conditions and due to being soil-based the primary concern in cultivation is soil quality. The value of groundnuts as a source of nutrition has increased throughout drought periods where maize is less reliable. Throughout 2015-2017 the ZIMVAC noted that while households increasingly relied and produced maize for nutrition and income this was coupled with an increase in groundnut cultivation. In between the 2014/2015 harvest season and the 2015/2017 harvest season, more smallholder farmers cultivated groundnuts following a decline in maize production (ZIM VAC 2016).

Figure 4.2 Groundnut Yield and Production 2015-2017



Source: FAOSTAT 2021, accessed 21 April 2021

The increase in groundnut production in relation to a slight decrease in maize cultivation by small-holder farmers indicates a minor shift in crop cultivation to offset drought conditions. The area of groundnuts harvested is however limited, peaking at 200 000 ha while groundnut production and harvest yields have followed the trend of decline (FAOSTAT 2020, WFP 2016, Dube 2016).The discrepancy between the extensive cultivation area and limited production highlights the ongoing challenge faced by smallholder farmers, who frequently contend with crop failures due to dry soil and inadequate rainfall when cultivating groundnuts on a larger scale. As noted in, figure 4.2, yields have also declined in line with the trend of production. Decreasing soil conditions and lack of sufficient rainfall decrease overall production as food systems become strained. The notable increase in harvested area indicates that, similar to maize, groundnuts also experienced more frequent crop failures as rainfall decreased. The impact on small-holder farmers is jarring as the ZIMVAC (2016) notes that

groundnut cultivation rose throughout drought periods to offset the challenges of cultivating maize.

Groundnut production was still relatively low and noted a slight decline throughout 2016. This is accompanied by a significant decrease in yields below 3000 kg/ha. As a substitution crop groundnuts have been unable to efficiently address food insecurity and declining production.

4.4 Food Availability and Food Access

4.4.1 Availability

USAID and the FAO throughout 2015-2017 estimated that more than 4 million Zimbabweans were food insecure following mass harvest failures and devastating droughts. These conditions have led Zimbabwe to contend with rising maize prices coupled with becoming a net importer of maize from neighbouring South Africa (WFP 2016, FAO 2017).

With declining food production, the means to address insecurity due to a lack of food has largely been attributed to food imports and aid packages. Throughout the 2015-2017 drought period, the FAO and WFP reported that to offset the deficits of low production yields. Within the 2016/017 drought period cereal production declined drastically. In 2015 cereal yields peaked at 558 kg/ha (World Bank 2020). In comparison at the height of drought conditions cereal yields dropped to below 435 kg/ha (World Bank 2020, WFP 2016, FEWS NET 2016). The lack of food availability due to poor harvests peaked in 2016 with sustainable food availability requiring 1.5 million tonnes of maize to sustain nationwide food stocks (WFP 2016). Food availability offsets reached 1.2 million tonnes of maize within 2016 in combining production measurements of maize combined with food imports (WFP 2016).

Zimbabwe has shifted from a net exporter of maize and food peaking in 2006 to a net importer. Following severe droughts maize imports have risen substantially with primary imports arising from South Africa to offset the deficit.

Table 4.1 Zimbabwean Maize Imports 2015-2017

Measurement Year	Food Imports: Maize (tonnage)
2015	571775
2016	821672
2017	308267

Source: FAO STAT 2020, World Bank 2020

The most prominent increase in imports is noted in 2016 when drought conditions led to severe water shortages and national rainfall. As a means to offset the extreme drought failures and to ensure higher food supplies imports became more prominent throughout the 2016 harvest period. Similarly, maize production is noted at 50k tonnes.

Apart from maize imports Zimbabwe experienced a variation in aggregate food imports with a significant decline throughout 2016. The decline in aggregate food imports is attributed to a decreased demand for diversified foods and diets and a focus on maize. With maize imports increasing aggregate food imports decreased.

Table 4.2 Zimbabwean Food Import Aggregate (Tonnage)

Measurement year	Food imports Aggregate (Tonnage)
2014	74420
2015	88396
2016	58450
2017	106841

Source: FAOSTAT 2020, World Bank 2020

The aggregate food imports have spiked between 2014 and 2015 and from 2016 to 2017. In breaking the trend imports throughout 2016 declined as maize imports rose. The reliance on maize for nutrition leads to less nutritional and diverse diets as other food imports declined in 2016 when drought conditions peaked at below 500 mm rainfall. Similarly, the reliance on maize is indicative of the high maize imports in relation to other food imports. Maize imports rose as maize production declined below 500 000 tonnes production in response to a demand of an estimated more than 1.5 million tonnes necessary for widespread food availability (FEWS NET 2017, FEWS NET 2016).

In response to drought conditions, many smallholder farmers began cultivation of substitution crops such as groundnuts and sorghum. While these crops became more prevalent the impact on food availability has been less than desirable. Groundnut yields throughout the 2015/2016 period declined coupled with a slight decline in production (FAO 2016, ZIMVAC 2016). The availability of different foods is much lower than the import and production of maize. The import aggregate indicates a decline in demand and imports of non-maize foods throughout 2016. This decline is catalysed by higher maize imports. In correlation with climate variation the trend in food availability indicates that higher rainfall as observed in 2017 is followed by

less food insecurity as maize and food stocks increase and imports decline (FEWS NET 2016).

Availability is widely determined to be centred on surrounding rural communities. Within small-holder communities in rural regions, higher reliance on small-holders for maintaining food stocks places severe strain on agricultural producers. Several observations throughout Masvingo province where the contribution of small-holder farmers has been limited by rising cases of stunting and malnutrition with rising drought conditions (Toringepi 2016) This reaffirms the severe impact of climate variation on the vulnerability that arises with decreasing food availability.

4.4.2 Market and Economic Access

Zimbabwe has a unique experience with food accessibility largely due to the extreme economic position that many small-holder agricultural producers and consumers face. Provincial differences are reflected by variating in food prices as availability shifts due to increased imports. With increased imports throughout the drought period, most households relied on market access to attain nutrition. Throughout the period between 2015-2017 Zimbabwe experienced low fluctuations in access to food through changing food prices (World Bank 2019). In Zimbabwe, significant obstacles to accessing food stem from limitations in market income. As economic conditions worsen based on the lack of selling harvested crops the prospects for income decline leading to decreased consumption. Throughout the 2015-2016 report period, FEWS NET (2016) reported an annual decline in food budgets by 4 per cent while maize prices had to be accessed largely through markets. These price increases present serious accessibility challenges with a lack of income alongside significant maize price increases.

In contrast, the variation that arises in market access and pricing is observed with the occurrence of drought through declining food price inflation during mid-harvest season. Throughout the 2016 harvest season with low harvests and declining overall food imports, the trend of food price inflation is largely attributed to the competitive market of low-producing households attempting to sell their maize harvests competitively (World Bank 2017). While inflation was on the downward trend maize prices were rising at an average of 15 – 25% above the average before the occurrence of drought in 2014 (FEWS NET 2016).

Through mid-year measurements, accessibility in terms of food inflation has improved slightly however through the late year December harvests in-between 2015-2016 food prices

began to increase above following rising inflation and low harvests and yields (FAOSTAT 2020). Within December 2016 food prices increased by 4.6% nominally from the national start above 0.41$ for white maize (WFP 2016). Throughout 2016 the maize prices, the most produced crop, peaked at $0.57/kg for arid and drought-stricken regions such as Matabeleland South which experienced a regional decline in rainfall below 350mm average rainfall (WFP 2016, Ndlovu et al 2020,). The prices in high drought areas note the impact of climate variation as the national average for pricing throughout 2016 averaged 0.33$/kg of maize (USDA 2016). The average pricing in relation to the end pricing notes how a lack of food within drought-stricken regions restricts financial access to food. Nominal maize pricing peaked at 0.41$/kg at the end of 2016 an increase above the yearly national average of 0.33$/kg of maize.

The concern regarding food accessibility in Zimbabwe is not primarily due to rapid inflation or immense rising food prices but mainly due to low purchasing power and low household income. Since household incomes primarily stem from agricultural production, the reduction in harvests has resulted in decreased income. Thus, while most markets had some form of supply either through food aid or imports these stocks were largely inaccessible due to the inability of households to afford to purchase these stocks while selling locally produced stocks (World Bank 2019, FEWS NET 2016, FAO 2017). The implication of low production throughout Zimbabwe in relation to access aligns with the argument presented by Amartya Sen in economic observation where decreasing production had a severe impact on the economic access to food and using food as a means of income (Sen 1981). Due to sustained imports and increased food aid, the question of availability arose as a means for maintaining livelihoods. Thus, the largest contribution to food insecurity arose from a lack of market access and a lack of income to attain food amidst climate variation as prices increased alongside demand.

