Small-scale farmers' adaptation strategies to climate change in rural Etete, KwaZulu-Natal, South Africa

by

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Dedication

Dedicated to the memory of my sister, Kavishni Chetti. You are gone but your belief in me has made this journey possible.

Declaration

I, Vikasa Chetti declare that this research project entitled: **Small-scale farmers' adaptation strategies to climate change in rural Etete, KwaZulu-Natal, South Africa** is my own work and has not previously been submitted by me for a degree at this or any other institution. It is submitted in fulfilment for the requirements of the master's degree in environmental management at the University of South Africa.

I declare that the dissertation does not contain any written work presented by other persons whether written, pictures, graphs or data or any other information without acknowledging the source.

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I declare that during my study I adhered to the Research Ethics Policy of the University of South Africa, received ethics approval for the duration of my study prior to the commencement of data gathering, and have not acted outside the approval conditions.

I declare that the content of my dissertation has been submitted through an electronic plagiarism detection program before the final submission for examination.

Vikasa Chetti **Date**

28/02/2023

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Abstract

Climate change is, undoubtedly, a major challenge confronting humanity partly because its causes are multiple and complex, and its impacts can be uncertain and interrelated. No sector of the global economy has been more adversely affected by climate change than agriculture, especially in developing countries. This is primarily because most agricultural activities are rain-fed. This study set out to critically analyze the constraints towards adapting to climatic and non-climatic risks. This study is significant towards capturing the full complexity of farmers' engagement with the phenomenon of climate change in resource-poor environments.

This study employed a mixed methods approach to determine constraints to effective implementation of climate change adaptation strategies. Primary data was gathered from the study participants in Etete through the use of seventy-four (74) questionnaires, and ten (10) telephonic semi-structured interviews. Site observations were conducted through transects walks. Data obtained from the interviews were analyzed thematically while data obtained from the surveys were analyzed using SPSS to develop the main themes for this study. Study results suggest that no systematic implementation of climate change adaptation strategies was enacted through government initiatives due to inadequate inclusion of stakeholders such as involved extension officers, lack of working facilities and political interference in the policy formulation process. The findings also show that farmers in Etete employ self-directed adaptation strategies such as growing drought-tolerant and early maturing crops, strategies such as intercropping and the use of crop rotation. However, effective adaptation through those strategies is limited by the absence of proper training and input from extension services as well as limited awareness of climate-smart agriculture by the farmers. The outcome of this research is expected to impart and develop a body of knowledge to equip planners, policy makers, local government, and academia with an understanding of the dynamics related to local livelihoods and how they are impacted due to climate change. With their focus on improving the relevance of extension advice through farmer's participation and staff training, these approaches could contribute to a significant improvement of the impact of extension.

Keywords: Climate change, small-scale farming, adaptation, extension officers, constraints to adaptation.

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List of Abbreviations

BEE	Black economic empowerment
CA	Conservation agriculture
CC	Climate change
CO_2	Carbon dioxide
CSA	Climate smart agriculture
DAFF	Department of Agriculture, Forestry, and Fisheries
DARD	Department of Agriculture, Land Reform and Rural Development
DEAT	Department of Environmental Affairs and Tourism
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross domestic product
GHG	Greenhouse gas
IDP	International Development Report
IPCC	Intergovernmental Panel on Climate Change
ISFM	Integrated soil fertility management
KZN	KwaZulu-Natal
LAPA	Local adaptation plans of action
LULUCF	Land-use and land-use change and forestry
MDP	Millennium development goals
NDP	National Development Plan
NGO	Non-governmental organisation
PPP	Public private partnerships
SA	South Africa
SAWS	South African Weather Services
SDG	Sustainable development goals
SPSS	Statistical Package for the Social Sciences
SSNM	Site-specific nutrient management
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WWF	World Wildlife Foundation

Chapter 1 : Introduction

1.1 Background of Study

Climate change (CC)[1] has a global impact and is currently one of the most significant threats to rural livelihoods, negatively impacting the natural environment and national and local economies (Ubisi, 2016; Saruchera, 2019). Consequently, a resolution to take urgent action on CC is the subject of United Nations (UN) sustainable development goal (SDG) 13 (Jacob, 2015; UNDP Annual Report, 2021; UN, 2021; UN, 2022). This was essential in developing countries as high temperatures have adversely compromised agricultural activities, particularly in rural areas in which small-scale agriculture is a direct source of sustaining a livelihood for most households (Pillay, 2016).

South Africa is a developing country in a region that is generally impacted by CC and so South African small-scale farming and the country's high reliance on the natural environment places vulnerable communities at risk from climate change (Saruchera, 2019; Meza et al., 2021; FAO, 2021). More specifically, CC has detrimental effects on agricultural activities that are highly sensitive to varying atmospheric conditions (Maponya & Mpandeli, 2012; Ubisi, 2016; Saruchera, 2019). In this regard, climate change is anticipated to contribute to a lower rainfall accompanied by an increase in temperature for Southern Africa by 2050, including an increase in erratic and heavy rainfall events resulting in flash flooding (Riedy, 2016; Pillay, 2016; Mathinya et al., 2022). Warmer weather conditions have been recorded in the past forty years in South Africa (SA) with high monthly average temperatures reaching 26^{o}C with a low monthly average temperature of 18^{o}C (KZN IDP, 2018). Highlighting the significance of small-scale agriculture in rural spaces in relation to CC, this research project focused on Etete, a rural community in South Africa that is overwhelmingly dependent on small-scale agriculture that is vulnerable to CC and whose effects may lead to an increase in poverty and reduced employment opportunities in the area and across South Africa (Tshuma, 2014; KZN IDP, 2018). The sustainable livelihood[2] framework is significant, particularly in relation to issues such as poverty reduction, sustainable resource use, empowerment, including gender

[1] Climate change is an adjustment in either the mean climate or climate inconsistency that continues over an increased period (Riedy, 2016).

[2] A livelihood is sustainable if it is able to deal with stresses and shocks, bounce back from them, and build on its strengths and assets now and in the future without affecting the natural environment. (Chambers & Conway, 1988).

empowerment, and good governance (Morse et al., 2009; UNDP Annual Report, 2021; Natarajan et al., 2022).

It is daunting when looking at estimations of Africa's food security targets that are estimated to increase by 2.9% by 2050, population growth being the primary influence that could contribute to the existing population of 1.1 billion on the continent in 2020 increasing to 2.4 billion by 2050 (Snodgrass, 2014). However, an average of 1% agricultural yield growth was recorded between 2001 and 2010 and if this trend continues consistently, a 75% shortfall of total food supply can be predicted for Africa by 2050 (Ubisi, 2016; Amosi, 2018).

In South Africa, CC presents a real threat to biodiversity systems, aquatic life, infrastructure, health, as well as food security (Ziervogel et al., 2014). Considering the country's increased levels of inequality and poverty, these adversities challenge national development (Ubisi, 2016; Saruchera, 2019). In addition, constraints such as population growth and lack of resources overall decrease small-scale farmers' ability to effectively adapt to changes in climate (Mathinya et al., 2022; FAO, 2022). In SA, for example, an increase in population from roughly 60 million in 2020 to 82 million by 2035 is expected. Considering this, food production must significantly increase, and food security must be stabilized to fulfill the food security targets of this growing populace (FAO, 2022; Saruchera, 2019). Although, many continents such as Asia and South America have thrived during a Green Revolution[3] with substantial economic outputs, much of Africa has yet to develop their agricultural sector to generate maximum profit (Hautala, 2013; Pillay, 2016). Over the past five years in rural areas within South Africa, variation in climatic conditions have contributed greatly to vulnerability experienced by small-scale farmers thereby compromising their ability to produce and source food efficiently (Saruchera, 2019; FAO, 2022). This has led to a decline in productivity in the long-term leading to these under-developed areas becoming more susceptible to climate change (FAO, 2022; Vicente-Vicente, 2022).

[3] "The Green Revolution is based on multiple research developments which ultimately contributed and increased technological advancement in agricultural production in many developing countries" (Ameen and Raza, 2017).

As mentioned, climate change often results in difficulties within agricultural communities, as the seasonal rains which farmers rely on are often unpredictable (Hautala, 2013; Ubisi, 2016, Tshuma, 2014). Additionally, a reduction in soil fertility due to monoculture and over-cropping is a major contributing factor to the vulnerability of farmers (Hellin & Fisher, 2019).

Small-scale farming can be defined as the production of agricultural commodities on a small area of land (≤ 2 hectares) with minimal or no usage of advanced machinery (Tshuma, 2014). This type of farming is usually characterized by physical, manual work and involves, in some cases, making use of animals in ploughing the land, finite usage of pesticides or chemicals and a relatively limited supply of produce to the local markets (Tshuma, 2014; Vincente-Vincente, 2022). Understanding small-scale farmer perspectives on variability and CC will help develop a system that will support and assist farmers to adapt to climatic risks[4]. This study investigated both climatic and non-climatic risks that small-scale farmers in Etete face which hinders them from effectively adapting to CC. Some of the non-climatic factors experienced in Etete are inadequate farm size, a lack of extension services, low soil fertility, and land degradation.

However, small-scale farmers are proactive towards adapting to these challenges and many have started using climate-smart agricultural (CSA)[5] practices. Some implementations of CSA techniques include soil management and the establishment of more adaptable ecosystems as well as structured supply chains (FAO, 2012; Ubisi, 2016). Other adaptation strategies practiced by small-scale farmers are commonly categorized into technology and management of the farm; agricultural investment (Below et al., 2010; Amosi, 2018); government interventions in infrastructure and Indigenous knowledge systems and governance (Osbahr et al., 2010; Travis, 2014). Despite various adaptation strategies employed by farmers, developing countries still experience food insecurity (FAO, 2015, Ubisi, 2016; Saruchera, 2019), partly due to the inability of farmers to effectively adapt to CC (Goldblatt, 2010; Jacob, 2015; Saruchera, 2019). By focusing on rural Etete, KwaZulu-Natal, South Africa, this study aims to establish those factors that limit small-scale farmers from adapting effectively to CC.

[4] An examination of the impacts of CC on livelihoods and the response to these impacts is used to estimate climate risk (Travis, 2014)

[5] Agriculture that sustainably improves productivity, resilience (adaptation), greenhouse gas emissions (mitigation), and national food security and development goals is referred to as CSA (Lipper et al., 2010).

1.2 Statement of the problem

A 5% -10% decrease in rainfall is projected for South Africa by 2050 leading to a drastic increase in stress on existing water resources (Engelbrecht, 2016). This, in turn, will negatively impact food security in South Africa (Ubisi, 2016; Partey *et al.*, 2018). While some small-scale farmers may employ irrigation, it is not as common a practice in comparison to its use by commercial farmers. This is attributed to the agricultural activities of small-scale farmers which is predominantly dependent on rainfall (Engelbrecht, 2016; Jacob, 2015).

There are many local skills projects directed at encouraging, empowering, and teaching farmers how to manage their resources and develop a capacity that is more adaptive to climate change, thus increasing their knowledge and local power (Ubisi, 2016; Saruchera, 2019; Mathinya *et al*, 2022). It should be noted that these farmers have developed local fundamental knowledge and how to be robust in their environment by having to deal with climate variability in the form of natural hazards, leading them to develop resilience[6] (Ameen & Raza, 2017; Partey et al., 2018). In Etete, KwaZulu-Natal, the participants indicated mixed cropping as an adaptation measure for rainfall and building a water harvest water scheme. Some participants practiced seasonal plantation to increase their harvest. Some of the farmers who were interviewed (30%) said that because of climate change, they have decided to change their harvest and the size of their farms.

In general, however, poor agrarian communities in South Africa lack access to adequate local government services (Churi et al., 2013; Ubisi, 2016; Ubisi, 2019, Saruchera) and small-scale agriculture will continue to suffer from ongoing climate change if appropriate climate change adaptation strategies are not used effectively (Amosi, 2018). Research has been done by Pillay (2016); Ubisi (2016); and Muthelo (2018) on the adaptation tactics used to address the effects of changing climate on agriculture. However, little is known about the obstacles that small-scale farmers face in the iLembe District towards implementing CC adaptation strategies. Many small-scale farmers in this region appear to rely entirely on rainfall to water their crops (Pillay, 2016), hence the analysis of the barriers to suitable implementation of CC adaptation strategies are necessary and are the focus of this study. Due to the heterogeneity of geographical areas with distinct microclimates and social systems, such site-specific research is necessary to fully

[6] "The ability of an impacted society or group to resist against adversities and have the stance to recover from it" (FAO, 2015).

capture the complexity of farmers' engagement with the phenomenon of climate change in a resource-poor environment (Gbetibouo, 2009; Saurchera, 2019).

There are various CSA practices including conservation agriculture, agroforestry (farmer-managed regenerations), climate information services, soil, and water conservation techniques (tie/contour ridges) (Partey et al., 2018). These pose a highly advantageous option for CC in rural areas such as Etete, KwaZulu-Natal, since many of the farmers are directly impacted by CC and have limited access to vital resources that can assist them to adapt more efficiently. One of the support systems provided by the local government to farmers in KwaZulu-Natal in equipping them in adjusting to CC is the provision of drought-resistant seeds (Ubisi, 2016; FAO, 2021). However, climate change adaptation strategies such as CSA practices are often established in societal hierarchies at the local level and are accompanied by politics that affect the results of these adaptation processes (Nightingale, 2017).

The Department of Agriculture, Forestry and Fisheries (DAFF) in South Africa has an extension system to describe all activities that combine data and advisory services needed and demanded by farmers (DAFF, 2018:1). For this extension to be efficient towards small-scale farmers in Etete, it should be able to stabilize the social capital of societies. It would be useful to examine whether and to what extent farmers associate with one another and to what extent farming activities complement and assist each other. In this regard, the identification of farmers who practice monoculture will be of assistance as these farmers can be targeted for specific agricultural training to utilize their land more effectively. Likewise, within an irrigation scheme, farmers should be mobilized to work as a merged system from the initial acquisition of inputs through to promoting their produce (Ubisi, 2016; Tshuma, 2014).

Despite these interventions, there are other factors that need to be improved in Etete, KwaZulu-Natal such as the direct link between policy discourse and local practice. A fundamental understanding on how these small-scale farmers adjust and react to CC would equip policy makers to develop enhanced strategies and policies that could enable small-scale farmers to build their adaptive capacity and resilience to these changes.

The province has one of the highest numbers of small-scale farmers whose primary source of livelihood is dependent on agricultural activities. Also, it is one of the areas that has been adversely affected by climate variability and change in South Africa (Ubisi, 2016; Pillay, 2016). However, while a considerable number of studies have been conducted in KZN regarding farmers' perception and adaptation strategies on CC (Pillay, 2016; Muthelo, 2018;

Saruchera, 2019), minimal research has explored the support systems in place to help farmers scale-up as well as farmers use of CSA to adapt to CC.

Future projections suggest that KwaZulu-Natal will become much drier, with the rainfall patterns being more erratic by 2050 (Akinnagbe & Irohibe, 2014; Saruchera, 2019). Therefore, improved insights are desperately needed into determining farmer awareness of what support systems are available to them and whether they can access them. Such answers may be provided by results from this study to provide further insight regarding the ways policy developers could improve their strategies and policies, making them more relevant to farmers in specific areas, all with a view towards helping small-scale farmers adapt and cope with significant environmental changes into the future.

1.3 Motivation behind study

The study investigated both climatic and non-climatic risks small-scale farmers face in Etete, KwaZulu-Natal which hinders them from effectively adapting to CC. According to previous studies such as Saruchera, (2019) and Pillay, (2016) the primary non-climatic risks that farmers in some SSA countries believe will have an impact on crop production are insufficient farm sizes, a lack of extension services, low soil fertility, and the degradation of the land. However, there appear to be nuanced differences and realities that exist in specific geographical regions, but this is characterized by the absence of studies in the Etete area that were developed to explore this issue. This study also focused on highlighting the impacts of external influences of global CC particularly upon the largely poor and vulnerable agrarian households in Etete, KwaZulu-Natal.