4.5 Conservation Agriculture and Crop Diversification

Zimbabwe has a unique relationship with climate-smart agriculture. As poverty has increased and economic collapse ensued the use of cost-effective cultivation has emerged as the primary means of adaptation. The use of local knowledge and climate-smart conservation agriculture is largely attributed to the declining implementation of government resilience policies. Farmers commonly express the view that the government provides some level of financial assistance. However, they perceive a lack of support in terms of irrigation

infrastructure and long-term adaptation measures. (ZIM VAC 2017). In responding to climate variation several methods have arisen as primary means of adaptation namely fertilization, seeding and crop diversification. Coupled with this are the challenges that farmers face in terms of institutional inclusion and access to capital as a means of adaptation.

4.5.1 Fertilisation

The utilisation of fertilizers across Zimbabwe is widespread with 85% of small-holder farmers indicating using fertilisers. The variation in fertiliser usage, however, is evident in terms of access and inequity.. Within Zimbabwe, the majority of market-based fertilizers are utilised in commercial agriculture. In comparison, market-based fertilisers are used to a lesser extent by smallholder producers who rely on manure and organic compost.

In utilising manure and organic compost in comparison to more expensive market-based fertilisers, farmers aim to limit soil degradation and maintain fertility (WFP 2016) Throughout Bulawayo 60% of small-holder farmers indicated the usage of manure as a means to fertilise their small croplands (ZIMVAC 2018). In more remote rural areas, these percentages rise to as high as 70%, particularly in regions abundant with livestock and manure, such as Matabeleland South. The use of fertilisation declines in regions where the average irrigated land is more substantial. This observation is noted throughout the Hwange district where rainfall precipitation shifts above the national average but experienced lower fertilisation usage.

While traditional knowledge is widely employed in promoting climate-smart agriculture from farmers' perspectives the institutional perspectives are different. The inability of external support leads to 80% of small-holder farmers using less reliant fertilisers and reseeding to address crop and climate deficiencies (ZIMVAC 2017, FEW-NET 2017). The primary form of soil fertilisation that is adopted is the usage of manure which is widely available and cost effective in comparison to compost and chemical fertilization. Total fertilisation utilisation experienced an increase from 22.9 kg/ha of fertilisation to 38.4 kg/ha with declining soil quality and declining rainfall between 2015-2017 (World Bank 2020). With 90% of farmers being smallholders, the rise in fertilization usage indicates that smallholder farmers rely more heavily on fertilizers to mitigate the effects of droughts (FAO 2016). However different forms of fertilisation have different impacts on crops. With compost and industrial chemical fertilizers being the most reliable these are not widely used throughout small-holder communities.

Agricultural conservation schemes throughout Zimbabwe have fallen short of sustainability with continued low production. This discrepancy emerges from the varied implementation of conservation agriculture, characterized by low diversification. (Moyo et al 2017). When cultivating maize, essential conservation methods, particularly the use of fertilizers, are significantly underutilized, with average fertilizer usage remaining below the 30 kg/ha threshold required for sustainable production. (FAO 2016). With the shift in economic and national fiscal stances, a strong reliance on conservation has been presented with the use of livestock manure as a means to fertilize croplands. The usage of fertilizer also decreases based on the varying methods of fertilization. Livestock manure is the most common use of fertilization however requires increased amounts to be effective. In comparison, ammonium nitrate is the second most produced and consumed fertilizer to improve growth conditions for Maize.

The inherent challenge of using manure-based or organic fertilisation, as identified by the FAO, is that organic fertilisation requires soft and moist soil for crop production (FAO 2020). With declining rainfall coupled with the arid climate of central and Southern Zimbabwe soil quality decreases eliminating the value that organic fertilisation, through manure or decomposing plant compost, would provide to crops. In line with fertilisation, the most common form of soil enrichment arises from manure due to the high availability of livestock. Within his study exploring agricultural production throughout smallholder communities Mutami (2014) notes that 90% of participants in the study owned livestock. Livestock provides access to manure which relates to manure being the most widely accessible form of fertilization alongside organic compost (Mutami 2014). Throughout Bulawayo, 60% of subsistence farmers used manure as a means to fertilize their small croplands (ZIMVAC 2018). In further rural areas, these increase up to 70% in regions where livestock and manure are widely available (ZIMVAC 2018). The high reliance on livestock manure and compost increased in tandem with fertilizer imports.

Throughout the 2015-2017 period, manure fertilization increased dramatically with an average increase of 30%. Alongside this more households began cultivating sorghum and groundnuts with a slight decrease in maize cultivation. These differences highlight that farmers and small-holder communities are striving to adapt, and from their viewpoints, these methods represent the most effective approaches. The primary concern that many producers have is the lack of labour and capital to acquire more efficient means of smart agriculture such as purchasing and using market-based fertilizers and having access to livestock for

manure and ploughing (SADC 2016). The challenge in acquiring these means is worsened by declining rainfall conditions. The most notable would be access to fertilization throughout drought periods which require significant imports and capital to offset the impact of climate variation. Throughout 2015-2016 imports of fertilization ammonium nitrate for maize decreased from 80 thousand to below 60 thousand tonnes (FAOSTATS 2020). Imports increased as the crisis worsened between 2016-2017 where imports and small-holder demand for fertiliser increased. Total imports of ammonium nitrate exceeded 70 thousand tonnes throughout 2017 as production slowly increased (FAO STATS 2020. While livestock is widely used for fertilization the second means of improving quality is through purchases of ammonium nitrate fertilizer. The FAO and WFP attribute the inability to adopt widespread fertilizer throughout Zimbabwe based on declining income from declining production output (WFP 2020, FAO 2006).

4.5.2 Crop Diversification and Seeding

A key theme that is presented with conservation agriculture is the continued use of diverse crops but not exclusion. This is noted with the promotion of continued cultivation of maize due to its high yields. Mafongoya et al (2016) note that through cross-regional access maize yields have the continued potential to be higher leading to increased yield profits and high demand for both cultivation and exportation (Mafongoya et al 2016). However sole cultivation of maize does present problems given that maize are highly volatile to climate stressors such as widespread geological droughts which between 2015-2017 severely limited the effectiveness of conservation agriculture. The trend of insufficient conservation agriculture is observed during 2016, coinciding with a decline in annual rainfall to below 1000 mm per annum. The consumption of maize decreased as stocks declined. Thus, in addressing these concerns there must be sufficient conservation mechanisms present arising from sufficient capital to gain access to fertilizers and robust water irrigation systems (Mango et al 2017, Mafongoya et al 2016).

In response to drought conditions, more small-holder farmers began production and consumption of groundnuts while maize production declined. As noted with food production trends, groundnuts became more widely cultivated (ZIMVAC 2017). However, alongside groundnuts, both cowpeas and sorghum saw significant increases in cultivation throughout 2015-2017 while maize declined. Small-holder farmers have thus attempted to diversify crops to offset low maize production. These attempts at diversification have however been unable to address the lack of food availability and access as the already low production scale and

output of diversified crops worsened. This is particularly evident in groundnut production, where despite higher cultivation rates, there were declines in overall production and yields (FAOSTAT 2020). The factors that primarily limit crop diversification are affordable and accessible access to maize in comparison to more variant crops (Dube and Guveya 2016) Throughout Manicaland, where recurrent floods are more prevalent in relation to recurring droughts, the factors that determine crop diversification is root crops versus stem crops such as maize. Widespread diversification as a factor increases diversification to cope with higher rainfall and possible crop failure (Dube and Guveya 2016). The limitations however are linked to continued poverty that limits access to seeds.

While crop diversification is argued to be necessary to address climate variation, Zimbabwe has experienced negative variation with maize remaining the predominantly cultivated food crop. Within Matabeleland North, where the lowest rainfall was recorded at under 350 mm in 2016, groundnut and sorghum cultivation rose in relation to maize (Chingarande 2020). However, production remained substantially low even with crop diversification. The low production is attributed to existing agricultural practices which are tailored to maize production. Groundnuts arose in response to climate variation however within Zimbabwe groundnuts are not consistently produced and lack production throughout non-drought periods. Thus, adopting crop diversification unless it is agriculturally consistent, does not provide an effective means to react to climate variation. The increase in groundnut cultivation also correlates with increased sorghum cultivation (ZIMVAC 2016, ZIMVAC 2017)

In addressing low crop diversification, seed production throughout Zimbabwe is due to limited access to diversified or drought-resistant seeds. The reuse of poor seed variants leads to poor seed quality and low production (Mabaya et al 2017). The seed usage differentiation is noted in the variation between 2014 and 2016. Seed production has not diversified with stagnating seed producers maintaining primary production and distribution of maize seeds. According to the African Seed Access Index, in Zimbabwe, with twenty-one active breeders, the most significant market is maize seeds, estimated to comprise 90% of total seed production and distribution (Mabaya et al 2017). The limited seed production of vegetable roots and tubers corresponds with the agricultural homogeneity prevalent among subsistence farmers. They typically have ready access to maize seeds, either by reusing them or purchasing from local breeders, while facing restricted access to a variety of other crops. The high risk that is aligned with a single crop and lack of diversification is also noted by the

acquisition of seeds. From 2015 to 2017 seed purchases were decreasing and reseeding became more prevalent (Mabaya et al 2017).

The risk of cultivating primarily maize has been devastating to small-holder producers and maize reliant communities throughout the 2015-2017. Throughout this period access to sufficient seeding declined and due to the rainfall-intensive needs of maize crop failures became common. The livelihoods of farmers are thus clearly at risk with little crop diversity. In terms of labour and capital seed production has also stagnated due to the attribute of limited competition and declining market demand following declining income and social capital (TASAI 2015). While there are 21 seed breeders there is little competition with the majority of breeders under government control with few private breeders (TASAI 2015).

While the avenues for accessing diverse seeds local farmers have already responded with shifting production dynamics. The cultivation of Maize decreased throughout the drought period as maize became unreliable. These variations are noted with the increase in sorghum and groundnut cultivation by individual households (ZIMVAC 2016, ZIMVAC 2017). While maize remained prominent the rising cultivation of different crops is indicative that farmers are autonomously adapting through diversifying their agricultural production.

The potential for adapting to rapidly changing climates through climate-smart conservation agriculture has an immense opportunity to promote sustainability. It is also already practised on a small scale by small-holder farmers with advanced fertilization and limited crop diversification. However, these factors are limited due to a disconnect between increased usage of crop diversification and fertilization leading to severe food production shortages.

4.6 Irrigation and Rain-Fed Agriculture

Zimbabwe is predominantly arid, characterized by limited water irrigation systems. Zimbabwe has an estimated 150,000 hectares of fully irrigated land. The amount of irrigated land only covers 11% of total irrigated land throughout Zimbabwe. This stands in contrast with 600 000 hectares of potentially irrigational land (FAO 2018)

The opportunity for irrigation is highly positively viewed by small-holder farmers as a necessity in supplementing water supplies in between rainy seasons. The limitations of irrigation schemes are observed throughout Zimbabwe with dependent cultivation of water-intensive maize. The lack of crop diversity leads primary water supplementary systems to dry up and become severely strained, most notably throughout dry periods such as maize

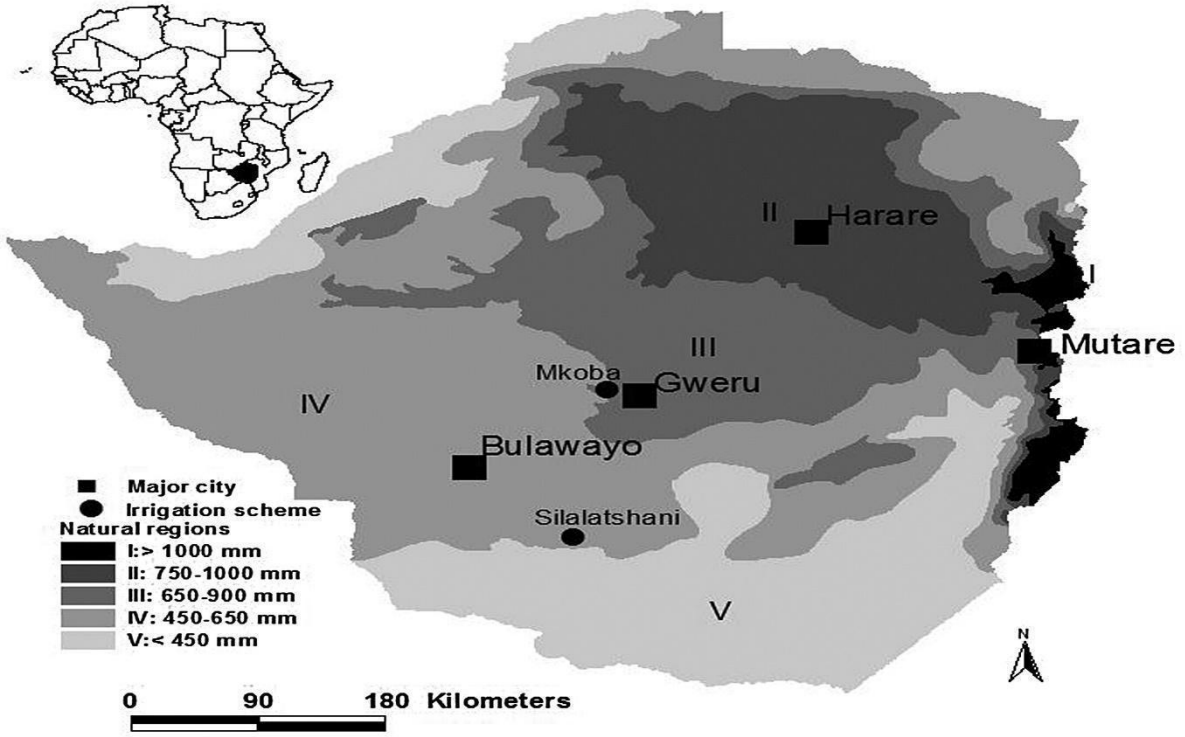
which is water draining (Moyo et al 2017). Farmers predominantly rely on consumption and agriculture for the largest form of farmer-led or autonomous irrigation, as opposed to structured irrigation primarily utilized for commercial and mining purposes (Moyo et al 2017).

Regarding their research on the various irrigation schemes of Silalatshani and Makoba Moyo et al (2017) indicated that the failure of irrigation and barriers to production is largely attributed to poor farm inputs and limited use of existing irrigated land(Moyo et al 2017, Crush 2017). The lack of irrigation used to supplement water systems presents immense stress on smallholder farmers who are unable to expand or access these resources due to their small operations of subsistence (Moyo et al 2017).

Major irrigation projects throughout Zimbabwe have been unable to support subsistence and small-holder farmers leading to a strong reliance on rain-fed agriculture. The most prominent case is the Shalintshali irrigation project. This is rooted in addressing the uncertainty of rainfall, leading farmers to expand natural irrigation systems and transition towards relying more on localised irrigation methods. These small-scale projects utilise local streams and underground water through technology or trench construction to increase water supply (Scoones et al 2019). Farmer-led irrigation covers more than 3.5 times that of structured official irrigation spanning 150 000 hectares. While farmer-led irrigation is the most reactive form to environmental stress Scoones et al (2019) note within their study that out of the total irrigated land farmer-led irrigation accounts for only 9.7% of total irrigated land (Scoones et al 2019). Thus, while farmers are responding to methods the increase in local irrigation methods is not sustainable in providing sufficient access to water for consumption and irrigation.

The regions that are largely farmer-led irrigation-reliant are also highly vulnerable to climate shocks and droughts that dry up local dams and rivers and limit access to underground water reserves. Within Zimbabwe, the most affected regions are Matabeleland South and Masvingo which experienced rainfall patterns below 350mm annually throughout 2015-2016. Declining rainfall has led to increased drying of riverbeds and local dams which are widely utilised by small-holder farmers to irrigate their crops.

Figure 4.3 Irrigation and Rainfall Throughout Zimbabwe



Source: Moyo et al 2016, ICRISAT Bulawayo GIS unit 2014.

Chapter 5. Summary, Conclusion and Recommendations

5.1 Introduction

This chapter aims to consolidate and conclude the research report by summarising and discussing the findings of the case studies of Mozambique and Zimbabwe relating to food security and adaptation approaches following climate shocks. The chapter reviews the state of food security by summarising the availability, production and market access of food throughout both case studies.

Furthermore the chapter summarises and highlights the key responses by small-holder farmers in adapting or reacting to climate change. The findings and summary indicates that various forms of adaptation have been implemented with variable success. Furthermore this chapter reviews on the person-centred and to what degree state intervention has been beneficial or limited in relation to the aforementioned case studies.

Furthermore this chapter provides recommendations on how to address and approach food insecurity through engagement with farmers and assessing the impact that climate variation has on vulnerable communities. Lastly this chapter concludes the research report by reflecting on the findings and concepts of human security.

5.2 Climate Change and Food Security

Throughout both case studies a key distinction is made on distinguishing different needs of each case study. Broadly the application of human security is reaffirmed throughout the findings as a person-centred approach has revealed that the food security dimensions of Mozambique and Zimbabwe varies significantly on community needs. This can be attributed largely to the varying effects of climate variation on different communities and how these communities are differently affected by various aspects of insecurity.

The broader literature on food security examined the debate between traditional production-centric approaches and the food entitlements approach. However, the findings from the case studies regarding production and access reveal that while global trends indicate a surplus of food, insecurity at the local level is primarily attributed to the production value chains influencing local market access. Moreover, the argument that global supplies need to offset local food insecurity lacks credibility due to the overall inadequacy of investment in agriculture and market access infrastructure in both case studies. The following summary of food availability, production, and food access throughout Mozambique and Zimbabwe elucidates how human and food security approaches can be utilised to foster grassroots solutions by assessing local production needs and access to food markets.