There has been a fundamental build up over the past 5 to 10 years on CC adaptation techniques, in which local communities have their own challenges relating to CC (Nelson et al., 2010; Ubisi, 2016; Saruchera, 2019). A study conducted by IPCC (2018) indicated that most of the research conducted on CC and agriculture have been on crop production in various regions such as Mpumalanga and Limpopo (Maponya & Mpandeli, 2021). However, the relationships between these analyses and the greater impacts of food insecurity and sustainable development in countries facing malnutrition and extreme poverty are not fully understood (Goldblatt, 2010; Ubisi, 2016). The systematic technique towards CC assessment corresponds with observations made by Smit and Pilifosova (2001) which states that there are three related factors that help to determine the adversities of CC normally regarded as adverse impacts. The fundamental interest of this thesis is to examine the compound set of risks associated with the impacts from

CC. This is deemed significant to highlight areas and segments of the populace where adaptation intervention is demanded (Pillay, 2016; Partey et al., 2018).

The outcome of this research is expected to impart and develop a body of knowledge to equip planners, policy makers, local government, and academia with an understanding of the dynamics related to local livelihoods and how they are impacted due to CC. According to Ubisi, (2016) and Jacob (2015), efficient planning of intervention techniques is required from the understanding of local constraints to address given adversities in local circumstances appropriately. This research will present strategic techniques that will assist towards developing an adaptive capacity to climate change for agricultural systems (including other rural land use systems), for the agrarian communities and policy makers to better manage land, the environment and food security in low-income nations such as South Africa.

1.4 Aim of study

The aim of this study was to critically analyze the constraints to adapting to climatic and non-climatic risks as well as the opportunities it provides small-scale farmers in rural Etete, KwaZulu-Natal, South Africa.

1.5 Objectives

- To determine the impacts of climate change on small-scale farmers in Etete, KwaZulu-Natal.
- To assess the perceptions about the availability and accessibility of climate change related interventions and support systems amongst small scale farmers' in Etete, KwaZulu-Natal.
- To determine the climate change adaptation strategies used by small-scale farmers and what informs their choices of strategies.

1.6 Research Questions

- What social, institutional and climate aspects impact the livelihood opportunities of small-scale farmers in Etete, KwaZulu-Natal?
- To what extent are small-scale farmers in Etete aware of CC and support systems from the local government?
- What are the constraints faced by small-scale farmers in rural Etete, KwaZulu-Natal with regard to CC and how useful is the current support aid by the local government?

- What current climate change adaptation strategies are applied by farmers in Etete, KwaZulu-Natal and which factors influences these choices?

1.7 Structure of dissertation

The dissertation is divided into six chapters.

Chapter 2 examines the literature on climate change and its adverse effects on agrarian communities of small-scale farmers; the knowledge of small-scale farmers about CC; the adjustment techniques available to small-scale farmers and what support systems are available to such farmers.

Chapter 3 covers the description of the study area, and the methodology used to gather and examine the data.

Chapter 4 presents study results as to availability, awareness and accessibility of climate change support and intervention systems available to small-scale farmers in rural Etete, KwaZulu-Natal.

Chapter 5 presents a discussion of the results of the study.

Chapter 6 provides study conclusions and suggests recommendations for future work.

Chapter 2 : Literature Review

2.1 Introduction

An independent analysis of climate change and adjusting to its effects is complex (Ubisi, 2016) as an increasing population creates various demands as well as constraints for policymakers, therefore a holistic approach towards addressing and adapting to climate change is required to make a significant change (World Bank, 2019; Saruchera, 2019).

Section 2.1 discusses relevant literature associated with CC as well as climate adaption strategies that relate directly to the specific objectives explored in this study. Section 2.2 discusses the concept of CC, the framework and the policies that define it as well as adaptation techniques developed to address CC. Section 2.3 defines rural farmers and the impacts of climate change on food security. Section 2.4 discusses the perceptions of small-scale farmers regarding CC and the context of their CC resolutions that are partly driven by personal ideas and responses to CC as well as external related risks (Pillay, 2016; Boko et al., 2007). Section 2.5 describes the adaptation strategies to CC adopted by small-scale farmers. Section 2.6 examines proposed climate change interventions for small-scale farmers in South Africa. Section 2.7 explains the concept of CSA and how it contributes to sustainable livelihoods. Section 2.8 discusses adaptive responses in South Africa towards the increased vulnerability to the impacts of CC while Section 2.9 describes adaptation techniques in response to climate change. Section 2.10 discusses the role of policies and institutions in influencing the ability of small-scale farmers to adapt to CC. Section 2.11 explores the constraints to effective adaptation faced by small-scale farmers. Section 2.12 demonstrates the conceptual framework for this study.

2.2 The concept of climate change

The unfolding of the CC argument dates back to the early 1980s as a global environmental and development constraint starting with the announcement of the Brundtland Report in 1987 (Wekesa, 2017). To provide further information on CC, the Intergovernmental Panel on Climate Change (IPCC) was established (UNFCC, 2007). During the UN Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, the UN Framework Convention on Climate Change (UNFCCC) was founded (Ubisi, 2016; Jacob, 2015). Fundamental responses that have been introduced to reduce global CC were assessed and then described in the conference of parties (COPs) (DePaul, 2012; Nhemachena, 2008). Climate change mitigation, adaptation, finances, system advancement and transfer, governance, as well

as the function of land-use and land-use change and forestry (LULUCF), particularly in developing nations, were among the many factors examined. (Drabo & Mbaye, 2011).

Figure 2.1 below indicates the climate construct for this research. Small-scale farmers are restricted from decision-making regarding adaptation techniques on climate change due to their limited experience and knowledge of the climate risk in their area as well as external local policies on climate change (Goldblatt, 2010; Tshuma, 2014). In addition, their decision-making process is also impacted by external recurrent aspects comprising social and financial constraints (Ubisi, 2016, Saruchera, 2019). As climate change disadvantages the agricultural activities of small-scale farmers (Ubisi 2016, Tshuma, 2014), this figure also indicates the relationship between climate change and associated social, financial, and institutional constraints on small-scale farmers. Small-scale farmers attempt to minimize the negative impacts of climate change by establishing various coping and adjustment strategies which may vary between male and female farmers (Pillay, 2016; Boko et al., 2007). Availability and accessibility of CC techniques, as well as improved knowledge brought on by access to CC data, impact the degree of adaptation to climate change and the capability of farmers for ensuring food security (Jacob, 2015; Goldblatt, 2010).

An overall assessment of Figure 2.1 below appears to favor a top-down approach to dealing with CC. The climate construct describes a link between climate change and variability on small-scale farmers represented socially, economically, and institutionally. Climate change and variability negatively affect the production system of small-scale farmers. The small-scale farmer attempts to mitigate the impacts of climate change by employing different coping and adaptation strategies. The adaptation capacity and well-being of the farmers is influenced by the availability and accessibility of climate change interventions and support systems as well as access to climate change information. Lack of support systems during unpredicted precipitation season, increased temperatures and prolonged droughts result in food insecurity amongst small-scale farmers. Therefore, for better adaptation towards the impacts of climate change there is a need for the government to put in place policies in a bottom-up approach that will support small-scale farmers towards adapting to climate change.

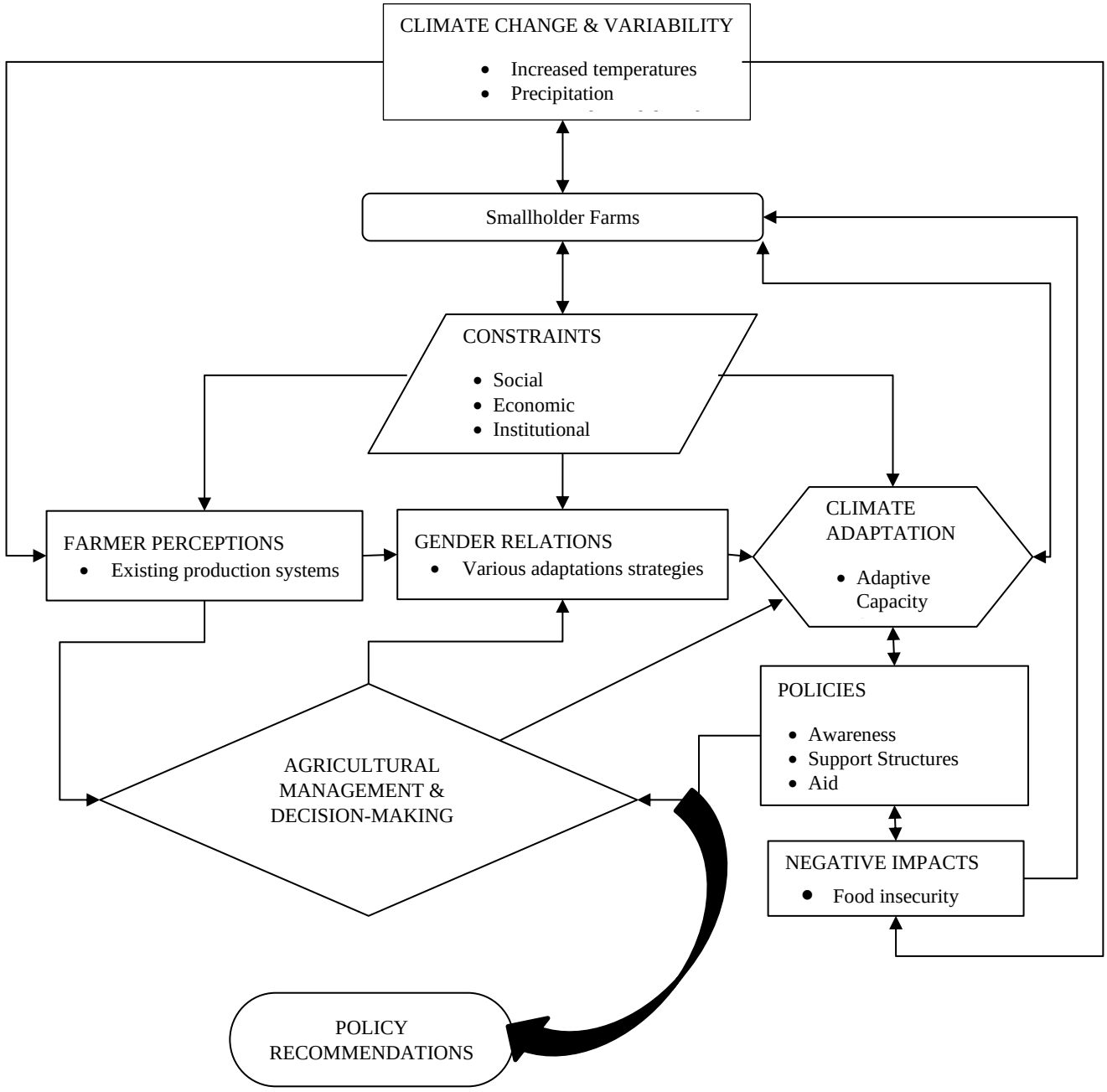


Figure 2.1. Climate construct (Adapted from Agrawal, 1995; Ubisi, 2016)

2.3 Defining rural and the impacts of climate change

Large open landscapes, traditional practices, agricultural activity, and reliance on nature are all signs of rural places (Ward & Brown, 2009; Madu, 2016; Amosi, 2018). These elements contrast with a metropolitan region which is more evolved and continually developing (Ward & Brown, 2009; Ameen & Raza, 2017). However, there are various definitions and personal

impressions and interpretations of a country region (Pillay, 2016; Alberts et al., 2019; Novotny & Hruska, 2015). According to the Agricultural Research Council, the agricultural sector of South Africa is significant to rural areas because it is an important source of income and subsistence (ARC, 2015). Subsistence farming, which is done on a small scale, and commercial farming, which is done on a much bigger size, are the two forms of farming that are practiced within this South African industry. (Knot et al., 2015; Duba, 2009).

Due to various socio-economic realities, small-scale farmers and rural groups are disadvantaged and susceptible to the impacts of CC (IFPRI, 2007; Wekesa, 2017). Within the Southern African region, most small-scale farmers are compromised in relation to climatic disparities due to restricted access to data, little or no funding or investment, coupled with low technological assistance (Morton, 2007; Mutekwa, 2009; Boko et al., 2007). Hence, adversities associated with climate change currently jeopardize vulnerable small-scale farmers whose primary sources of sustenance are rain-fed agricultural commodities. Variation in climate compromises agricultural growth; soil structure is often impacted due to extreme temperatures together with dry winds that create erosion banks, soil loss and stagnant crop growth and food production (DEDEA, 2013; Saruchera, 2019). Variation in atmospheric conditions and rainfall patterns detrimentally impacts soil standards which increases reduction of soil resources (Soils Matter, 2013). Such degeneration in the quality of soils fundamentally compromises growth of agricultural commodities. To exacerbate these problems, many small-scale farmers in agrarian communities have little or no formal education, and so it is challenging for them to acquire skills on the latest advancements and changes in soil management (Wanyama et al., 2010; Alberts et al., 2019).

In Etete, KwaZulu-Natal the small-scale farmer are exposed to a number of drawbacks common to rural locations, including poor service delivery, a lack of access to basic care, and a lack of educational facilities. As a result, the concept of the rural reality regarding small-scale farming is important to understand in the context of this research (Housing Assistance Council, 2008). The adjustment by small-scale farmers to climate change at a rural district is often compromised by a lack of infrastructure, inconsistent precipitation that may result in floods, damage to buildings and destruction of transportation routes (Ngigi, 2009, Goldblatt, 2010). In addition, many South African rural small-scale farmers may be situated in inaccessible regions, making them harder to contact because of the absence of telephonic communication and because transportation routes are either degraded or absent (Pillay, 2016; Goldblatt, 2010).

This further results in higher transportation costs and wasted time due to lack of transportation facilities that delay conveyance of agricultural commodities to the markets (Reddy, 2016; Jacob, 2015; Louw et al., 2007). This leads to a reduced quality of produce as well as poor time dispatch to the markets, which ultimately leads to commodities purchased at reduced prices or being discarded. These factors all contribute to reduced financial stability and income for the small-scale farmers, to further influence and compromise their household lives and their daily battle with food insecurity (Baloyi, 2010; Saruchera, 2019).

2.4 Small-scale farmers perceptions on climate change

Climate change adjustment resolutions by small-scale farmers are driven by personal experience, ideas, responses to climate change as well as external related risks (Pillay, 2016; Boko *et al,* 2007). Thus, they must be equipped towards identifying variations in climate that are currently experienced in their areas and establish applicable farming techniques and climate adaptation strategies (Jacob, 2015). A farmer's comprehension surrounding climate is imperative for their decision-making to manage, adjust and optimize their farming outputs (Morton, 2007; Novotny & Hruska, 2015). Small-scale farmers' adaptation and subsistence methods are based on their understanding of and experience with CC (Kihupi et al., 2015; Knot et al., 2015) that requires farmers to comprehend current climate changes in their area and thereafter seek measures and adjustment techniques that would be specifically suited to conditions in that area (Adger et al., 2005; Akinnagbe & Irohibe, 2014).

Hence, any absence of adjustment techniques must be considered as risks to agrarian households that rely on agriculture within a changing climate (Kalinda, 2011; Goldblatt, 2010). However, in spite of obstacles inherent in rural communities, over a period of time such small-scale agrarian societies have adjusted and coped with the adversities associated with climate change (Alberts et al., 2019; Rahman, 2012).

This prompts the need to comprehend varied perspectives from small-scale farmers addressing the local challenges posed by CC (Deressa et al., 2018; Tecklewold et al., 2013). Adjustment to climate change requires simultaneously addressing temporary and permanent approaches (Adger et al., 2003; Jacob, 2015). An adjustment approach suggests what ethical, financial, environmental and government systems and segments of the populace can do to adjust to a varying environment (Below et al., 2012; Novotny & Hruska, 2015). A proportion of sustainable adjustment relies on adjusting the size of accessible farmer aids to facilitate effective adaptation to climate change (IPCC, 2007). The size of this adjustment is influenced

by factors such as comprehension of climate change, the need for multiple aids towards acquiring appropriate technology, and local government intervention (Adger et al., 2003; Saruchera, 2019). Environmental viewpoints are inclusive of fundamental components that influence the undertaking of climate change adjustment techniques (Kalinda, 2011). Measures that are associated with viewpoints of climate change include various factors such as inclusion of vulnerability to climate change, availability of resource subsidy, societal norms and government intervention, and there is no certainty that a solid comprehension of climate change will positively facilitate effective adjustment responses (Weber, 2010; Osbahr et al., 2010).