5.2.1 Impacts on Food Production and Availability

The impact of climate change on regional and local food systems is complex, varying from extreme drought conditions to rapid floods. Rising temperatures affect the gestation of vital food crops and which indirectly affects economic and social growth. The high reliance on agriculture as a source of income and income distribution is indirectly tied to climate change through the acquisition of cultivated food crops and the reliance on these crops for local growth and sustainability. Climate change has thus emerged as a significant threat to food and human security with developing countries most susceptible to climate disasters. The challenges of climate change are observed with factors pertaining to crop production and overall yield (Raimundo, 2016; FAO, 2017). The broader findings of the cases of Mozambique and Zimbabwe reaffirms the detrimental impact climate change has on production systems of which small-holder farmers are reliant on.

Production as a key pillar is essential in promoting local food stocks and limiting reliance on food imports for availability. Small-holder farmers had to contend with heavy strain on local production affecting their livelihoods and regional supplies. The findings of the cases of Mozambique and Zimbabwe outline the importance of production from local producers. Small-holder farmers rely on local cultivation and production for income and for nutritional consumption. However, the case studies reveal that the impact of production decreases overall security as food producers are also highly reliant on market access. Farmers who were unable to sell their food were also unable to purchase food for sustainability.

Zimbabwe:

The climate of Zimbabwe features dry and arid regions across Southern, Central, and Western areas, while tropical conditions prevail near the border with Mozambique. Zimbabwe stands out in this context due to its heavy reliance on agricultural production which is the primary source of income for the majority of Zimbabweans. When droughts resulted in crop failures, farmers were unable to produce food and, coupled with low regional incomes, struggled to afford food in local markets. The key outlining trend is that food imports increased substantially to fill up food stocks however the purchasing of food was low due to low incomes. The findings through production broadly indicate that Zimbabwean small-holders are under severe strain in maintaining production to generate income (FAOSTAT 2021, ZIMVAC 2016). This is most prominent with the widespread cultivation of maize which is the most produced crop throughout Zimbabwe.

Zimbabwean food stocks have been reliant on imports to sustain food security. This challenge is the lack of localised food availability through production has led to income strain which in turn leads to food being unaffordable for purchase. This is most notable with maize where more than 84% of small-holder and subsistence farmers rely on maize cultivation. However, Low production levels did not solely provide insecurity through the lack of availability but rather through the lack of access due to low commodified prices limiting income (Baez et al 2018).

To offset high pricing and limited food availability there has been a notable market trend of increased imports to offset food shortages. The impact of increasing imports are noted with the average household consumption of food which is considerably higher in market centres such as Harare and Buluwayo in comparison to rural areas where farmers are more reliant on local production to fill up food stocks.

Mozambique:

Mozambique's volatility stemmed from severe weather events such as flooding in Niassa and Tete, alongside severe drought conditions in Gaza, Inhambane, and Nampula. These challenges underscore the critical importance of addressing both the production and accessibility pillars of food security to mitigate the impacts of climate shocks on vulnerable communities.

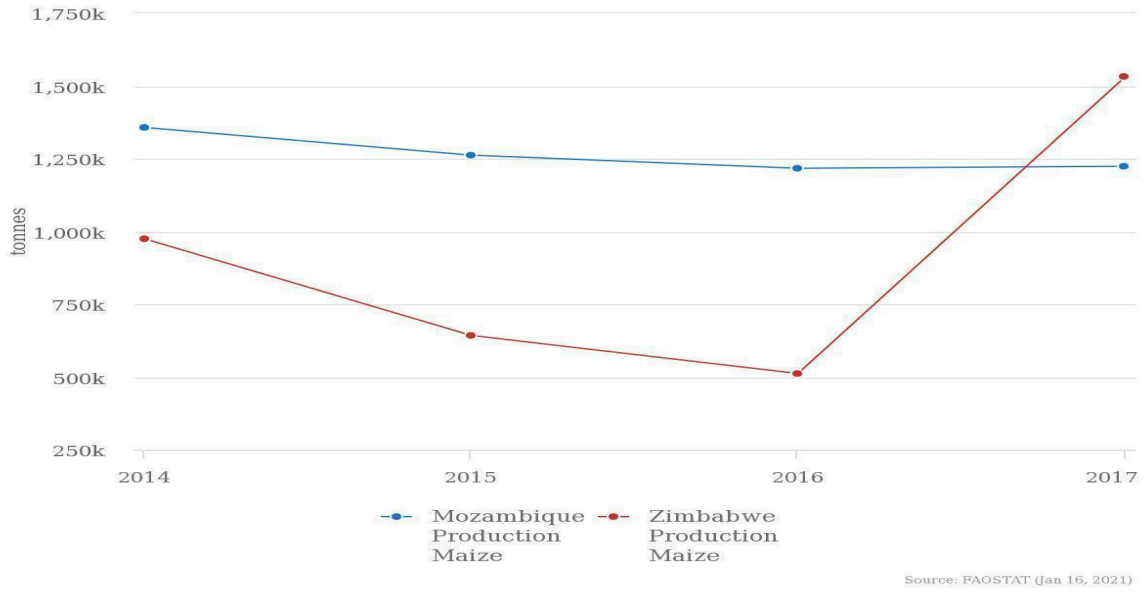
Mozambique witnessed a notable decline in food availability and production between 2015-2017 which is reflected increasing food imports. While Mozambique maintained stable maize production levels throughout the El Niño-induced droughts and erratic rainfall this has only been due to increased irrigation in Southern Mozambique.Regarding the case of Mozambique findings from the 2015 Mozambican smallholder survey reveal disparities in the production of maize and cassava, which serve as primary nutritional sources (FAO 2015, World Bank 2016, CGAP 2015). Roots and Tubers as subsidiary crops saw an increase in production to offset deficiencies from cassava and maize, which resulted in higher cultivation and increased production between 2015-2017.

In exploring the import factors of both states imports throughout drought periods increased significantly as a means to subsidise the lack of availability. While Mozambican imports of foods increased throughout the primary drought period of 2015/2016 Zimbabwe experienced an average increase in imports throughout the 2016 period coupled with heavy reliance on

donor imports (WFP 2016). Mozambique continued to increase imports of other foods throughout 2015-2017

Production as a key pillar is essential in promoting local food stocks and limiting reliance on food imports for availability. Small-holder farmers had to contend with heavy strain on local production affecting their livelihoods and regional supplies. The findings of the cases of Mozambique and Zimbabwe outline the importance of production from local producers. Small-holder farmers rely on local cultivation and production for income and for nutritional consumption. However, the case studies reveal that the impact of production decreases overall security as food producers are also highly reliant on market access. Farmers who were unable to sell their food were also unable to purchase food for sustainability. The challenges in production is underscored by declining maize production in both case studies between 2014-2017 as indicated in figure 5.1 .

Figure 5.1: Maize Production in Zimbabwe and Mozambique 2014-2017



Source: FAOSTAT 2021, accessed January 16, 2021

The impact of climate change on production and availability is noted during the La Niña transition at the end of 2016. The partial end of severe drought conditions led to increased production in maize as outlined by figure 5.1 within both case studies led to an increase in production and overall food stocks at the end of 2016 (FAOSTATS 2021). While Mozambique maintained stable maize production levels throughout the El Niño-induced droughts and erratic rainfall, Zimbabwe experienced a decline in maize production to

emergency levels, prompting the immediate implementation of an emergency response plan following widespread crop failures in 2016. (ZIMVAC 2016, ZIMVAC 2017).

Based on the specified data, the main challenge arising from climate conditions and production is identified as the direct relationship between accessibility and availability. Although production experienced a notable decline, the effect on food availability, measured by both staple production volumes and crop production trends, does not reflect fluctuations in food insecurity across Mozambique and Zimbabwe. As noted in 2015 at the start of the El Niño crisis the immediate concern was rising temperatures and heat stress which caused significant shortages in water and irrigation stressing crop production (Geoglam 2020). These factors directly relate to maintaining high harvest yields. Secondly, throughout 2016 the variation is accustomed through the occurrence of extreme rainfall variation leading to immense dry spells and droughts with Mozambique experiencing below 1000mm rainfall and Zimbabwe below 500mm (Geoglam 2020).

In short the findings from both case studies confirm that low production and high reliance on imports is unsustainable to offset insecurity arising from climate change. However, in reaffirming the access and entitlement approach as argued by Amartya Sen, increased production does not translate in food security. The case of Mozambique highlights this argument where multiple crops were cultivated increasing overall production however the production and availability of food remained lower leading to increased imports.

5.2.2 Climate effects on food access and food pricing

Food access determined by market access and purchasing power varies across the two case studies. Prices of widely cultivated crops have been constantly rising between 2015-2017 with imports often employed to increase local food stocks. High food prices have through the case studies affirmed that alongside production access to food needs to be taken into consideration. To offset high food prices both states have increased imports.. The key trend throughout the findings is that access to food is tied to income generation from the production of food. Given the high reliance on agriculture as a source of income, climate shocks lead to declining income which in turn increases food prices which results in small-holder farmers and individuals unable to afford the purchasing of food. Increased imports have also not substantially promoted market access as many small-holders also contend with low development and poverty with limited external support to access nutritional food.

Mozambique:

Mozambique throughout the drought period experienced rapid food inflation throughout November 2016 peaking at 40% above food prices in 2015 (World Bank 2019). In drought-prone areas such as Nampula, where low yields and crop failures occurred, food prices increased substantially. The average price of maize stood at $0.50/kg in Niassa, but exceeded $1.26/kg in severely affected provinces namely Nicala and Nampula. Food prices fluctuated considerably across Mozambique, with increases observed in the northern provinces, while prices remained steady in southern Mozambique. This is because urban centres enjoy greater access to regional markets compared to rural agricultural areas. Access to food throughout rural areas in Mozambique is dependent on local production. Above 80% of small-holder households in rural Mozambique attain food and income from local production hence the rapid change in pricing leads to the unaffordability of food decreasing local purchasing power (UNDP 2017).

The unsustainability of price increase is noted with the price of maize. Mozambican maize prices nationally at $0.90/kg (FEWS NET 2017). In severely affected areas experiencing continuous droughts and rapid flooding the price for maize has reached as high as $1.26/kg (FEWS NET 2017). Hence while maize production and imports remained stable, the consumption of maize decreased in favour of alternatives such as roots and tubers.

Zimbabwe:

Market location is a key factor affecting access with the case of Zimbabwe revealing that most accessible and low-priced markets for food are centralised. Bulawayo and Harare are focal points in the Zimbabwean case study, where regional markets tend to have higher food stocks, prices remaining unsustainably high. This trend is evident in Matabeleland South, where Bulawayo hosts the primary food market; however, prices there significantly exceed the national average of $0.33/kg for key food crops namely maize (WFP 2016). An unusual pattern observed in Zimbabwe is that, despite relatively stable prices, food insecurity persists due to insufficient income to purchase food. In rural areas such as Matabeleland South, there is a notable phenomenon of minimal food inflation despite severe drought conditions, which is nevertheless is compounded by already elevated food prices(FEWS NET 2017, FAO 2017, WFP 2016).Lower food inflation however is noted in Zimbabwe with the national average of maize as a staple food peaking at $0.55/kg. Zimbabwe experienced significant declines in inflation with a relatively stable food price nationwide with average prices increasing

in-between 12-25% above average (FEWS NET 2017). As observed, what stands out is that despite heightened economic activity and few economic constraints, access to food remains severely restricted because smallholder households rely solely on agriculture for income.. With no other income streams households and small-holders are unable to afford food which is worsened following climate shocks.

Farmers in both cases had to contend with rising food prices on limited income. The factors that influence food prices are based on food availability and production. Policy and government market systems are usually attributed to changing food prices however within both cases rising food prices does not correlate with severe government challenges or economic decline as both cases experienced economic stability. Mozambique has before the 2015-2017 drought decreased overall food access and food insecurity below 48% of the total population and Zimbabwe experienced stabilising inflation (USDA 2016). Thus, in attributing the impact of climate change rising demand arose with the lack of production which exacerbated food insecurity due to already existing underdevelopment and lack of market access. To offset unsustainably high prices both states relied on increased imports and food aid with limited success. The FAO and WFP being the primary food aid providers note that food market accessibility due to economic stabilisation is not attributed to the lack of access but due to market concentration in regions vulnerable to climate variation (WFP 2016).

Numerous scholars have highlighted the importance of access in bolstering food security. Amartya Sen's argument advocating for equitable access, whether through market channels or financial aid, to promote food security despite the global increase in food production, has been challenged by the case studies of Mozambique and Zimbabwe during the El Niño drought period (Sen 1981). Essentially, production plays a pivotal role in facilitating market access, as heightened production levels contribute to increased local access by lowering overall food prices and improving average supply, and vice versa. The findings consistently highlight the correlation between food prices and food access, reinforcing the argument that accessibility is closely linked to production but uniquely distinct relating to insecurity. The challenge of food insecurity is thus a lack of entitlement through access and dwindling supply due to low production and not solely reliant on production.

5.3 Climate and Agricultural Adaptation.

Throughout the two case studies within the 2015-2017 El Niño drought period small-holder farmers undertook autonomous adaptation namely through conservation agriculture to offset climate variation. The overall lack of investment in key infrastructure developments such as seedbanks and irrigation has severely limited small-holder access to planned interventions relating to climate change. The findings in short highlight how planned adaptation is not viable in addressing issues of climate change throughout developing states due to limited investment and financial resources aimed at undertaking medium to large scale projects.. This stands in contrast with the broader literature as the general consensus is that there is a need for large scale planned adaptation rather than person-centred small scaled autonomous adaptation. Both case studies experienced variant adoption of conservation agriculture and farmer-led irrigation methods. However, lower levels of planned adaptation have been adopted at a very small or limited scale. Throughout both case studies adaptation has had varying impacts ranging from improved cultivation due to fertilisation and utilisation of irrigation.

In adapting to climate variation Mozambican farmers have been able to better offset the impact of climate variation which is attributed to higher crop diversification coupled with higher rainfall than neighbouring states. In contrast, in Zimbabwe, severe water shortages, combined with heavy reliance on maize production, hindered the ability to adapt and mitigate the effects of climate variability, resulting in increased crop failures and decreased yields.. The key trend is how farmers have responded to climate change. The findings note how autonomous adaptation has manifested through crop diversification, traditional rain-fed irrigation and traditional fertilisation techniques employed by farmers. Whereas planned adaptation has been manifested with water irrigation projects.

5.3.1 Conservation and climate-smart agriculture.

Throughout the study it has been identified that small-holders are not passive actors when engaging with disasters such as drought. In both cases smallholders undertook various initiatives and engaged in various techniques aimed at adapting or mitigating the effects of climate change. It has been identified that conservation and climate smart agriculture are the most utilised methods alongside providing the most stable and cost-effective means to respond to continued drought periods. The practice of engagement in conservation agriculture includes using variant fertilisation to offset. In addition to the broader literature the study and cases outline how fertiliser use is key to smallholder adaptation with manure being used as a

cost-effective fertiliser whereas chemical fertilisers are more efficient in maintaining crop gestation during drought periods.

Within the case of Mozambique chemical and compost fertiliser usage was relatively low with 6.7 kg/ha utilised and imported by smallholders (World Bank 2020). The low imports of fertilizer in the case of Mozambique are indicative of local use in manure rather than expensive fertiliser imports. In adopting compost and manure to replace market-based fertilizers small-holder farmers throughout Mozambique namely wet areas where rainfall is on average higher than drier provinces. The use of compost and manure has been partially effective in combating climate shocks due to higher rainfall precipitation leading to softer and more absorbent soil (FAO 2016, Zavale et al 2020)/

Similarly throughout Zimbabwe manure as an inexpensive fertilizer has been utilised widespread. The limitation however is that manure is effective when coupled with substantial irrigation or above average rainfall precipitation. Zimbabwean farmers largely utilise manure and compost with assistance from market-based fertilization where applicable. Severe dry spells and droughts lead Zimbabwean farmers to contend with dry and poor soil quality thus limiting the effectiveness of manure and fertilizers. These conditions require more fertilization to be viable and as observed in Zimbabwe the higher fertilization increases to maintain minimal soil quality.

5.3.2 Crop diversification and seed usage.

Small-holder farmers in both case studies have adopted crop diversification as a means to cope and offset the impact of climate variation. The cultivation of diverse crops among small-holder farmers is prevalent among Mozambican smallholder farmers who cultivate a combination of maize, root tubers and cassava. Crop diversification in the case of Zimbabwe is sorely limited due to high dependency on maize. Zimbabwean farmers have been attempting to diversify crops through cultivating sorghum and groundnuts however production and opportunity for income generation remains stubbornly low.

Tillage and cultivation of various crops have limited the impact of droughts and a lack of rainfall primarily throughout Mozambique. With high production of both maize, cassava and various other roots and tubers Mozambican farmers have been able to offset the impact of drought and variant rainfall with substitute crops. This is noted with increased food availability due to high food production of substitute crops such as roots and tubers in regions where maize or cassava production declined (FAO STATS 2020). With declining production,

the availability of food was offset by increased roots and tubers production. Combined with stable harvests of maize in northern Mozambique and drought-resistant cassava farmers have been better able to mitigate the impacts of climate change by adopting drought-resistant crops and cultivating a larger variety of crops. Within the 2015-2017 El Niño drought season while cassava and maize noted declining production the increase in roots and tuber cultivation to offset the shortages has led to more availability of food stockpiles. Combined with the long-lasting storage of cassava the ability to store and stock food is more efficient (Costa 2019).

Zimbabwean crop diversification was largely concentrated on offsetting maize production deficits through cultivating groundnuts and sorghum. Within the case period higher cultivation of these crops was undertaken by Zimbabwean farmers to offset climate variation (ZIMVAC 2016). The production of these crops, even in regions with slightly higher rainfall, remained relatively low both in cultivation and yield. Maize was the primary cultivated crop at 88% in 2015 and 84% in 2015/2016 with lower cultivation of substitute crops such as millet below 20%. Groundnuts are the sole exception; however, despite increased cultivation, production declined during the drought period.(ZIMVAC 2016, WFP 2017).