2.5 Adaptation strategies used by small-scale farmers to counter climate change

In various global regions, humankind has tried to acknowledge climate change by adjusting environmental-ethical-financial structures according to current or predicted CC estimates (Akinnagbe & Irohibe, 2014; Adger et al., 2008). The aim of CC counter measures is to develop resilience within societies to multiple variations in their region.

Resilience is defined as the magnitude to conserve functioning amongst major triggers (Adger, 2001; Jacob, 2015). When a societal or environmental system loses resilience, there is more at-risk regarding change that previously could be adjusted for and assimilated (Eriksen & Kelly, 2004; Alberts et al., 2019). Within the sector of response to climate change, adjustment and sustenance are used simultaneously but could intend different meanings. The two are, however, related (Clements et al., 2011; Meza et al., 2021).

Within the context of CC, *coping* is a temporary response whereas *adjustment* is associated with permanent changes (Gbetibouo et al., 2010; Pillay, 2016). Agricultural adaptation is important to counter climate change to establish food security in the international forum (FAO, 2012). Research has shown that adjustment to climate change can minimize commodity losses or may increase commodity growth where climate change is advantageous (FAO, 2007, Ubisi, 2016). Inexpensive adjustment techniques such as crop rotation and patterned farming activities, may reduce degenerating impacts, and greater benefit will result from more investment opportunities including government intervention measures and assistance regarding related agricultural machinery assistance (Adger, 2001). These adjustment techniques demand an adequate distribution of investment to farmers and international research has concluded how small-scale farmers can adjust to varying climatic conditions in their regions and the importance of rapid, efficient change towards sustainable agriculture (Deressa et al., 2018; Partey et al., 2018).

Research has reported that many farmers understand the demands involved in climate change and their responses have indicated a positive attitude towards adopting various adjustment techniques to minimize the impacts of climate change (Saruchera, 2019). These adjustment techniques implemented by farmers are described by Below et al. (2010) in which 104 varying adjustment techniques were grouped into categories such as (1) farm control and technology; (2) farm financial management; (3) variation of farm and external farm activities; (4) government interventions in infrastructure, (5) health and risk reduction; and (6) knowledge management, networks and governance (Below et al., 2010; Osbahr et al., 2010).

Crop heterogeneity and sustenance variation are global adjustment techniques established by farmers. However, the decision as to adjustment technique choice is impacted by multiple contextual factors (Gbetibouo et al., 2010; Below et al., 2012; Saruchera, 2019). Alternative adjustment techniques include growing various heterogeneous crops, mixed farming, water preservation practices and changing from cropping to non-cropping activities when it becomes difficult to plant due to extreme heat conditions (Gbetibouo et al., 2010; Saruchera, 2019). As an example, certain farmers in Malawi and Limpopo have adjusted their crops to include plants such as cowpea that are resistant to extreme heat conditions (Saruchera, 2019). By assessing the adjustment procedures practiced by farmers, results support the successful establishment of techniques that are inexpensive, such as varying cropping schedules and mono-cropping. However, certain techniques demand a high financial input such as boreholes for irrigation and these adjustments are seldom implemented by farmers (Below et al., 2012).

Adjustment techniques alone cannot minimize all adversities associated with climate change, but an emphasis on climate change education and adjustment techniques contributes towards local societies coping with these challenges (IFAD, 2010). There have been very few technological advancements advocating for environmentally friendly agriculture (Osbahr et al., 2010; Morton, 2007). Overall, efficient adjustment techniques are those that strengthen, and structure official government systems geared towards stimulating effective action (Kalinda,2011; Osbahr et al., 2010).

2.5.1 Impact of climate change on Africa's food security and agriculture

The challenges of CC are numerous and widespread, and it is unfortunate that developing nations with a relatively poor industrial infrastructure and so might contribute relatively little to climate change suffer the most from its negative effects (Ringler et al., 2010). According to the IPCC (2014), threats to the food security of subsistence farmers in Africa include poverty,

rising urbanization, accelerating rates of population growth, environmental degradation, and CC. Climate change will cause Africa to experience higher temperatures and fewer rainy seasons, which would ultimately reduce small-scale agriculture productivity and yields and endanger food security, especially in rural families (Wlokas, 2008; Mathinya et al., 2022). Most (95%) of South Africa's land is dependent on rainfall, placing the country at risk of food insecurity (Masipa, 2017). Global climate models (GCMs) have predicted that Southern Africa will experience a general warming, with the eastern regions experiencing more rain and the western regions experiencing hotter, drier conditions. Rural household farmers were also impacted by the rise in food commodities between 2007 and 2008 (Nawrotzki et al.,2014) and if CC continues to intensify, its effects could get worse in the future, causing the price of basic cereals and staple crops to rise worldwide (Ubisi, 2016; Baloyi, 2010). In South Africa, the UNDP indicated that one in four households fail to access adequate food (UN, 2012).

Southern Africa experiences a higher CC risk and estimations indicate the severity experienced will become more intense, which will ultimately pressurize rural livelihoods (IPCC, 2007). Farming activities is expected to diminish from 21% to 9% by 2080 due to CC in Southern Africa (The IPCC, 2015). For instance, Masipa (2017) and Tshuma (2014) estimate that by 2050, a 2°C increase in temperature will reduce the average growth of maize, sorghum, and rice in Tanzania by 13%, 8.8%, and 7.6%, respectively.

The aforementioned highlights how CC poses a serious danger to food security in Africa in terms of crop growth, commodities transportation, and consumption (Masipa, 2017; Saruchera, 2019). A combined strategy to protect fertile land from global warming is needed to mitigate these challenges. Additionally, agrarian small-scale farmers require additional support and funding to sustain their agricultural operations and outputs, particularly at the household level (Amosi, 2018). Extreme heat waves would have a severe negative impact on food security, putting 5 to 170 million people at danger of poverty and hunger by 2080, according to the Statistical Review on World Energy (2016). A legal deposition suggests concentrating on reducing greenhouse gas emissions as well as the rehabilitation of soils in areas affected by climate change in order to lessen the effect of CO2 emissions on food security (Jacob, 2015; Ubisi, 2016). This would benefit small-scale farmers who need a more suitable solution and a more stable system for food security (Tecklewold et al., 2013; Jacob, 2015).

2.5.2 Impact of climate change on South Africa and KwaZulu-Natal

According to Neville (2010) and Amosi (2018), agriculture makes a significant contribution to South Africa's economy and household food security on a local level and significantly to the GDP of the country. High temperatures and varying patterns of precipitation are evidence of a shift in South Africa's climate over the past few decades (Ziervogel et al., 2014; Albert et al., 2019). Food security will suffer greatly because of the negative influences of climate change on South Africa. According to the FAO (2009), maize, which is a staple crop for many subsistence farmers, is likely to be most affected by climate change, particularly in rural households and on the women who run these households (Turpie & Visser, 2014; Saruchera, 2019).

In the agricultural sector of South Africa, water resources play a crucial role. The growth of many crop species is affected by regional variations in precipitation (Neville, 2010). According to Riedy (2016), agricultural yields are dependent on precipitation for small-scale farming and agricultural production in rural South Africa is hindered by climate variations such as a decrease in rainfall patterns (Turpie & Visser, 2014). Due to its high rates of poverty, density, and land degradation, the province of KwaZulu-Natal has the highest human vulnerability to climate change, according to the KwaZulu-Natal Provincial Growth and Development Strategy (2016). Communities experience more flooding and drought spells in the Eastern regions of KwaZulu-Natal (Ubisi, 2016; Masipa, 2017). When there is severe weather, there will be more soil deterioration and related land degradation, which will harm agricultural products and hinder small-scale agricultural output (Jacob, 2015; Boko et al., 2007; Pillay, 2016). In less than 24 hours in April 2022, KwaZulu-Natal was severely damaged by torrential rains that exceeded 300mm in some locations. Two major highways and other crucial pieces of infrastructure, including bridges, were badly destroyed. (IFRC, 2022). According to the Clausius-Clapeyron connection, heavy rainfall is forecast to rise with warming on average, however many places, such Eastern Southern Africa, are anticipated to see higher rain rates, especially on daily and shorter durations (Seneviratne et al., 2021). Due to KwaZulu-limited Natal's resources, many rural small-scale farmers were forced to relocate because of this incident. (Ubisi, 2016; Amosi, 2018). If cities expand in a way that concentrates the poorest and most disadvantaged people in flood-prone, high-risk areas, these catastrophic disasters are likely to reoccur. (Vincente Vincente, 2021). Despite the very high quantity of rain during this event, it is customary for this type of storm to occur and is anticipated to do so again in the future, maybe with even greater intensity (Pinto *et al.*, 2022). Rapid and comprehensive

adaptation that considers changes in both the frequency of extreme weather events as well as current (and increasing) susceptibility and exposure is necessary to prevent future disasters. Nevertheless, there are encouraging signals, particularly as the eThekwini municipality strives to put current plans regarding ecosystems-based adaptation, enhanced flood protection infrastructure, and a cutting-edge impact-based warning system into action (Pinto *et al.*, 2022).

The farming sector in KwaZulu-Natal produces a large percentage of essential crops and so is a very significant contributor to the South African GDP. Climate change is likely to harshly impact crop production especially in regions dependent on rainfall for farming such as in Etete, KwaZulu-Natal (Ziervogel et al., 2014). The KwaZulu-Natal Provincial Growth and Development Strategy (2016) states that KwaZulu-Natal Province has a high poverty level together with a high population density that contribute significantly to the province experiencing the highest human vulnerability (Pillay, 2016; Ubisi, 2016). Some areas of KwaZulu-Natal will see opportunities for agriculture because of climate change, while others will see losses. In this regard, the province experiences extensive land erosion due to extreme weather while communities in the eastern part of KwaZulu-Natal are also prone to severe drought and flooding, factors that harm agricultural outputs as they make it harder for small-scale farmers to produce food (KwaZulu-Natal Provincial Growth and Development Strategy, 2016). Food insecurity in districts such as iLembe, the focus area of this study, will increase following changes in the weather and the farming environment.

2.6 Proposed climate change interventions for small-scale farmers in South Africa

Farmers have faced harsh climatic episodes extreme as droughts and uneven rainfall patterns, leading to reduced crop yields (Morton, 2007; Adger et al., 2009). According to a study on how climate change is believed to affect agricultural yields and household sustenance in rural Limpopo Province, South Africa, small-scale farmers' livelihoods are negatively impacted by the phenomenon. (Ubisi, 2016; Kalinda, 2011).

In South Africa, climate change intervention techniques for small-scale farmers are not efficient, due to a top-down strategy which was implemented in a hierarchical manner - people at high level deliberate on interventions and techniques they think will work for small-scale farmers even though they do not have a full understanding on how small-scale farmers in agrarian communities are really impacted by climate change or without comprehending the underlying aspects influencing them ((Adger et al., 2008; Baloyi, 2010; Ubisi, 2016; Jacob, 2015). Therefore, a bottom-up strategy where farmers are involved in decision-making may be

most effective as the farmers can prioritize the key climatic and environmental challenges they are facing, and a participatory approach that includes small-scale farmers in decisions/policy may lead to a significant improvement in dealing with the effects of climate change (Tecklewold et al., 2013; Pillay, 2016).

Climate change challenges are not constraints that should be solved individually - the issues facing small-scale farmers are constant and local government officials need to implement guidelines that will advantage small-scale farmers who are adjusting to climate change (Ubisi, 2016; Goldblatt, 2010). In addition, there should also be investment from local government in agricultural research to obtain feedback on whether suggested climate change adaptation techniques are being established and being evaluated and whether farmers are receiving necessary aid (Pillay, 2016; Baloyi, 2010).

Small-scale farmers have adjusted to adverse situation by implementing adjustment strategies such as minimizing consumption, varying diets, obtaining loans, and increasing dependency on food aid organizations. Irrespective of these livelihood techniques, the small-scale farmers are vulnerable to poverty and malnutrition because their agricultural livelihoods are reliant on rainfall (Boko et al., 2017; Jacob, 2015). In minimizing climatic vulnerability, gender roles amongst small-scale farmers leaned towards various coping techniques, such as diversification of commodities, mainly undertaken by male farmers, and changes in planting schedules, carried out mainly by female farmers (Ubisi, 2016; Pillay, 2016). Important in determining options for small-scale farmers when adjusting to climate change were that as agriculture was the primary basis for maintaining their livelihoods, they required CC awareness campaigns and were reliant on local officials as a source of climate change data, but who may lack in CC knowledge and who are required to present support structures and techniques (Morton, 2007; Adger et al., 2013).

Therefore, government officials need to realize that recognized climate change adjustment techniques are encouraged and advocated to minimize agricultural vulnerability in the face of climate change, and the relationship between small-scale farmers and government and extension officers should be reinforced. Thus, it is essential to educate local government officers on all aspects of CC and associated adjustment techniques so they can liaise with farmers and present information to them regarding efficient CC adjustment to improve the well-being of the farmers (Goldblatt, 2010; Jacob, 2015). As occurred in Ethiopea and Malawi, climate change should be introduced into nutrition-related policies and guidelines for the youth

to learn about “the energy crisis” and how to adapt to CC (Tecklewold et al., 2013; Saruchera, 2019).

2.7 The concept of Climate Smart Agriculture

At the Hague Conference on Food Security and Climate Change in 2010, the FAO panel introduced the idea of climate smart agriculture (CSA), which was defined as an agricultural practice that successfully and effectively increases commodity yields (adaptation), reduces carbon footprint (mitigation), and increases achievement of national food security goals. (FAO, 2010). The adverse effects of CC on agricultural activities to which farmers must adjust have demanded the requirement for resistance in agriculture (Baloyi, 2010; Vera et al., 2017). Government and development planners influence small-scale farmers to adopt viable farming techniques that will strengthen farming structures to create an equilibrium between commodity yield and environmental stability without jeopardizing either of the two (Abegunde et al., 2017).

Climate-smart agriculture (CSA) practices are very effective in incorporating the advantages of a viable increase in commodity yields, the adjustment and building of resistant food security systems and the minimization of greenhouse gas (GHG) emissions from agricultural activities (FAO, 2013; Lipper et al., 2014; World Bank, 2021). However, some of the negative effects of agriculture and climate change may go hand-in-hand in cases where agricultural practices such as land use and deforestation contribute 30% of global GHG emissions while climate change may lead to land degeneration and food insecurity (Pillay, 2016; Ubisi, 2016; World Bank, 2021).

A sustained livelihood demands a more climate change-resistant production system where more efficient agriculture demands control and evaluation of surrounding resources (FAO, 2010) and transitioning to structures could result in fundamental alleviation techniques (World Bank, 2019). Farmers enjoy more advantages when they undertake various CSA techniques, as some of the techniques can complement each another and advantage the farmers (Vera et al., 2017; Teklewold et al., 2013). Ultimately, the adoption of multiple CSA techniques assists in building a sustainable agricultural structure that is very resistant to shocks associated with CC and other aspects that influence agricultural production (Abegunde et al., 2017).

2.7.1 Novelty of climate smart agriculture

The focus of CSA is a viable increase in commodity yields, climate change adjustment and minimalization or elimination of GHG emissions (FAO, 2013; Amosi, 2018). In the absence of CSA, large areas may become less viable for fertile plantation use because of land degradation following deforestation (World Bank, 2021).

The idea of CSA is to incorporate small-scale farmers' objectives to facilitate commodity yields and food security within a changing climate. Small-scale farmers in developing countries are fundamental to CSA efforts because they are fundamental to initiate change across the entire agricultural structure (FAO, 2013). Simultaneously, the development of technological advancements that are integrated towards the establishment of CSA and that fit into the CSA framework are identified as CSA technologies (Wekesa, 2018). These objectives also include the creation of an enabling policy environment for climate change adaptation and the development of new technologies, such as heterogenic characteristics of seeds, to aid farmers in an uncertain climate (World Bank, 2019). Additionally, the CSA is concerned about crop commodity post-harvest control and the effective marketing and sale of those commodities to stabilize the food supply (FAO, 2010; World Bank, 2021).