Regarding seed production access to seeds is widely limited across Mozambique and Zimbabwe with less than 10% of small-holder farmers utilising adapted and improved produced seeds (Mabaya et al 2017, TASAI 2015). Poor quality seeds and limited market variety in seed manufacturing has negatively impacted farmers indirectly blocking access to drought resistant seeds and promoting the reuse of lower quality seeds that are highly susceptible to climate shocks.

Alongside widespread food system sustainability, Mozambican farmers have mitigated climate variation by adopting diversification due to existing agriculture production practices. Cassava is widely produced due to its drought-resistant properties alongside other roots and tubers alongside maize (Sousa 2017). However Mozambican farmers have used existing agricultural structures such as maize production to better adapt to changing conditions as maize area cultivation increased alongside the cultivation of roots and tubers. The challenge in adaptation is the limitations of crop diversification. The diversification of crops was able to partially offset challenges posed by climate variation however as noted with the 2015-2017 drought period the severity of climate variation ensures that agriculture is highly volatile (Sousa 2017). Regardless of crop diversification, food production and access are still

vulnerable to severe shocks. Nampula and Tete are the leading regions dependent on maize cultivation, as well as cassava roots and tubers. However, they exhibit declining production and limited access compared to Maputo. Tete and Nampula similarly experienced severe drought and water shortages indicating that crop diversification, while widely utilised, is limited in mitigating or adapting to severe weather conditions.

Zimbabwean farmers have attempted to improve crop resilience by adopting drought-resistant varieties. However, these efforts have not yielded the desired results, as they have been accompanied by persistently low food production and heightened food insecurity. In observation, food insecurity is noted with higher reliance on market produce than self-sustainable food sources. (ZIMVAC 206, AGRITEX 2016) As an adaptation tool crop diversity within Zimbabwe has been unsuccessful due to widespread severe low production of primary and substitute crops. This inability to adapt is due to the already low production of different crops and the historical sole reliance on maize is identified throughout 2016 where the production of maize declined alongside a decline in groundnut harvests. These low production figures arise on the backdrop of increased cultivation by small-holder farmers of diverse crops. The reliance on maize as a primary source is attributed to both seed access and availability throughout growing seasons. Whereas roots and tubers can be produced in off seasons as substation crops maize is planted in October and November and harvested throughout April. The gestation and period of maize correlate with the state incentivisation of maize seed distribution and production limiting access to diversified seeds. The low production trends that limit diversification are noted with the cultivation of groundnuts which indicated a rise in household cultivation but continuously noted a decline in production and yields.

In conclusion, crop diversification is a prominent tool for adaptation throughout Zimbabwe and Mozambique. During the initial drought period, Mozambican farmers experienced higher production and limited the impact of drought through the wide cultivation of maize, cassava roots and tubers. The success and occurrence of crop diversification in Mozambique are based on pre-existing cultivations of a variety of crops. In contrast, Zimbabwean farmers were unable to effectively adapt to climate conditions due to pre-existing cultivation and reliance on maize as the primary staple crop.

5.3.3 Water irrigation and rainfed agriculture.

Water and irrigation are vital throughout in maintaining sustainable production of food crops. Within both case studies the majority of small-holder farmers have limited or no access to

formal water irrigation systems, such as dams and canals, and have to rely on extremely volatile and variant rainfall or vulnerable water sources such as wells and rivers. With reliance on rain-fed agriculture, both Mozambican and Zimbabwean small-holder farmers do not have the means to utilise or access irrigation schemes and have resorted to smaller climate-dependent irrigation methods. Within both cases, less than 10% of households utilised formal or widespread irrigation schemes and instead relied on local streams, wells, and rainfall.

The disparities in access to irrigation schemes are noted with low irrigated land coupled with the concentration of irrigation schemes surrounding urban centres. Within Mozambique and Zimbabwe, irrigation schemes, such as the 25th of September scheme in Maputo, the Shilalatshani scheme in Matabeleland South and the Chokwe Irrigation Scheme in Gaza, are widely underutilised. Individuals thus are reliant on autonomous means of water storage and irrigation above planned irrigation support projects (Veldwisch 2015, Sousa et al 2017).

The scale of irrigation is sorely lacking with small-holder farmers in both cases having limited to no access to irrigation schemes. Throughout Zimbabwe, only 11% of arable land is irrigated amounting to a total of 150 000 hectares of irrigation. Regarding the case of Mozambique 90 000 hectares of irrigated land was irrigated in 2015 and 2016 which amounts to 2.5% of arable land (Sousa 2015, World Bank 2018, Scoones 2019,). With the expansion of Zimbabwe's irrigation infrastructure, its utilisation has increased however these projects are not large enough in scale to promote widespread adoption amongst small-holder farmers. In Mozambique, the main formal water irrigation system in the Gaza province serves only 3.5% of smallholder agricultural producers, yet it covers one-third of the total irrigated land in Mozambique.(Scoones 2019).

Planned Adaptation:

The lack of formal utilization of existing irrigation infrastructure, attributed to insufficient access, indicates that irrigation systems in both Zimbabwe and Mozambique face challenges in formally adapting to climate variations. The cause is clear given that there has been limited investment in large scale irrigation from government and multilateral stakeholders. Furthermore small-holder farmers are unable to financially access irrigation schemes or contribute to maintaining irrigation infrastructure (Moyo 2014).

The case of Mozambique adequately reflects the challenges in promoting planned adaptation amidst increasingly severe climate shocks. With more than one-third of formerly irrigated

land concentrated in Southern Mozambique, the inequities in access to water for agriculture have negatively impacted farmers throughout northern Mozambique who utilise river and groundwater irrigation. With little access to pumping machinery farmers are note able to utilise irrigated water canals or use deep groundwater reserves (Sousa 2017). Likewise, irrigation schemes are not adequately developed in the most vulnerable regions. Producers in northern Mozambique, despite experiencing higher rainfall compared to southern Mozambique, are highly susceptible to limited water access during drought periods attributed to limited or no access to local irrigation schemes.

Autonomous Adaptation:

Farmer-led irrigation in contrast is largely reactive and autonomous which increases vulnerability amidst climate shocks. The practice of rainfed agriculture is cemented in agricultural production throughout Mozambique and Zimbabwe with farmers relying on vulnerable water sources such as rivers and make-shift dams. Due to limited alternatives farmers continue to use local river basins, underground water, and rainfall to offset the challenges following severe climate shocks.. In utilising local irrigation and adaptation production of food remains vulnerable as drought seasons arise. The high usage of rainfall-driven irrigation is noted with the impact of variating regional rainfall precipitation. In short, provinces and regions with overall higher rainfall such as Manicaland in Zimbabwe and Inhambane in Mozambique have higher levels of small-holder adaptation and food security and better overall yields and production. The challenges of drought forces smallholders in dry regions to adapt more stringent adaptation mechanisms coupled with increasingly severe water shortages.

In Zimbabwe, severe drought conditions led to average rainfall dropping below 500mm, impacting households and small-holder farmers largely dependent on rainfed agriculture. Southern provinces faced particularly harsh drought conditions exacerbated by limited access to widespread irrigation systems. Manicaland, in particular, has become highly vulnerable to drought, with rural farmers encountering substantial challenges in accessing reliable water sources. This, coupled with extensive maize cultivation, a water-intensive crop, further exposes farmers to food insecurity.

The limitation in irrigation varies widely across both case studies. Within Manicaland in Zimbabwe and Niassa in Mozambique, the need for drought adaptation has been limited as these regions experience overall higher rainfall precipitation throughout drought periods and

experience subsequent periods of flooding. Adaptation and interventions by farmers were thus more effective in responding to climate shocks than drier regions. These interventions are partially successful despite the threat of floods which also decrease overall production and food security.

In conclusion irrigation and rain-fed agriculture, Mozambican farmers have been able to better adapt to changing rainfall conditions due to higher average rainfall and geographical support features that provide variable access to water. Zimbabwean vulnerability is attributed to its exceedingly low rainfall which impacts vital sources of water irrigation such as dams and rivers. Within both cases, access to formal irrigation is extremely limited as observed with high reliance on rainfed water sources. Thus, the means of adapting to declining water availability is extremely limited, requiring access to large, planned adaptation schemes such as formal irrigation projects. Small-holder farmers in utilising all available water conservation mechanisms are thus unable to significantly adapt to the challenge of low rainfall.

5.5 Conclusion and Recommendations

Within human and food security debates scholars widely argue that poor governance and socio-cultural variables are the primary drivers of food insecurity. In exploring the case studies of Mozambique and Zimbabwe the complex system of rural food production and the impacts of climate variation the arguments that poor governance and inequity are the primary means to address food insecurity is limited at best. Instead as the findings have suggested the dimensions of food security are more complex with small-holder farmers acting with more autonomy in addressing challenges arising from climate shocks.

Planned adaptation approaches aimed at offsetting the effects of climate change have been unable to address widespread concerns regarding access and production whereas autonomous engagements and reactions by small-holder farmers have had partial success in mitigating the effects of climate change. The solutions to food insecurity throughout Southern Africa thus cannot be relegated to government donations, large scale irrigation projects, food imports, food packets and food aid promoted by international institutions (WFP 2016, Crush et al 2010). Rather than solely addressing these issues, it is imperative to advocate for comprehensive protective and support mechanisms that empower small-holder farmers and vulnerable communities to adapt to the challenges of climate variation in a more efficient and effective manner..

The evidence of food production and accessibility coupled with small-holder responses and adaptation suggests that recent declines in food security are predominantly the effect of climate variation. Before 2015 both explored cases noted increased production of food and increased availability and access to healthy and nutritious food. However, with recurrent flooding, severe droughts, and rising temperatures these gains have subsided as noted by declining food production and increased food vulnerability. Increasingly impoverished communities and individuals are more at risk of food security than before. The gains of halving hunger as outlined in the millennium development goals have dissipated among agricultural and climate crises. The research report concludes thus that food security interventions need to desperately focus on providing individual farmers access to more sustainable water sources and shift away from vulnerable rain-fed agriculture. These would require expanding water irrigation systems such as in Chokwe and Shilalatshani alongside promoting countrywide crop diversification. Alongside expanding planned adaptation systems international organisations, regional organisations, NGOs and CSOs would need to comprehensively improve access to vital agricultural resources to empower individual communities to adapt to rapidly changing climate conditions.

One of the main suggestions emphasised across the case studies is the necessity for governments, multilateral organisations, and NGOs to collaborate closely to assist communities in adjusting to swiftly evolving climate conditions, thereby enhancing food security. These interventions would need to assist in facilitating broader access to localised irrigation schemes and promoting autonomous responses such as crop diversification and climate-smart agriculture. These recommendations are in the backdrop of the core assumptions of human security that a person-centred approach is needed to address local challenges related to climate change. As outlined in the literature review, solutions for adaptation must be implemented from grassroots levels upward. The findings suggest that this approach has been evident in Zimbabwe and Mozambique, where there has been limited support for larger irrigation projects, crop diversification, and investment in fertilizers leading smallholder farmers to attempting to adapt to climate change and climate variation utilising climate-smart agriculture and local manure-based fertilisers.

Small-holder farmers have been identified as being highly vulnerable with limited resources to adapt and limited access to formal mitigation mechanisms. In exploring the livelihoods and responses of small-holder producers some synergies between autonomous adaptation and food security are feasible in mitigating climate variation. These synergies however are

unsustainable due to the severity of climate variation and continued underdevelopment and poverty. Thus, to effectively empower small-holder agricultural producers to adapt to severe climate variation interventions effectively and sustainably in irrigation, fertilisation and climate-smart agriculture would need to be carefully implemented.

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Appendix A

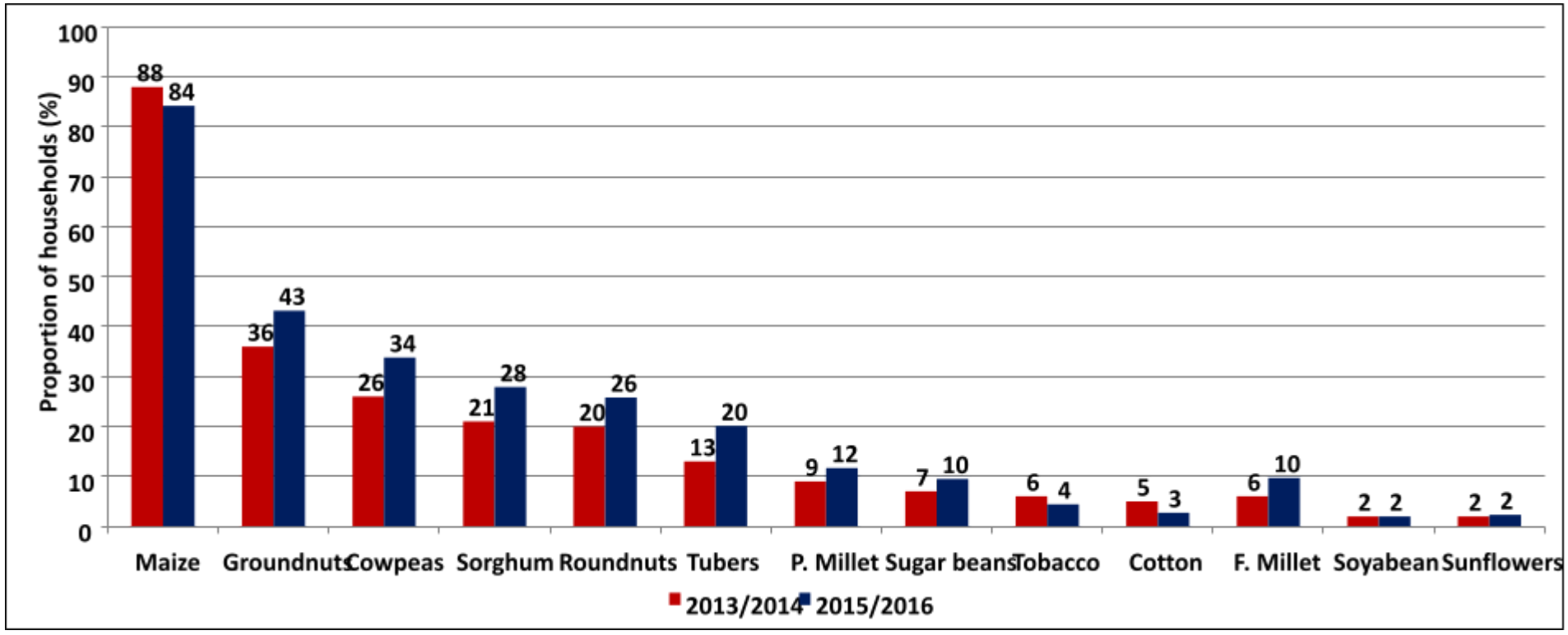
Household Food purchases, Household food insecurity and income (Maputo)

Food items	HFIAP		Income terciles		
	Food secure (%)	Food insecure (%)	Upper (%)	Middle (%)	Lower (%)
Rice	92.5	86.4	90.9	88.3	81.5
White bread	89.0	82.4	83.8	77.5	72.3
Sugar	62.6	66.0	61.9	67.7	59.6
Vegetables	70.3	60.5	65.9	64.3	51.9
Fish (frozen)	68.9	52.1	66.6	61.8	39.8
Pasta	58.1	38.8	53.4	41.2	26.1
Chicken (frozen)	58.4	37.6	51.6	43.1	26.4
Fruit	40.1	21.9	32.8	24.6	17.2
Chicken (fresh)	27.2	18.1	31.3	21.5	10.2
Fish (fresh)	17.0	18.5	21.9	15.1	15.6
Brown bread	12.7	4.8	12.5	2.2	3.2

Source: Crush and McCordick 2017

Appendix B

Household crop cultivation (ZIMVAC 2016)



Appendix C

Several visual materials in the form of short documentary videos provide a wide array of information on recurring challenges faced by smallholder farmers and general responses.