2.7.2 How can climate smart agriculture address food security?

Communities that live on a subsistence basis need to understand the importance of food security. According to Abegunde et al. (2017), a household meets food security requirements if all members have constant physical and financial access to nutritious food for healthy living. Food markets are disrupted because of climate change, making certain segments of the population more susceptible to food shortages. In an agricultural production system, it is necessary to provide farmers with tools to adjust and increase their acclimatization capacity (FAO, 2007). Commodity yields and food structures vary according to climate change, as does the strategy for altering agricultural systems to support global food security. To ameliorate the effects of climate change, CSA prioritizes food security (Turpie & Visser, 2014) and currently, food security can be controlled and maximized by farmers modifying agricultural structures with improved crop seed and fertilizer (Ziervogel et al.,2014). According to the FAO (2010), improved commodity yield structures and resource utilization following the use of CSA methods offers a viable opportunity to increase agricultural yields and resilience of agrarian societies while minimizing agricultural discharge. With the right strategies and investments, the agriculture sector can move into CSA pathways, reducing food insecurity and poverty in

the short term and moving on to reducing climate change's threat to food security in the long term (Abegunde et al., 2017).

2.8 Adaption

Due to increased vulnerability to the effects of climate change, adaptable responses to climate change are urgently required in South Africa. Additionally, a multidisciplinary approach is required to address the challenges of climate change and food security (Campbell et al., 2016). In South Africa, relief, and variation to an adjustment of environment is certainly not another strategy. Adaptation methods are inextricably linked to climate change because it has the greatest impact on development sectors (Koch et al., 2006; Kalinda, 2011). Consequently, farming must be the primary focus of adaptation strategies, and as the threat posed by climate change increases, it is more critical than ever for rural female farmers to begin employing adaptation strategies in order to prepare for and mitigate the effects of climate change on their agricultural production (Saruchera, 2019). Due to their mutual trust and shared experiences, farmers are more likely to employ adaptation techniques when they share data and personal experience (Wilk et al., 2012; Ali et al., 2012). If new strategies have been tried out and proven successful by established farmers, rural farmers are also more likely to implement them (Tshuma, 2014; Windle, 2009). It is essential to acknowledge that small-scale farmers in rural areas do not have access to capital, making them more susceptible to the concept of adjustment strategies (Ubisi, 2016; Saruchera, 2019).

2.8.1 Climate smart agriculture and food production

Changes in the current agricultural practices and methods used by small-scale farmers are required to develop the food production system. Through sustainable agriculture, not only will these farming methods improve food security, but they will also solve other societal problems such as reducing poverty, protecting local resources and preserving potential agricultural sites (Campbell et al., 2016). The first edition of the CSA sourcebook was published in 2013 and has continued to be updated since then. It includes climate-smart agricultural practices and techniques such as

- for sustainable intensification of crop production, management of agricultural ecosystems that facilitate climate change adaptation and mitigation is essential.
- making use of high-quality seeds and well-adapted planting materials; the cultivation of multiple crop species in combination or rotation
- utilizing strategies for integrated pest management

- adoption of sustainable mechanization and conservation agriculture to preserve healthy soils and effectively manage water.
- gaining an understanding of the kind and extent of variation in climatic variables that affect crop production.
- integrated studies on water, soil, and crops
- farmer participation facilitated by system-wide capacity-building initiatives.

This last point is crucial as experience and knowledge of these agricultural practices allow small-scale farmers to make optimal decisions regarding challenges presented by climate change.

According to a study by Mnkeni and Mutengwa (2014), national governments are beginning to incorporate climate-smart agricultural practices. However, apart from the use of climate-resistant crops, crop rotation that is appropriate for the climate as well as methods for harvesting water, there are few policies in place regarding CSA in South Africa (Amosi, 2018; Vincente Vincente, 2021).

2.8.1.1. Soil and nutrient management

Crop yields are largely dependent on nitrogen, phosphorus, and potassium but the soils of many small-scale farmers lack essential nutrients. Consequently, small-scale farmers must be able to effectively manage soil nutrients (Richards et al., 2016) and organic composting and the production of organic manure rich in necessary nutrients can accomplish this (Tecklewold et al., 2013; Kalinda, 2011). Additionally, this makes it less necessary for small-scale farmers to purchase costly synthetic fertilizers (FAO 2010).

Fertilizer input suggestions are made based on data from large areas and how crops react to nutrients (Richards et al., 2016) but general, blanket recommendations for fertilizer implementation will result in land being over-fertilized in some areas and under-fertilized in others (Wekesa, 2017). A solution to this is site-specific nutrient management (SSNM) that focuses on balancing and enhancing nutrients over time and space to match the nutrient demands of crops (Bruulselma et al., 2012; Alberts et al., 2019). Such SSNM requires the ability to assess the nutrient status of crops and adjust fertilizer inputs accordingly, as well as using data on the characteristics of the soil in the target area. Thus, SSNM can theoretically be used wherever fertilizers are applied and financial utility, net farm profitability, and lower nitrogen dioxide emissions are all advantages linked to the use of this management process.

However, projections of efficiency and monetary utility might be founded on rancher-announced information received by government officials (Sapkota et al., 2014). Many nations are looking into using Geographic Information Systems (GIS) to approximate biological crop yield, which is likely to become the foundation of productivity monitoring in the future (Richards et al., 2016). Evidence of nutrient enrichment in coastal waters is indicated particularly in nitrogen green tides off the French coast of Britany (Charlier et al., 2007; Partey et al., 2018) as well as the Gulf of Mexico's dead zone (Diaz & Rosenberg, 2008; Rabalais & Turner, 2001). Research has shown that agricultural yields influence the nutrient cycle in surface and groundwater (Rupert, 2008; Libra & Schilling, 2000) and conservation structures must be implemented to manage agricultural nutrients at their source, when they are transferred and receive water, in order to reduce agricultural nutrient deprivation (Osmond et al., 2015; Tshuma, 2014).

2.8.1.2 Integrated soil fertility management (ISFM)

Integrative soil fertility management (ISFM), which aims to improve agricultural yields by increasing the agronomic efficiency of applied nutrients, includes the use of fertilizer, organic inputs, and improved germplasm (Richards et al., 2016). While the processes of ISFM and SSNM complement each other, ISFM aims to increase productivity in very low-input systems, whereas SSNM has been used on farming structures where farmers already use fertilizers and might be better for farming structures that rely on organic sources of fertility (Sapkota et al., 2014). Ghana, Mali, and Nigeria, for example, follow the "ring management" method in West Africa. In this method, a circle of more fertile soil close to houses is surrounded by infertile soil, and the fertile soil moves further away from the settlement as bush fields further from the village are less frequently cropped (Prudencio, 1993; Vanlauwe et al., 2015). Cattle were used to gather nutrients for fertile banana–coffee–food crop (bibanja) gardens in the Bukoba region of Western Tanzania, which is surrounded by vast grasslands (Baijukya et al., 2005).

2.8.1.3 Conservation agriculture (CA)

Conservation agriculture is a way to grow crops and manage soil that relies on crop rotation, requires minimal tillage and leaves crop residues on the surface of the soil. This method alters the nutrient dynamics in soil and has a positive effect on soil physical, chemical and biochemical processes (Richards et al.,2016). For example, CA has been used in the Western Cape to produce rainfed grain and other field crops in a way that works. According to Ubisi (2016), residue cover can sometimes become so thick in the Western Cape that tine planters

are unable to cultivate the soil effectively. During the transition to CA, comprehension of systemic variation and unanticipated difficulties for system components is also required. For instance, farmers moving to California need to adjust to a new approach to managing weeds and pests. According to Adger et al. (2008) and Boko et al. (2007), CA practices are used by between 75% and 80% of grain farmers in the Western Cape. However, these farmers vary in how much they adhere to the CA principles (Baloyi, 2010; Morton, 2007).

2.8.1.4 Harvesting and storage

Harvesting

To minimize waste and loss, small-scale farmers must be educated as to how to effectively harvest crops, knowledge that will lead to an increase in crop yields and contribute to food security (FAO, 2012). It is important to harvest during the cooler part of the day as harvesting in high temperatures negatively impact highly perishable crops. The concept of "field heat" refers to the heat stored in crops from being out in the sun. This phenomenon was particularly relevant recently in South Africa that experienced a major drought (Saruchera, 2019), and resulting empty dams, particularly in the Western Cape Province, because this area did not receive its annual winter rainfall (Schoeman, 2017, Vanlauwe et al., 2015).

Storage

Farmers can also make use of safer and more convenient storage facilities such as silos so that, with the assistance of government and non-governmental organizations, communities can construct grain storage facilities (Saruchera, 2019; Boko et al., 2007).

2.8.2 Water harvesting

Domestic water supply

Improvements in infrastructure that promote rainwater harvesting, grey water recycling and general reuse of water are useful tools that not only raise awareness of water conservation but also increase water security for low- to high-income groups in both urban and rural settings (Jacob, 2015; Schoeman, 2017). There is a need to adopt a more sustainable lifestyle and to green their home environment using these methods).

Agricultural water supply

Within the agricultural sector, water is a critical resource. However, many small-scale rural farmers in South Africa lack access to water due to the country's general scarcity of water (Stagnari et al., 2016). As indicated, the daily lives of women are hampered by a water scarcity

that has a negative impact on crop production (Kahinda et al., 2007; Alberts et al, 2019). Water is used by many rural women farmers for cooking, cleaning, and laundry, in addition to drinking and agriculture (Saruchera, 2019; Vincente Vincente, 2021). As a result, educating small-scale farmers about the significance of water harvesting and water conservation is crucial. One method of water harvesting is the installation of rainwater tanks, which are typically supplied by the local municipality (Stagnari et al., 2016). Rainwater from these tanks can be used to water crops and *in situ* water harvesting techniques such as potholing, mulching, ridging, and pit planting are other forms of water harvesting (Mudatenguha et al., 2014; Yosef & Asmamaw, 2015). In addition to providing a supply of water, these methods reduce surface runoff and soil erosion while increasing water infiltration into the soil (Stagnari et al., 2016; Ali et al., 2012). Within the context of the present study, rainwater tanks are used to store water in the Etete communities for use during dry spells and for irrigation.

2.9 The role of policies and institutions in influencing small-scale farmers to adapt to climate change

There is a sense of urgency required to move towards CSA, which can be acquired through establishing and enabling legislature for adjustment (FAO, 2015). Advocacy for both the theory and practice of adapting to CC has grown as a result of climate change (Alberts et al, 2019). Practically speaking, CC research has demonstrated that farmers can reduce climate change risks by making practical adjustments (Saruchera, 2019; Gbetibouo, 2009).

Such adjustment cannot be solved by policy and guidelines (Chikozho, 2010; Kalinda, 2011). Global partners, with whom scientists have strong professional ties, who provide the framework for international climate change policymaking and governance are mentioned in the UNFCCC as having an impact on policy development and inclusion (Amosi, 2018). A similar agreement was signed in 1994, but there were no mandatory output caps for individual nations or enforcement mechanisms (UNFCCC, 2007). On the other hand, what it did indicate was a foundation for members to organize particular global treaties that could, in turn, establish restrictive controls limits on GHG outputs (Ali et al., 2012; UNFCCC, 2014; Vincente Vincente, 2021). For instance, the Kyoto Convention laid out obligatory necessities that expected created nations to decrease their GHG yields, while "one of the main strategies set by the UNFCCC was the execution of public inventories and GHG expulsions" by signatory countries (Ali et al., 2012; UNFCCC, 2014; Saruchera, 2019). Through constant meetings and

discussion, the treaty aimed to create data among member states (Alberts et al., 2019; DAFF, 2018).

2.10 Constraints to effective adaptation

Socio-economic factors that encourage undertaking of adjustment techniques involve both households as well as farmers. The life span of a farmer can have beneficial or detrimental effects towards the decision to undertake new technologies (Tshuma, 2014; Vincente-Vincente, 2021) so that farmers with more experience are more viable and endowed to examine and adopt attributes of modern technology as compared to farmers with minimal farming experience. Farmers who are willing to take risks are thought to be more likely to take on the project on a larger scale than those who are more susceptible to negative impacts and threats (Ayuya et al., 2012; Riedy, 2016). According to Alberts et al. (2019) and Nkonya (2008), a farmer's literacy level is thought to increase their ability to recognize the challenges of CC, which in turn raises the likelihood of acquiring new technologies. In a similar vein, education equips families with the ability to gather and conceptualize information necessary to make major decisions (Adesina & Forson, 1995; Ali et al., 2012; Saruchera, 2019).

The constraints of gender of the head of a household towards decision making are site-specific and culturally driven (Rahman, 2012; Saruchera, 2019). Due to social barriers, women frequently lack access to land in many African regions (Ubisi, 2016; Amosi, 2018). According to De Groote & Coulibaly (1998), women have fewer advantages and resources than do men. Female household leaders, on the other hand, are more likely to use climate change adaptation strategies (Nhemachena & Hassan, 2007; Gbetibouo, 2009). According to Windle (2010) and Saruchera (2019), more women than men reside in most African rural small-scale farming communities, where the majority of the agricultural work is performed. Based on historical data on climatic conditions and other factors, such as markets and household food needs, women have a greater number of farming skills and knowledge of multiple management procedures and how to manipulate them (Nhemachena & Hassan, 2007). The ability of small-scale farmers to implement development strategies is significantly influenced by how they spend their resources (Nkonya et al., 2008; Gbetibouo, 2009)

Both long-term investments in climate change adjustment techniques as well as land acquisition influence legal rights. For instance, tenure security can encourage the use of land-related technologies such as irrigation equipment and soil conservation practices. However, if farmers don't get the most out of their investments, there is no incentive to invest money or

time into them and a household's reliance on agriculture may be reduced (Gbetibouo, 2009; Shiferaw et al., 2009). Other factors that may reduce the likelihood of climate change adaptation include off-farm employment providing alternative sources of financial support; farmer groups may occasionally serve as a means of farmer development and data dissemination; government officials who target groups of ranchers for sign of innovation. How small-scale farmers allocate their resources has a significant impact on their capacity to implement particular development strategies (Smit et al., 2001; Mariara & Karanja, 2007; Gbetibouo, 2009).

2.11 Conceptual framework

This study was led by a conceptual framework that the researcher created after analyzing several literature sources. The Knowledge, Attitude and Practice (KAP model) demonstrates connections between various tools or resources, climate change, and adaptation techniques to climate change that have an impact on agricultural output among small-scale farmers. Figure 2.2 indicates some of the interacting factors that contribute towards small-scale farmer resistance to CC and their adaptation to climate smart agriculture. However, other non-climatic factors, such as social and economic constraints also influence their adaptation. To influence the implementation of the climate smart agricultural techniques, government and cultural factors should intervene (Ubisi, 2016; Saruchera, 2019).

Since climate change adaptations are developed into means-to-end chains, various actors are involved, and their relationship is crucial to their successful implementation (Alberts et al; 2019) . To guarantee food production, these methods either make it easier or harder for them to interact with the environment (Nhemachena & Hassan, 2007; Gbetibouo, 2009). Farmers respond to climate change by using resources like irrigation, growing drought-resistant and early maturing varieties, intercropping, cultivating varieties that are resistant to pests and diseases, and expanding their farms (Pillay, 2016; Amosi, 2018). As a result, resources that small-scale farmers cannot control shape the climate change adaptation strategy and may limit it (Mnkeni and Mutengwa, 2014; Ubisi, 2016). During unanticipated precipitation seasons, which are characterized by higher temperatures and prolonged droughts, small-scale farmers experience food insecurity because of a lack of support systems. Therefore, to enhance adaptation to the effects of CC, the government must implement policies that support small-scale farmers adapting to CC from the bottom up. (Vincente Vincente, 2021).

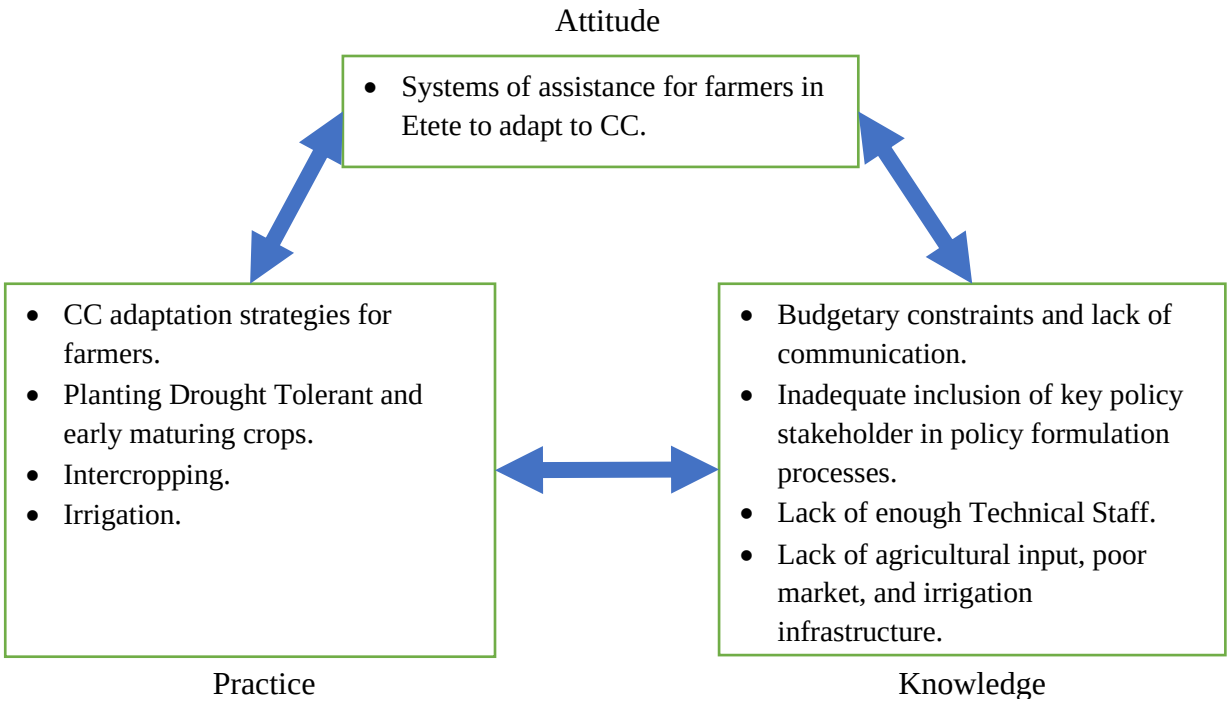


Figure 2.2: KAP Model (Researcher: 2022)

2.11.1 Climate change adaption

Climate change is the primary instrument for developing international action (UNFCCC, 2019). The strategies and actions taken to reduce or eliminate the anthropogenic causes of climate change, such as removing or reducing greenhouse gases in the atmosphere, are referred to as climate change mitigation policies at the international level (TERI, 2016). The capacity of a system to adapt to CC, reduce its exposure to climate change, and build resilience to the "observed and anticipated impacts" of CC are all examples of adaptation. (Ali et al., 2012; UNFCCC, 2014; Saruchera, 2019).

Climate adaptation can take many forms at the individual or household level, including adopting new technologies, moving one's farm or home, or migrating (Adger et al, 2005; Saruchera, 2019). Adaptation typically entails collective action at the community level, such as investing in river management or pooling resources, including knowledge. At this scale, social capital plays a significant role, as these examples suggest (Ostrom, 2005; Reid, Alam, Berger, Cannon, Huq and Milligan, 2009). At the institutional level, government programs and policy interventions encourage adaptation. However, at this level, infrastructure deficiencies and implementation flaws are frequently a problem (Saruchera, 2019).

2.11.2 Develop farming resilience

According to La Valle (2008) and Pillay (2016), resilience can be defined as the capacity of a system, such as livelihoods and environment, to maintain stability in the face of change and shocks. Resilience in the food system includes social strength, environmental versatility, financial flexibility, and utilization flexibility (Eriksen et al., 2010a; Amosi, 2018). Climate can impact ecological resilience, which is linked to food availability. Negative ecological effects on soil erosion, nutrient cycles, and soil fertility typically accompany the conversion of natural ecosystem land to agricultural land (Richards et al., 2016). Droughts, erosion, and climate shifts are all natural factors that can alter the land. One type of anthropogenic change is the physical alteration or conversion of land for human gain. Land change may increase a system's vulnerability to land degradation and, ultimately, food insecurity (La Valle, 2008; Saruchera, 2019).

Within the pillars of food security, social resilience and food stability are linked. According to La Valle (2008), social resilience is thought to represent the system's human, political, and cultural wealth. The idea of educational and institutional stability underpins social resilience. A system's social resilience and adaptability to changes and shocks increase with increased stability in education and political norms. Political regimes, or "social safety nets," can also help people become more resilient and able to adapt to change. Programs and training workshops, as well as transfer schemes aimed at enhancing systems and livelihoods as a whole, may be examples of these (Ubisi, 2016).

Accessibility to food is related to economic resilience. The financial capital and wealth of a system typically reflect its economic resilience so that when it is low, a livelihood's capacity to deal with shocks and disturbances is reduced if the system or livelihood does not have sufficient financial wealth to obtain food or market access. According to La Valle (2008) and Pillay (2016), regions with greater market access are more resistant to changes, shocks, and food insecurity. Additionally, households with a more diverse income that does not rely solely on rain-fed agriculture to bring in income to the household stand a greater chance of resilience and overcoming shocks and changes than households whose sole source of income is agricultural produce (Jacob, 2015; Boko et al., 2007; Pillay, 2016).

Consumption resilience is different from the other dimensions because the individual's nutritional status shows where they are in the adaptive cycle (Eriksen et al., 2010a; Amosi, 2018). Additionally, this dimension asserts that a household need not be food insecure in order

to be food insecure (Jacob, 2015). According to La Valle (2008), the way different households understand and consume food is influenced by varying beliefs about food preparation, health, diet, and what is considered healthy or unhealthy. Gender equality is a major factor in the utilization and consumption of food in some households (Alberts et al., 2019).

2.12 Conclusion

In different agrarian social orders, horticulture involves the establishment of food provision. Drought and floods resulting from climate change affect livestock and contaminate drinking water to impact agricultural yield and growth (Amosi, 2018). These effects are enormously capable by most limited scope ranchers in agrarian social orders. They are extremely vulnerable due to their high reliance on rain-fed, climate-sensitive resources (Baloyi, 2010; Adger et al., 2008). Due to a general lack of knowledge, resources, and data on relevant issues, some small-scale farmers are taking longer to adapt to CC. On the other hand, some farmers are adopting adaptation strategies like varying their cultivation dates, monoculture, and the growth of diverse crops (Kalinda, 2011; Tecklewold et al., 2013).

Extreme weather conditions resulting from climate change, such as droughts and floods, negatively impact the quality and quantity of crop yields in KwaZulu-Natal, South Africa. According to Saruchera (2019), research demonstrates that many rural farmers lack the environmental knowledge and skills necessary to either ensure that their yields do not suffer from climate change that is taking place or the need to adapt to these climate changes. Through the establishment of Public Private Partnerships (PPPs), environmental education and training workshops must be carried out in these far-flung rural areas to inform these small-scale farmers about the dangers of climate change and sustainable farming methods (Morton, 2007; Baloyi, 2010).

Therefore, there is a need for various forms of investment in small-scale farmers including insightful government policies, confident and active training extension officers, an efficient transfer of climate change knowledge and practical experience to and between small-scale farmers, investment in agricultural infrastructure, and a transfer of confidence to and between small-scale farmers that their adaptation to climate chance and their adoption of climate smart agriculture can develop and improve their agricultural output, in spite of the risk of climate change, to contribute to food security and, further, to an increased income from their farming activities (Schlenker and Lobell, 2010; Saruchera, 2019).

Chapter 3 : Methodology

3.1 Introduction

This chapter provides an explanation of the study area, Etete, including demographics and weather patterns. In addition, this chapter highlights the agricultural activities embarked upon by small-scale farmers in Etete. Further, the chapter underlines the methodology applied to obtain primary data as well as the data analysis technique employed. The chapter also explains the technique used to ensure data validity and ethical considerations employed to ensure participants were not exposed to harm and their rights were not breached during data collection and presentation of the results.

3.2 Study Area Description

This study was undertaken in the KwaZulu-Natal Province which ranks as the fourth largest province in South Africa (South African Government, 2015). KwaZulu- Natal comprises of ten (10) districts (KZN IDP, 2018). The Kwa-Zulu-Natal province has an area of 94,36 million hectares, which is 7.7 % of the entire area of SA (iLembe District IDP, 2021). This study focused on Etete, a rural community located in iLembe district, KZN (Figure 3.1). The average yearly temperature for iLembe varies from 21°C in regions along the coast to 16°C in non-coastal regions at greater elevation (Goba, 2016). The average yearly rainfall declines from the coast to inland areas so that much of the area acquires relatively high rainfall greater than 900 mm, with even the drier, non-coastal regions usually receiving more than 750 mm (Goba, 2016).

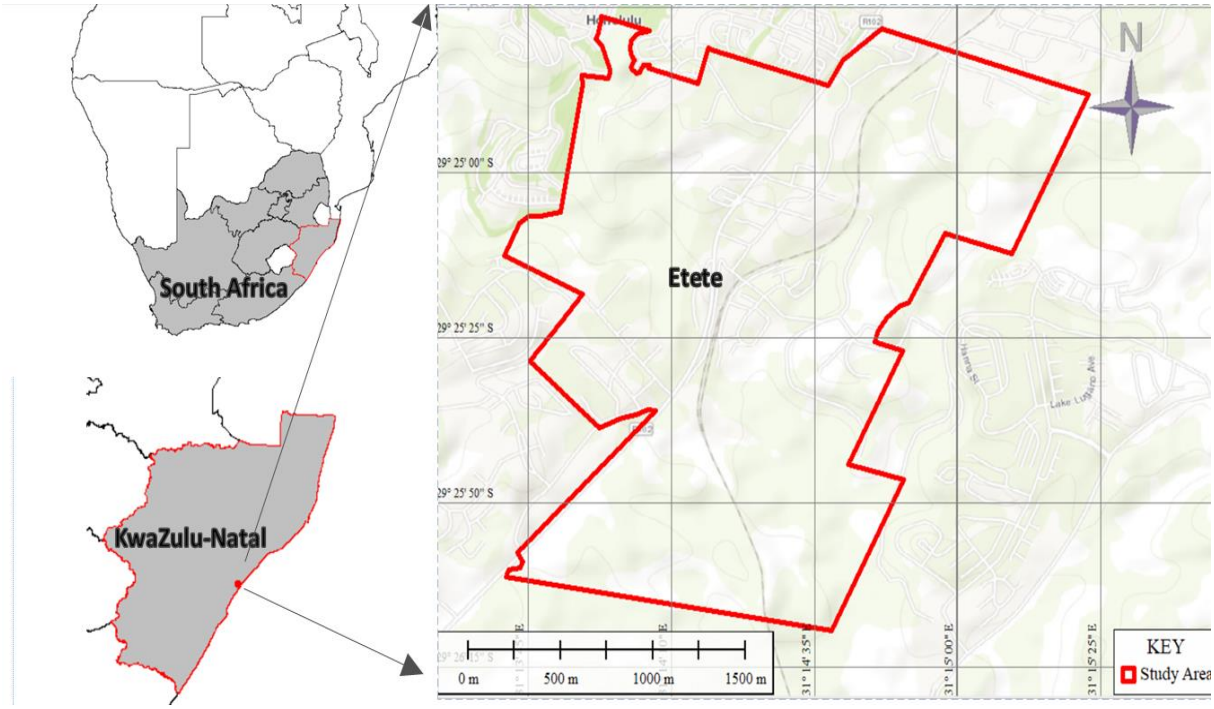


Figure 3.1. Map of Etete, KwaZulu-Natal. Source: Author (2022).

The weather patterns experienced in the iLembe district permit the region to grow a diverse range of agricultural products such as tropical fruits and vegetables. The demographics for the study area indicate that the total population in Etete is 5 193, of which 52% is male (iLembe District IDP, 2021). The two main languages of Etete are English and IsiZulu. The approximate number of houses in the area is 1700 and 31.1% of these households are headed by females. Much of the area sustains a livelihood primarily involving small-scale farming. The staple crops that are mostly grown in the area are mielies, yam, potatoes, spinach, and cabbage. Very little households sell their produce to the local market (iLembe District IDP, 2021).

The iLembe local municipality allows various land uses including, but not limited to agriculture, traditional, conservation and urban (IDP 2018/2019). The Tugela River is the major river that crosses the iLembe local municipality and is significant for KwaZulu-Natal as they form catchments and provide water which is a natural capital to inhabitants downstream for their day-to-day activities such as drinking, cooking, and cleaning. In times of drought, there is a negative impact on the community who rely on this water resource. Residents of the iLembe local municipality reside in rural areas characterized by poverty (IDP, 2018/2019). They rely on livestock and small-scale farming for food on farms that are mainly small plots of land. Figure 3.2 is a photograph depicting the average land size used for farming in Etete, KwaZulu-Natal. (IDP, 2015/2016).

Figure 3.2. Average land size used for farming. Source: Author (2021).

3.3 Methodology

3.3.1 Research design

3.3.1.1 Case study

This research is a case study of small-scale farmers in rural Etete, KwaZulu-Natal. The researcher adopted a case study approach because it would illuminate certain features that may be difficult to comprehend using methods such as ethnography, phenomenology, narrative, and grounded theory (Creswell, 2008). According to Vincente-Vincente (2021), case studies can demonstrate a variety of aspects including identifying, examining, and studying various occurrences. However, case studies have not been without criticism. For instance, Tshuma (2014) explained that the research outcome is influenced by the researcher's experience to just one case. To facilitate data collection for the case study, a mixed-methods approach was employed.

3.3.1.2 Mixed-methods research

Researchers must decide on a particular strategy when carrying out their study. “A procedure that is established in order to associate researchers with specific approaches and techniques of acquiring and examining empirical data” is the definition of a strategy of inquiry (Genot, 2018). Research design can be defined by various methods, usually split into three key categories: quantitative, qualitative, and mixed methods. Conversely, Creswell (2008) is critical of adopting these three approaches individually and elects that the researchers should combine these methods.

Quantitative and qualitative aspects are encompassed in the mixed-methods research approach adopted by the researcher. Quantitative research techniques depend on “quantifying an analytical examination” (Creswell, 2008) and include closed questionnaires, surveys, site checklists, performance tests, secondary assessments of various datasets and sometimes, post data research. Quantitative data are set numerically and can be mathematically captured on a spreadsheet (Ubisi, 2016; Reddy, 2016). Quantifying quantitative data utilizes various scales, that can be grouped as interval scale, ordinal scale, nominal scale, and ratio scale. They use a structured uniform technique and implement approaches such as ask questions and surveys (Goldblatt, 2010; Jacob, 2015).

Qualitative approaches adopt a variety of techniques which include open-ended interviews, observation, storytelling, discourse analysis and focus group discussions. Qualitative data are comprised of literature and are generally descriptive in nature (Ubisi, 2016; Pillay, 2016). This indicates that the data obtained are comprised of words and sentences. This data group captures subjective perceptions of something, emotions, and feelings. Qualitative approaches focus on examining the ‘why’ and ‘how’ of a system and are most likely to use unstructured techniques for data acquisition to study the topic (Alberts et al., 2019). Qualitative approaches are fundamental in examining the unforeseen consequences and adversities of a program. However, they take more effort to establish. Additionally, the results are non-transferable to participants outside of the program and are subjective to the primary group on which the research was conducted (Saruchera, 2019; Tshuma, 2014).

Various aspects of a given research problem can be addressed by the researcher using the different research methods from a mixed-method research design (Kalinda, 2011; Vickers & Offredy, 2010). For this study, a mixed-method approach was adopted to differentiate between responses from the study participants because all participants were interviewed using identical

questions to identify significant differences in their responses according to the participant and study area (Crossman, 2014).