Mozambique: Responding to the El Niño Droughts

https://www.youtube.com/watch?v=QvTmWOu_EXI&t=161s

Agdevco: Mozambique

https://www.youtube.com/watch?v=gjbAQv1iFfE

Farmer-led irrigation development in Africa. Example from Mocambique

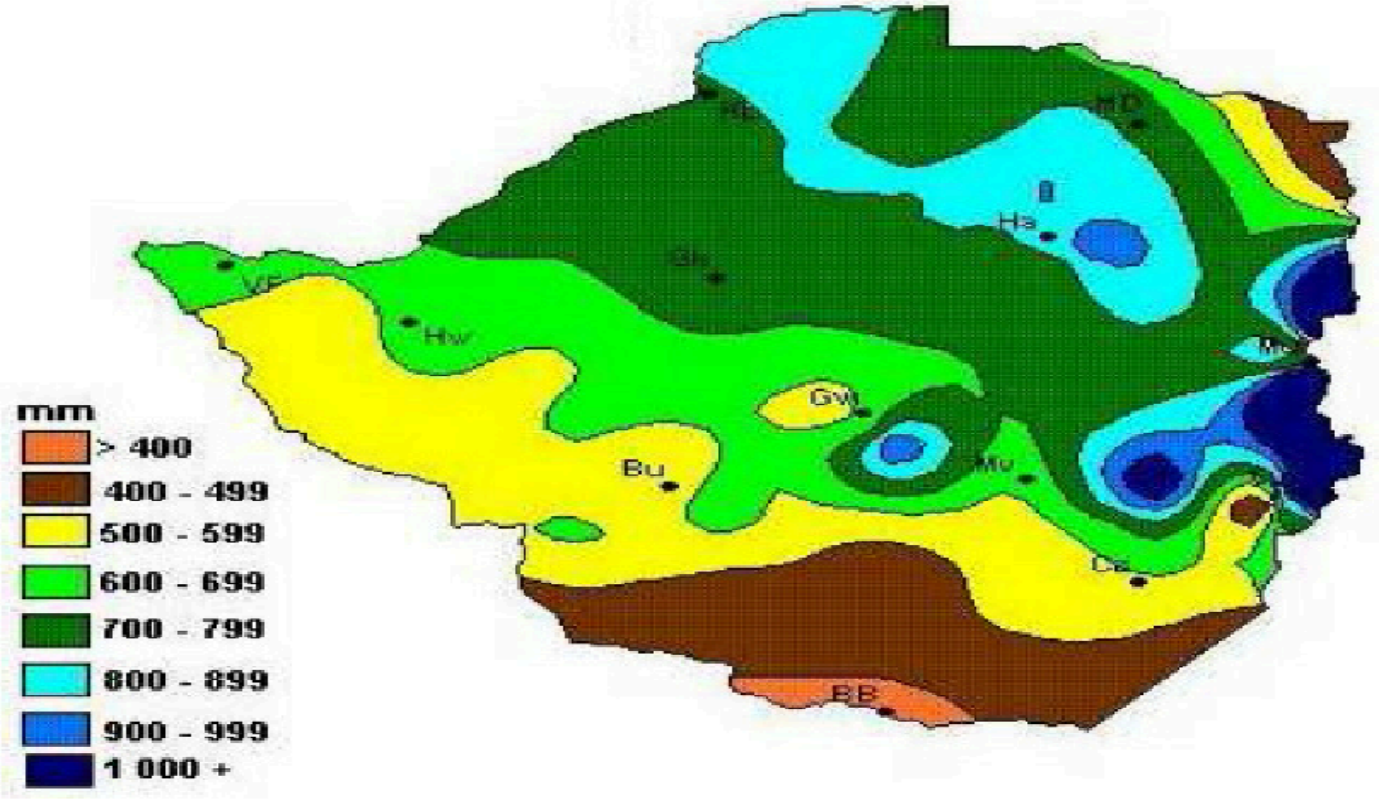
https://www.youtube.com/watch?v=agNxd7l0tyQ

Using Conservation Agriculture to help Zimbabwe's farmers produce more.

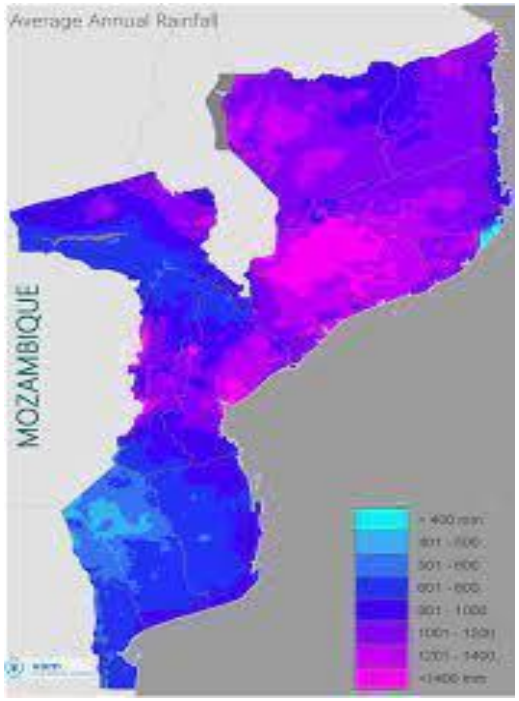
https://www.youtube.com/watch?v=E1IJ_C64O60

Appendix D

Rainfall precipitation across Zimbabwe and Mozambique has had varying effects throughout different regions. Precipitation and erratic rainfall present a variety of challenges from flooding in areas experiencing intense rainfall destroying crops while the majority of low-lying and plain areas experience extreme drought and dry spells.



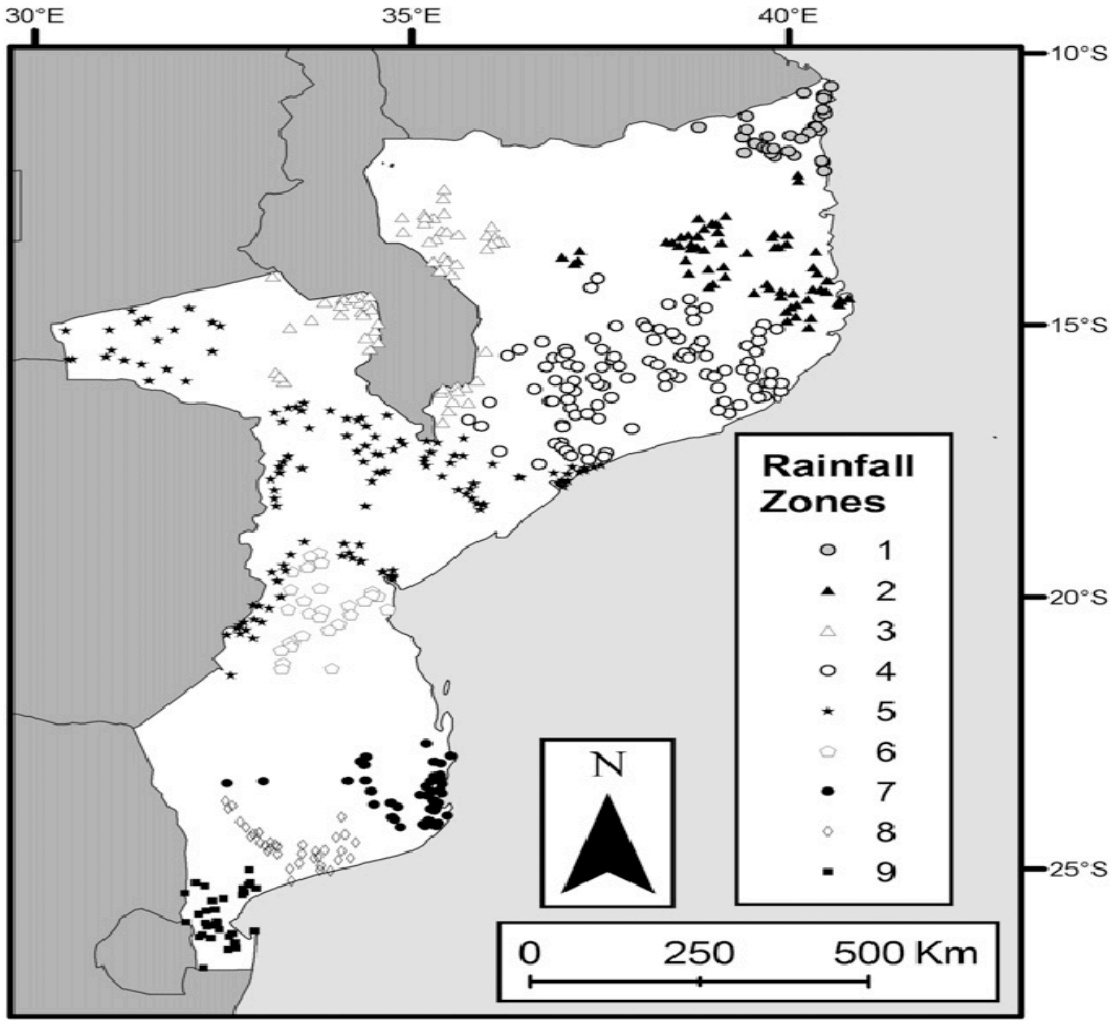
Source: Zimbabwean Meteorological Services Department



Source: USAID 2017, WFP 2017

Appendix E

Primary Rainfall Zones throughout Mozambique.


30°E
35°E
40°E
10°S
15°S
20°S
25°S
Rainfall Zones
1
2
3
4
5
6
7
8
9
N
0
250
500 Km

Appendix F

GMO demographic and Genetic modified consumption

Table 1: Demographic characteristics of respondents

Characteristic	**Disaggregation**	**Number**	**Percent (%)**
Gender (N=301)	Male	147	49
	Female	154	51
Age (N=294)	28	IQR (21;38) years	
Residence (N=299)	Urban	267	89
	Rural	32	11
Religion (N=301)	Christian	273	91
	Muslim	2	1
	Traditional African	10	3
	Rastafarian	4	1
	No religion	10	3
	Other	2	1
Educational Level	No education	2	1

	Primary	7	2
	Secondary	79	26
	Post-Secondary	211	71
Employment status (N=299)	Formally employed	124	41
	Self-employed	38	13
	Unemployed	137	46

Table 2: Factors influencing intention to consume genetically modified foods.

Factor	p-value
Knowledge of GM foods and genetic engineering process	0.000*
Religion	0.835
Residential area	0.466
Past exposure to GM foods	0.007*

*Level of association significant ($p<0.05$)

Source: Chagwena et al 2019