Appendix A indicates a letter of consent and a short explanation of this study that were administered to participants before the survey was conducted. Appendix B indicates the participant consent form to participant in survey. Each questionnaire consisted of open and closed-ended questions (Appendix D) that was administered to each study participant who met the requirement of practicing small-scale farming with a minimum of 1-2 years' experience. The questions were designed to obtain data from the farmers as to their perspectives towards climate change. While the study used a minimum of one year experience in farming as a selection criterion, priority was given to older people (> 50 years) who had more experience in farming because they may have faced more climate-related challenges than new farmers, and thus, would likely provide more in-depth comments This aided the researcher in determining the support structures available to the farmers to adjust with climatic and non-climatic adversities - as well as their perceptions on the extreme changes in weather conditions they have observed in their community. This further helped the researcher to understand their adjustment techniques to cope with variations in temperatures, the crops they were cultivating and what factors impacted their decision-making.

The population of Etete consists primarily of English-speaking residents and hence no translation either of the questionnaire or of the responses was required. This was established from a prior pilot study conducted by the researcher in the area. Appendix E indicates the site observations. Appendix F indicates the semi-structured interview guide that was used with study participants. The data collection was undertaken by the researcher and two field workers between April and May of 2021. The field workers in this study reside in Etete, KwaZulu-Natal and were trained by the researcher and thereafter assisted by filling out the questionnaires on behalf of participants. This process maintained COVID-19 protocols which ensured a 2-meter distance between all participants and no physical contact between participants.

To obtain qualitative data, the researcher arranged telephonic interviews with each of the ten participants in Etete- these interviews were digitally recorded. Prior to each interview, consent was obtained from the participant. Due to South Africa being at stage 4 COVID-19 lockdown restrictions between April and May 2021 (period of data collection) whereby movement was restricted, study participants were more comfortable with telephonic interviews. Telephone

interview recording was used to gather the level of details needed by the researcher for data analysis and the use of potential participant quotations in the results.

3.4 Sampling Technique

The population that participated in this study are small-scale farmers that live in Etete, KwaZulu-Natal. From both the interviews and survey questionnaires a total of eighty-four (84) small-scale farmers were selected to participate in this study using a specific criterion applied to recruit eligible participants. The criteria were discussed with the field workers who were tasked with initiating the process of visually identifying prospective participants - thereafter the researcher confirmed that the prospective participants met the criteria. This was done by a site visit to Etete. Etete, KwaZulu-Natal as chosen on the basis that small-scale farmers in this area have been facing harsh climatic vulnerability for a long period of time (Census, 2012). According to Tluczek (2012) much of the small-scale farmers in Etete experience social and economic risks such as lack of water for irrigation, lack of support from extension officers, poor access to markets and due to CC, and much of the populace have basic education. Since access to technological innovations such as seasonal climate forecast, etc. are known to scale-up farmers adaptation to climate change (Amosi, 2018, Vincente-Vincente, 2022), understanding how Etete farmers adapt to climate change is crucial to provide valuable lessons for development practitioners responsible for improving rural farmers' welfare in Etete, KwaZulu-Natal. Contacts was made with participants at Etete in person and the study was explained to participants utilizing the research proposal justification as a framework to support involvement for the survey questionnaires and interviews. This has been established from a prior study done by the researcher in the area. There were 74 participants for the questionnaire, each questionnaire took approximately 20 minutes to complete. There were 10 participants for the semi-interviews which took 10-15 minutes per interview.

The two recruited field workers assisted by filling out the questionnaires on behalf of the participants. This was to ensure there was limited contact between interviewer and participant and so limited chance of infection with COVID-19. Figure 3.3 below indicates the Personal Protective Equipment (PPE) worn by field workers when filling out the questionnaires in Etete. This process maintained COVID-19 protocols and there was no physical contact with the participants. The researcher arranged interviews with potential participants who were identified by the field workers who live in the area. The selection criteria as discussed below were explained to the field workers who were tasked to initiate the process of visually identifying

prospective participants - thereafter the researcher confirmed that the prospective participants met the criteria. This was done by a site visit to Etete. All the interviews were telephonic, and consent was obtained from each study participant before each interview was recorded.

Figure 3.3. Example of PPE used by researcher and field assistants during field work. Source: Author (2021).

3.4.1 Purposive sampling technique

Also known as judgment sampling, purposeful sampling involves the researcher choosing participants who exhibit particular traits and characteristics for which mts the research criteria (Genot, 2018). Purposive sampling is defined as a strategy where specific settings, events or persons are deliberately selected to provide significant data that will not be possible from other sources (Taherdoost, 2016). It is where the researcher includes participants or cases in the sample to warrant inclusion. In KwaZulu-Natal 18% of households farm and the number of

households in Etete is 1700 (Statistics SA, 2016). Based on this figure, it can be estimated that 18% of the 1700 households in Etete are involved in small scale farming, resulting in a population size of 306 households. Using a confidence level of 95% and a margin of error of 10%, the overall sample size required for the survey is 74 participants. There were 10 (ten) participants who participated in the semi structured interviews using a purposive random sampling technique.

Since not every prospective participant will be willing to partake in a study, it can be argued that purposive sampling may be useful to compensate for this deficit as the set of criteria used to select an individual who declined to participate in a study may be applied to easily replace the participant.

To select the sample participants, the following criteria must be met:

- Participants must be 18 years of age or older
- Participants should be individual small-scale farmers
- A focus on crop production as a practice
- Producing for sustenance and extra yields for sale
- Agricultural practice must be predominantly dependent on rain-fed agriculture
- A land size within a range of 0.01 - 5 hectares
- The participants must be a small-scale farmer with one or more years of experience to have a better insight on the farming conditions and how the climate has changed over time impacting the produce used to sustain their livelihoods.

While the study used a minimum of one year experience in farming as a selection criterion, priority was given to older farmers (> 50 years) who had more experience in farming because they may have faced more climate-related challenges than new farmers, and thus, would likely provide more in-depth comments. The above criteria were discussed with the field workers who were tasked to initiate the process of visually identifying prospective participants - thereafter the researcher confirmed that the prospective participants met the criteria. This was done during a site visit to Etete.

3.5 Data collection techniques

3.5.1 Site Observations and transect walk

Observation is a technique of obtaining data by watching behavior patterns, events, or noting physical characteristics in their natural environment (Saruchera, 2019). This method allows the researcher to become the main tool for obtaining data by noting as an individual observer what people do or say and how they interact and function in their everyday locations. Transect walks are a method for collecting spatial data on an area by walking around the area and observing people, their surroundings, and resources. On transect walks, significant amounts of qualitative and quantitative data can be collected by observing indicators and involving a variety of stakeholders. When going on the walk, it's important to get as many people involved as possible. The indicators you will be observing should guide your choice of who to engage. Depending on their experience, expertise, values, gender, and age, different stakeholders will have different perspectives on a situation.

Visual observations and transect walks were carried out in Etete, Shakaskraal. The transect walk conducted in Etete was aided by the participants, who assisted in identifying small scale land plots by walking through the area and the types of crops being cultivated. Appendix E depicts a site observation matrix of the small-scale farming plots. Visual observations allowed the researcher to note that land was not being used to its fully capacity, there was extensive erosion and many of the small-scale farmers practiced monoculture. This aided the researcher in understanding the behaviors and routines of individuals in the community. After the interviews and administration of questionnaires, the field workers and researcher took pictures of the areas.Figure 3.4 indicates how farming produce is harvested – this small-scale farmer uses her produce for household consumption.

Figure 3.4. Example of produce being harvested by a small-scale farmer. Source: Author (2021).

The small-scale farmers are aware of which indigenous crops will grow healthier, however their resources to use their land to the maximum potential are limited. The soil type in the area is fertile and can support the growth of many household crops as indicated in the Figure 3.5 below. The crops planted in the area are staple food items for the community- such as mielies, yam and cabbage.

Figure 3.5. Example of crop variety supported by good soil profile. Source: Author (2021).

3.5.2 Survey

The researcher considered the study's problem statement, research questions, and goals during the significant process of developing the survey's guiding questions. Since they were best suited for data collection, probing questions were developed in order to collect as much information as possible. The questions indicated comprised both closed and open-ended questions (Appendix D). The benefits of closed and open-ended questionnaires over other forms of surveys include their cheapness to produce, little effort from the questioner as compared to a telephonic/verbal survey and are often made simple to compile data due to standardized answers (Taherdoost, 2016; Omer, 2017).

A distinction is made between closed and open-ended questions. An open-ended question requires the respondent to create their answer based on their opinion/view. A closed-ended question, on the other hand, requires the respondent to select an answer from a predetermined list (Kabir, 2016; Taherdoost, 2016). The options for a closed-ended question should be mutually exclusive and comprehensive to get a better understanding of the study (Omer, 2017). Personal contact was made with each study participant at Etete, Shakaskraal and the study was explained to each participants utilizing the research proposal justification as a framework to increase support by potential participant as to their involvement in the study. The questionnaire was pre-tested by two alumni from the University of KwaZulu-Natal to ensure that there was no ambiguity in the questions, if the questions served the aims and objectives of the study and

to obtain an approximation on how long each survey would take to complete. Lastly, the final survey form was developed. To ensure confidentiality, a consent form was signed by the field workers.

3.5.3 Semi-structured interviews

When preparing the guiding questions for the semi-structured interviews, the problem statement, the research questions, and the study goals and objectives were all taken into consideration (Appendix F). The researcher was able to learn more about the study participants and their circumstances as well as conduct in-depth research on specific topics because of this. Ten people participated in the semi-structured interviews that the researcher conducted. As discussed in section 3.4.1 the participants were selected on a set criterion. The telephonic interviews were done by the researcher and all the interviews were recorded. Table 3.1 describes when the interviews were conducted and the sector of the participant. The interviews took approximately 15-20 minutes for each participant. The interviews were recorded to further analyze the responses and for record purposes.

Table 3.1: Table of interview participants

Participant	Sector	Type	Interview Date
A	Government Sector (Provincial)	Telephonic	09/03/2021
B	Local community member	Telephonic	23/07/2021
C	Local community member	Telephonic	23/07/2021
D	Local community member	Telephonic	23/07/2021
E	Local community member	Telephonic	23/07/2021
F	Local community member	Telephonic	24/07/2021
G	Local community member	Telephonic	24/07/2021
H	Local community member	Telephonic	24/07/2021
I	Local community member	Telephonic	24/07/2021
J	Local community member	Telephonic	24/07/2021

After conducting 10 interviews the researcher found that data saturation was reached when the study participants provided recurring themes in their responses, and which corresponded with survey findings.

3.7 Data analysis

The Statistical Package for the Social Sciences version 23 (SPSS) was used to analyze and present statistical data and to develop the main themes for this study (Landau & Everitt, 2004). The main themes that emerged from the study included:

- Demographic characteristics of small-scale farmers in Etete, KwaZulu-Natal.
- Climatic risks and their impact on food production in the study area.
- Non-climatic challenges and food production.
- Adaptation strategies to both climatic and non-climatic risks.
- Interventions and support systems to tackle climatic and non-climatic risks in the study area.
- Opportunities provided by climatic and non-climatic risks.

After the quantitative data were analyzed, frequencies were used to show how small-scale farmers in Etete dealt with both climatic and non-climatic shocks and how they adjusted to these changes. The process by which a researcher transforms written data (such as those from interviews or field notes) into findings is known as data analysis in qualitative research (Saruchera, 2019). The researcher uses this method to thoroughly examine, clean, transform, and model the data gathered from the interviews to find relevant information. For the analysis of the qualitative primary data, the researcher used QSR NVivo, which creates and refines categories and traces linkages between some concepts as defined by the codebook. A transcription of the digital recordings was necessary to complete this study, and it became a useful method to analyse, interpret, and report the words of the participants into findings.

After inputting the interview transcripts in QSR Nivo, the researcher developed theme nodes (from the interview) and from these nodes various text queries were formed which allowed the researcher to find all occurrences of a word or concept from the interviews. From these queries various themes emerged which were grouped and analyzed by the researcher. Both qualitative and quantitative methods allowed an increased reliability overall for the research, making it valid for other researchers. This was verified by comparing participants' responses from the surveys and interviews to identify similar themes. The data analysis process is linked in its final stages by arranging and organizing the research's thoughts and concepts. By using two data methods, comprehension of the results can be made in these final stages. During this final stage, clarification between the meaning of identical and contradictory data is required (Creswell, 2007; Omer, 2017).

3.8 Validity of data

Rigorousness is crucial if a study is to have few errors. Using Guba's trustworthiness model, this study looked at accuracy and rigor. The model includes the following segments representing credibility, dependability, transferability, and conformability (Reddy, 2016). The primary objective of research is credibility, which is linked to central rationality. This ensures that the intended study can be quantified by the researcher. Dependability ensures the authenticity of the research while extrinsic rationality is linked to transferability (Middleton, 2019). The researcher used a method called member checking to make sure the study was always credible. To ensure that the participants' responses were correctly interpreted, they were summarized and divided into segments. Dependability ensures the authenticity of the research.

In order to guarantee that the research was completed on time, a timeline was established. According to the research by Kyngas (2020), neutrality is linked to conformability. This indicates that measures were taken to guarantee that the participant's ideas and opinions, not the researcher's, influence the research conclusions. To ensure that the data reflect the information obtained from the participant and not the researcher, consent forms were signed and responses from participants were scanned and attached. The ability of the planned research to be applied to other situations is known as transferability.

Participants completed and signed an ethics application and consent form to guarantee authenticity and to confirm that each participant was aware of details of the study and that their participation was voluntary, they would not receive any incentives to participate in the study and that they could withdraw from the study at any stage.

3.9 Ethical Considerations

When undertaking any research involving human participants at the University of South Africa requires reassurances, ethical issues were considered to protect respondent rights. There was an ethical letter drafted to the Ethics Committee of the University of South Africa seeking permission to perform the field research in 2021 (2021/CAES_HREC/026). Due to COVID-19 restrictions, there were mitigation measures established, such as the use of masks and carrying of sanitizers during the field work. There was a first aid kit on hand in a case of emergency. A limited number of participants in groups of 3 were engaged with at a given time with a 1-meter distance to minimize risks. Local government officials have already been notified about the research via email - Appendix E indicates the research permission letter that was sent to the KwaDukuza Municipality. A letter of consent to conduct the study as well as a series of public

and secondary data had already been sent by the KwaDukuza Municipality via email to facilitate the research.

Field workers were informed of their participation in the study, they also signed a consent form to ensure confidentiality of data. Appendix C indicates the field workers consent form. Before data were collected from participants, they were informed about the study and a consent form was signed by each participant before data were obtained. Appendix B indicates the participant consent form. The option to participate in or withdraw from the study was made clear on the form. Contact information was provided if they had any research concerns to the investigator and committee. The participants could withdraw at any time and their data could only be utilized with a formal signed consent. Data obtained was retained with the researcher in a locker. Data will be stored for 5 years on an external hard drive and thereafter deleted, and any paper-based data shredded.

3.10 Conclusion

The methodology applicable to this study was described in this chapter. The focus of the research topic was Climate Change and Sustainable Livelihood Analysis of Small-Scale Farmers in Rural Etete, KwaZulu-Natal, South Africa.

Data were collected in the Etete area, KwaZulu-Natal primarily using the responses from small scale farmers to questions in a survey questionnaire and also from semi-structured interviews. The aim was to draw comparisons from different responses.

In this study, semi-structured interviews involving the study participant farmers were used to gather data in the form of their demographic details as well as their responses to the questionnaire(s) regarding their opinions/perspectives on the impacts of climate change on small-scale farming, and the way forward regarding adapting to climate change and adopting climate-smart agriculture practices.

Chapter 4 : Results

This research study investigated the impacts of climate change on small-scale farmers in Etete, KwaZulu-Natal. This chapter presents the results of this research study using the questionnaire data that was captured and analyzed using Statistical Package for Social Science version 23 (SPSS). Frequency tables and graphs were formulated using SPSS and Excel to explain relationships between the various variables. The interview data were transcribed and analyzed using QSR NVivo and from the analysis emerged various themes which are discussed in this chapter. Section 4.1 analyses and explains the demographic characteristics of the small-scale farmers in Etete, KwaZulu-Natal. Section 4.2 presents the results from the analysis. Section 4.3 presents the qualitative data of the study to address adaptation strategies to both climatic and non-climatic risks as well as interventions and support systems to tackle climatic and non-climatic risks in the study area. Section 4.4 presents the transect walk observations. Section 4.5 provides a summary of this chapter.

4.1 Demographic data

4.1.1 Gender Distribution

As illustrated in Figure 4.1, nearly two thirds (64%) of the study participants from the Etete community were female.

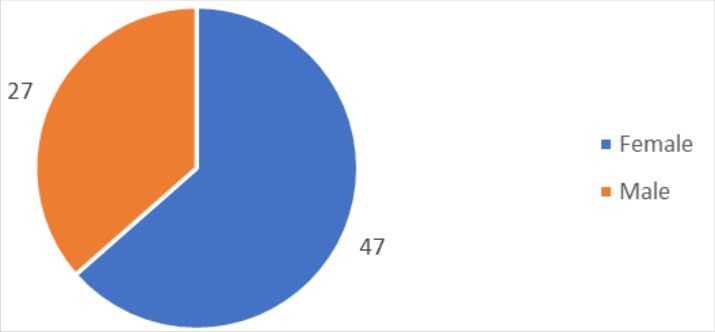


Figure 4.1. Pie chart illustrating gender statistics of Etete

4.1.2 Age distribution

The distribution of the age groups of the study participants is represented in the bar chart below (Figure 4.2). While the study used a minimum of one year experience in farming as a selection criterion, priority was given to older people (> 50 years) who might have more experience in farming and faced more climate-related challenges than new farmers. Thus, they could likely

provide more in-depth comments on farming in general and on dealing with challenges facing small-scale farmers.

Figure 4.2 indicates the age distribution for the small-scale farmers in the study area and reflects a relatively large number of older farmers (36%; n=27) over the age of 54 years. There were no participants under the age of 24 and so the remaining study participants (n=47) were spread evenly over the three age brackets between 24 years and 54 years.

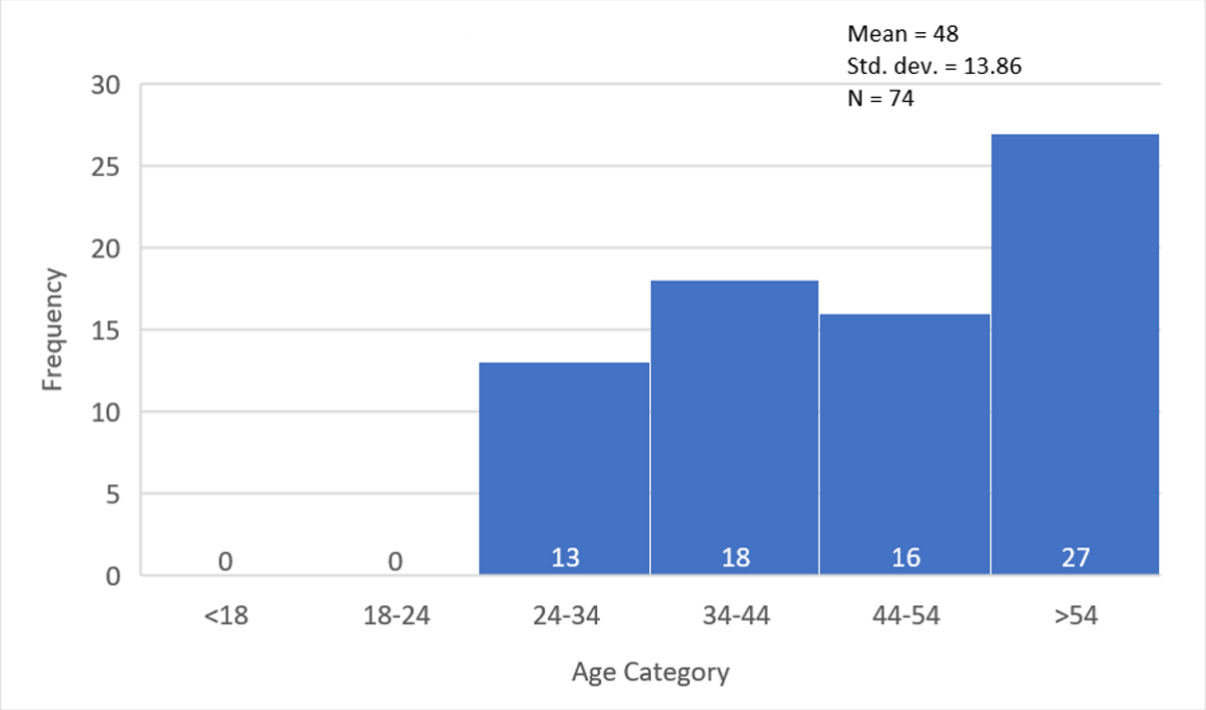


Figure 4.2. Age distribution of study participants

4.1.3 Education level

Figure 4.3 shows that nearly a half (47%) of the study participants had completed secondary schooling. Of the remaining study participants, 19% had no formal education or up to a primary school level of education (37%). None of the study participants had tertiary education.

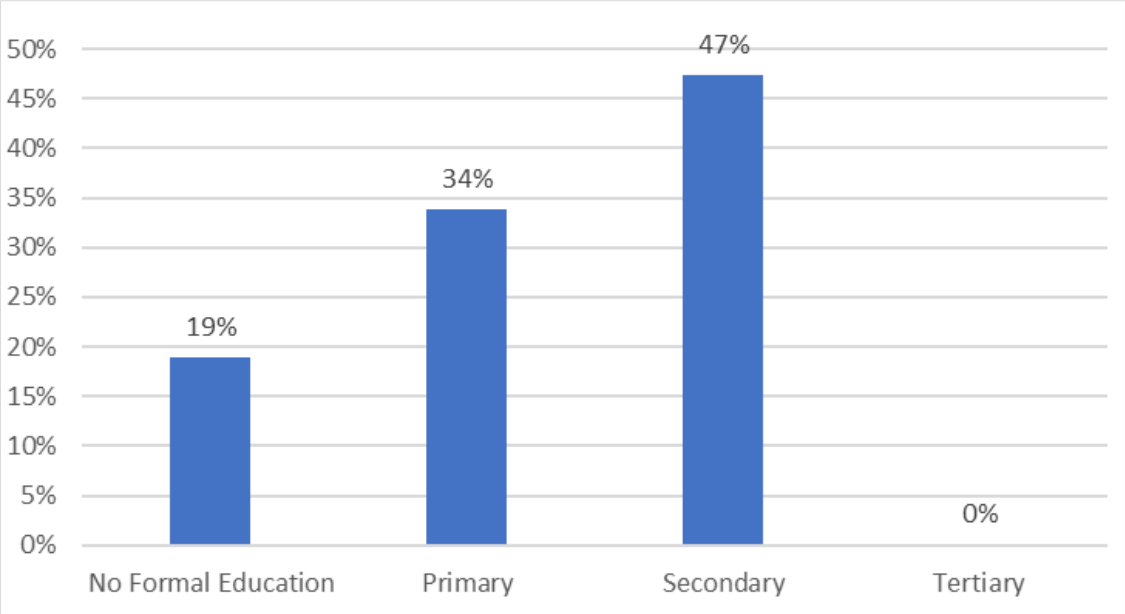


Figure 4.3. Education level of respondents

4.2.4 Employment levels

Figure 4.4 below indicates the income bracket for the study participants. A total of 34% earn an income between R1501-R3500, 26% earn an income between R801-R1500 and 16% earn an income bracket over R3500.

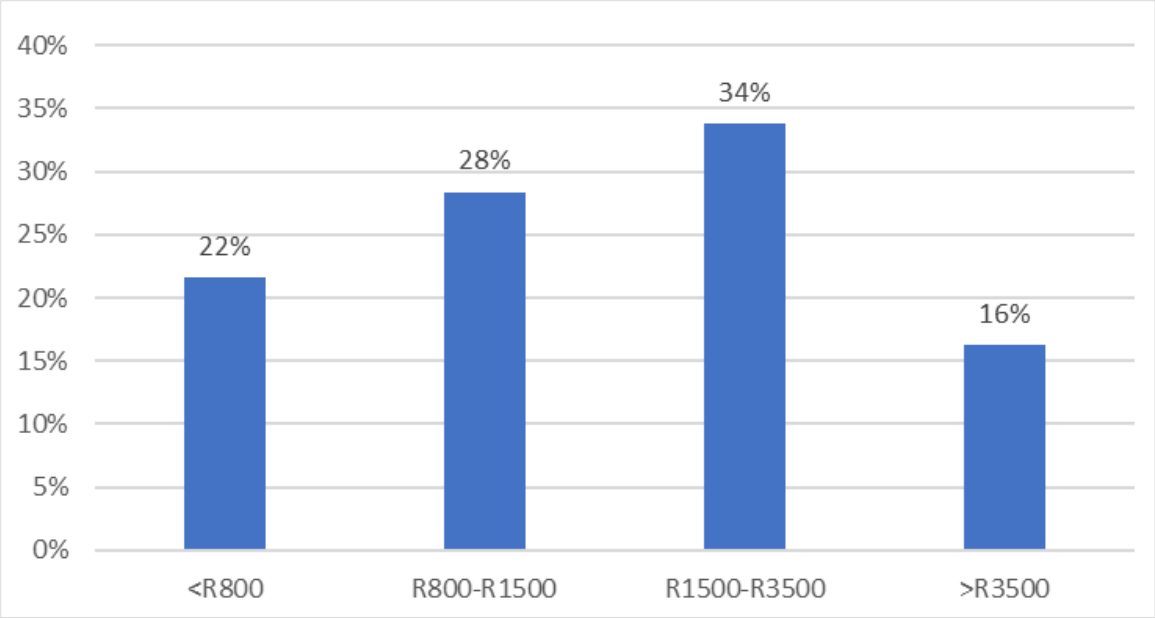


Figure 4.4. Income bracket of respondents

4.2 Questionnaire results

4.2.1 Experience gained by farmers.

Due to the number of years the small-scale farmers have been in Etete, they often rely on each other for advice on farming. Figure 4.5 below indicates the number of years of farming experience by the participants. A total of 36% of the participants had farmed for between 6 and 10 years, 27% of the participants were farming for 11-20 years and 37% were farming for more than 20 years. Most households interviewed practiced mixed crop farming (maize, lettuce pumpkins, amadumbe).

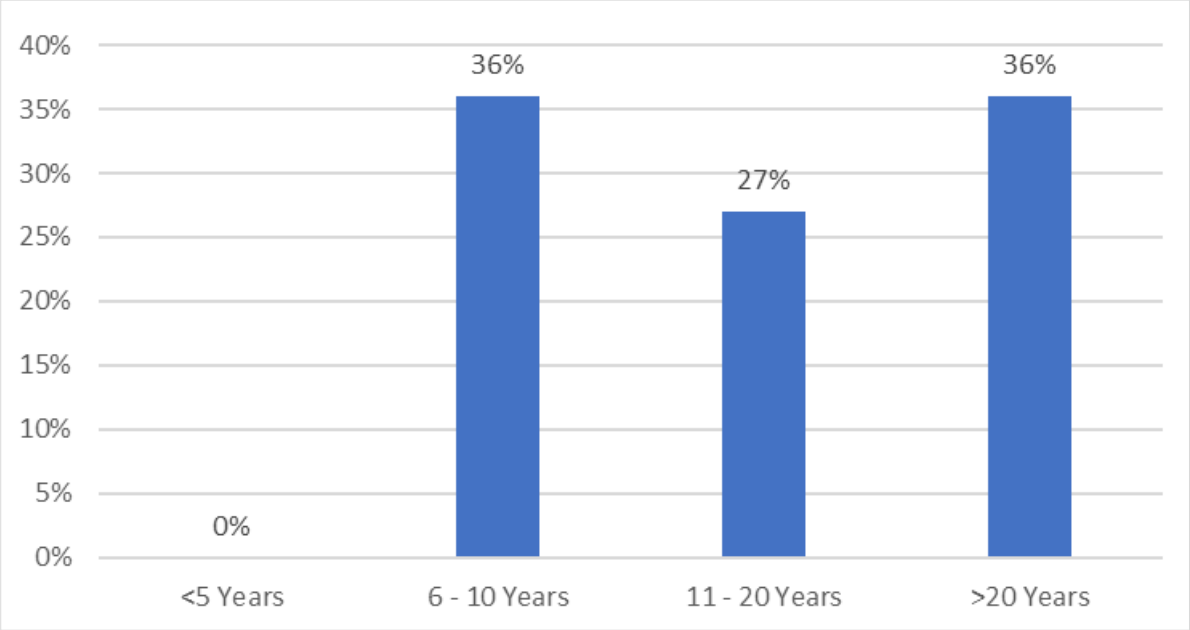


Figure 4.5. Number of years farming

4.2.2 Climate change awareness

Figure 4.6 indicates the participants responses towards CC awareness, 64% of the participants indicated that they are aware of climate change while the remaining participants indicated that they are not aware of CC and its impacts. The latter group of participants belonged to a younger age group between 24-34 years, some of whom had only been farming for fewer than 5 years, or who were more involved in off-farm activities that did not require attention to their farm's performance. The 64% who farmers who were aware were mostly poor and elderly farmers, who did not specifically identify temperature as some of the changes in the weather patterns, but rather reduced rainfall, long droughts as well as unpredicted rainfall.

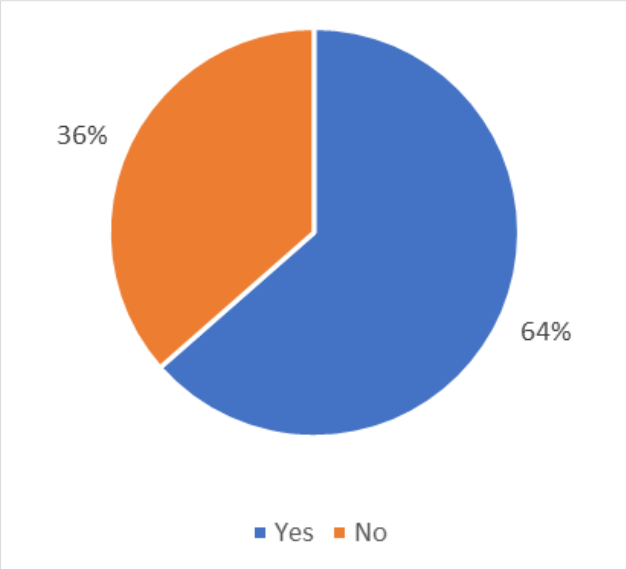


Figure 4.6. Climate change awareness

4.2.3 Challenges affecting optimal food production

4.2.3.1 Arable land size

According to reports, small-scale farmers in Etete have chosen to either decrease or increase the amount of land they cultivate in response to the effects that changes in climatic conditions have on agricultural production. Figure 4.7 below indicates how the respondents use their land for farming. Due to CC, some of the farmers interviewed said that they have decided to change their harvesting system and farm size. The results indicate that 97% of the participants indicated that their land size is less than 1 hectare. A total of 18% of the participants indicated that they farm a quarter of their land and 7% indicated that they farm around a half of their land area. A total of 76% indicated that they farm their total area.

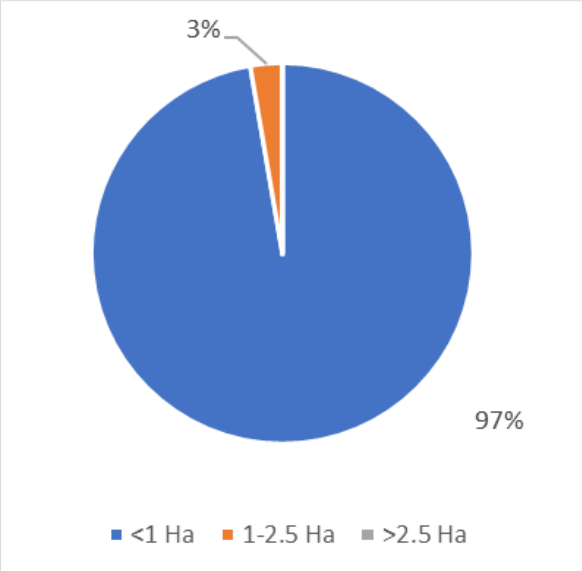


Figure 4.7.Land size

4.2.3.2 Seed and fertilizer

Many of the participants who were interviewed said that small-scale farmers are limited because they don't have good agricultural inputs like drought-resistant seeds and fertilizers that can help them adapt to the bad effects of CC.

4.2.3.3 Other factors

Examples of non-climatic risks that affect farming include pests and diseases, lack of credit, land degradation, inaccessibility, or limited extension services, weed infestation, shortage of farm inputs, etc.

4.2.4 Adaptation strategies to climatic risks

In terms of the impact of CC, many participants stated that they used to plant more water rich vegetables such as tomatoes, beans, cucumber, whereas now the farmers produce commodities such as maize, yam and traditional leafy vegetables as their staple crops, they have easy market access and they believed that they can withstand the climatic variability. Figure 4.8 below indicates the participants responses for the influence on crop selection. A total of 38% of the participants indicated farmer to farmer influence and 62% of the participants indicated traditional knowledge influences crop selection. Due to the absence of extension services aid towards CC adaptation the researcher intended to identify the local adaptation strategies employed by small-scale farmer to help them improve agricultural production.

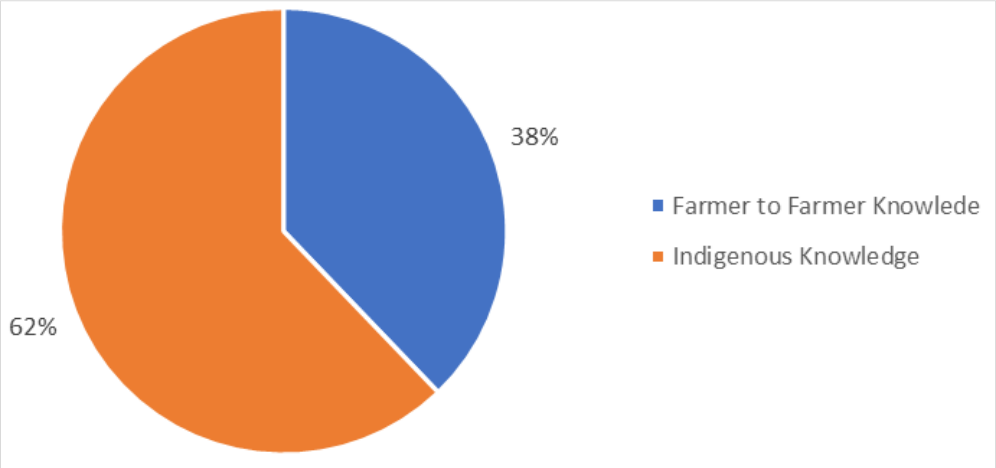
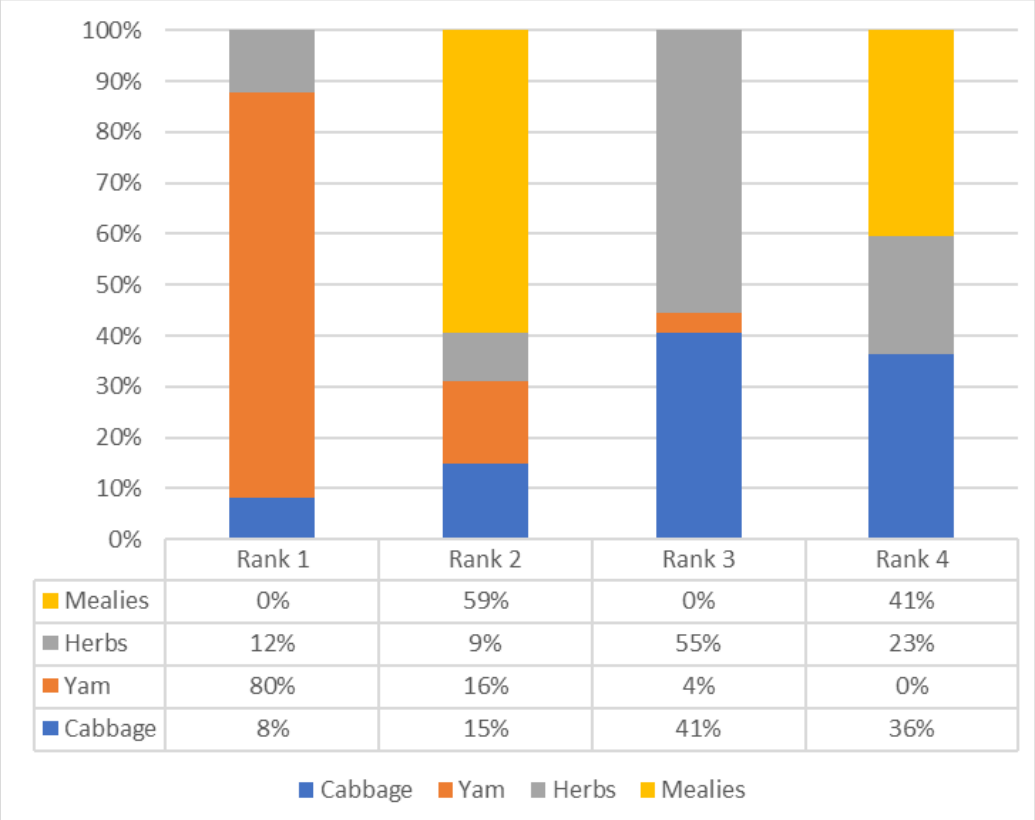


Figure 4.8. Influence on crop selection

The ranking index below was developed by the researcher to determine which was the most popular crop grown in Etete. Figure 4.9 below indicates the crop ranking by the participants. In Rank 1, 80% of participants indicated Yam as their first choice. In Rank 2, 59% of participants indicated mielies was the main choice. In rank 3, 55% of participants indicated herbs as their main choice. And in rank 4 cabbage was the main choice. These crops were chosen primarily for human consumption at the household level.



	Rank 1	Rank 2	Rank 3	Rank 4
Mealies	0%	59%	0%	41%
Herbs	12%	9%	55%	23%
Yam	80%	16%	4%	0%
Cabbage	8%	15%	41%	36%

Figure 4.9. Crop selection

The graph (4.10) below indicates the adaptation strategies undertaken by the farmers in Etete when there is an extended period of an increase/decrease in temperature and rainfall. A total of 26% of participants indicated mix cropping as an adaption measure when experiencing an increase/decrease in temperature for an extended period, 18% indicated building a water harvest water scheme and 20% indicated that changing date of plantation. A total 26% of participants indicate mix cropping as an adaption measure for rainfall, 18% indicate building a water harvest water scheme and 20% indicate changing date of plantation.

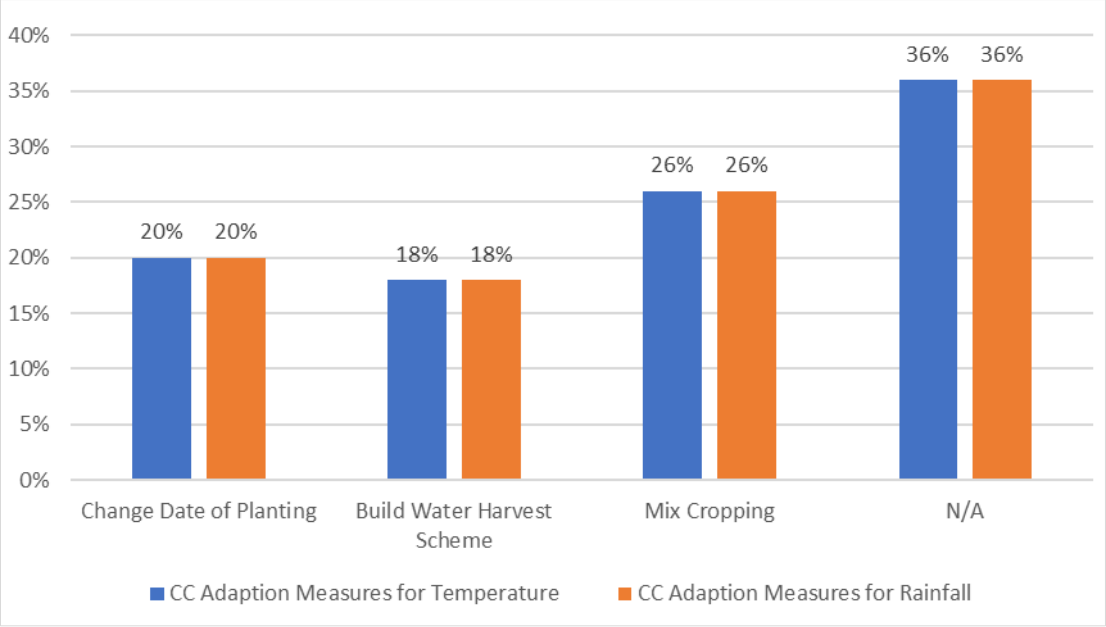


Figure 4.10. CC Adaption Measures for Temperature and Rainfall

4.2.5 Adaptation strategies to non-climatic challenges

According to the study, low-quality agricultural inputs make it difficult for small-scale farmers to adapt to CC's negative effects. This will likely compromise some household's ability to obtain an income, especially those that rely significantly on food production. Figure 4.11 depicts the responses as to how participants cope with food shortages. A total of 7% of participants indicated to consume less food, 23% of participants stated, "borrow money", 16% of participants indicated that they "receive food from family" and 20% of participants indicated "send older children to work".

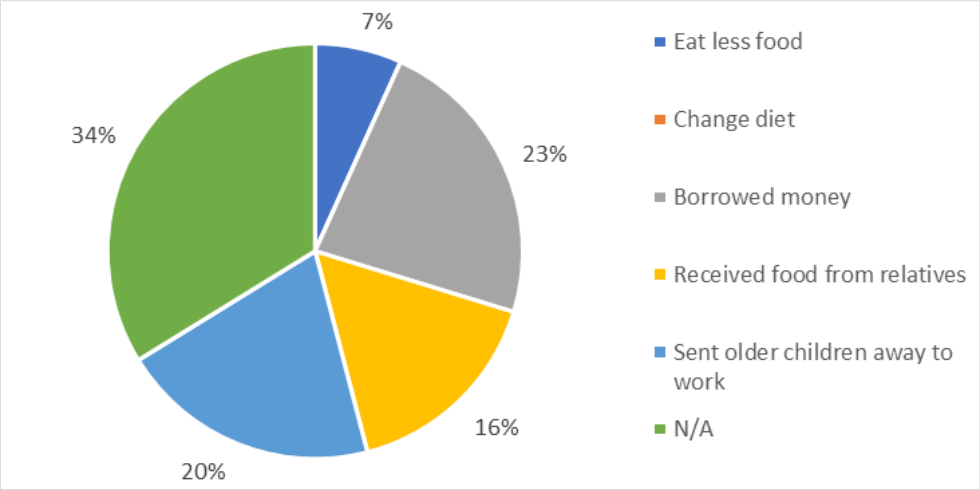


Figure 4.11. Coping with food shortages

4.2.6 Interventions and support systems to tackle climatic and non-climatic risks

One of the most important agricultural sector interventions for rural development, food security, poverty alleviation, and the generation of income for new farmers is still the provision of support services. The survey results from 74 participants indicated that no climate change training was received by any of them and there are no change institutions and organizations in the area.

4.2.7 Constraints to climate change adaptation

Adaptation remains essentially necessary to reduce the adverse effect of climate change. Figure 4.12 below indicates the participants responses to why they did not adapt. A total of 14% of participants indicate lack of information and 12% indicated that they did not see the need or had limited information on how they should adapt.

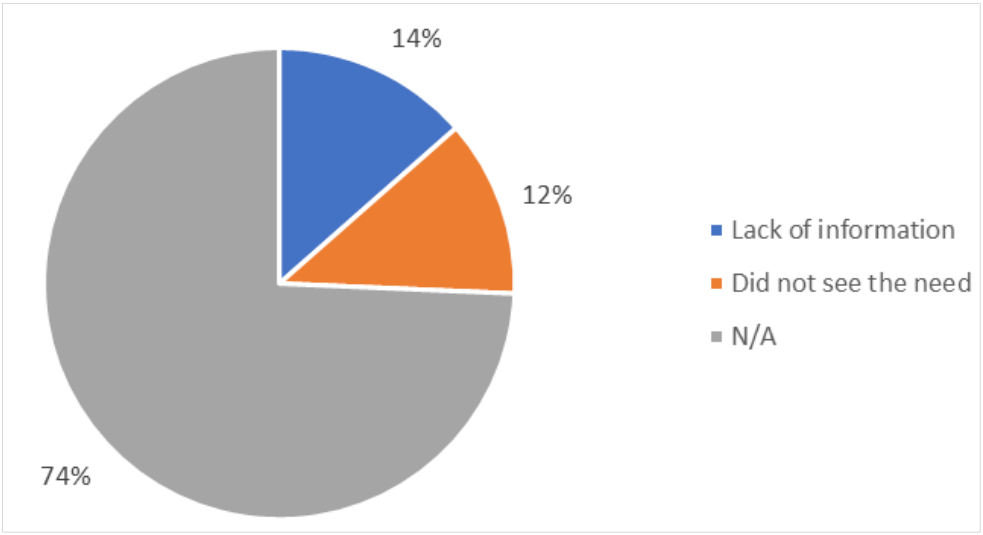


Figure 4.12. Reason for not adapting

4.3 Qualitative Data

Following the transcription and coding of the semi-structured interviews, the five main themes of this study were identified. Table 4.1 below indicates the responses of participants from the semi-structured interviews.

Table 4.1. Qualitative Data of Participant Responses

Theme 1: *Farmer's perception of climate change on food production*
1. Informant G: "The past 5 years have significantly impacted our farming as compared to 10 years ago. We are noticing our soils are drier and our rainy seasons are shorter. This is slowly affecting our produce."
2. Informant A: "As a department we work closely with them and in some areas, there are economic development institutions that also assist in terms of farming…We have offices locally that farmers can go to, and the extension officer will keep in contact for any further questions or help."
3. Informant D: My vegetables aren't as green and healthy as they could be, and they always need more water, which I don't have."
4. Informant J: "Many farmers in Etete continue to use traditional seeds, which are susceptible to diseases and drought."
5. Informant H: "Due to the absence of extension officers I often rely on my neighbor or fellow farmer for advice on which crop will be good to grow this season."
Theme 2: *Climatic and Non-climatic risks impact on food production*
1. Informant E: "Because farming inputs are too expensive, I've decided to scale back the farm. I have therefore decided to reduce the size of the farm where I grow spinach and increase the size of the farm where I grow maize and yam, both of which do not require a lot of water or pesticides."
2. Informant H: "Because the government does not make an effort to hire environmental staff, there is no climate change strategy. We are unable to inform farmers in villages about climate change and how to adapt to its negative effects because we have a small staff. However, if the government had been serious about putting that strategy into action, they could have hired enough employees to reach farmers in villages and provide them with the necessary education."
3. Informant I: "Insecticides and pesticides are important agricultural inputs, but quality seeds are also a concern. You need to utilize quality seeds to increase agriculture productivity, but sometimes you can't afford to acquire those seeds."
Theme 3: *Adaptation to climatic and non-climatic risks*
1. Informant F: "I rely on my neighbor who is also a small -scale farmer to help me choose the best crop to grow because there is no one nearby to advise"

2. Informant I: “In the early 2000s, I used to grow a lot of tomatoes and eggplant. But these days, I cannot do that because the harvest will be small. I must grow more mealies and vegetables to ensure I obtain a livelihood”.
3. Informant J: “Due to our reliance on agriculture, farmers in Etete are dissatisfied; however, climate change is causing a steady decline in production, making it impossible for us to escape poverty. Because of how much we are affected by changes in the climate, it is time for the government to focus on climate issues.”
4. Informant K: “The availability of agricultural inputs, particularly seeds, is questionable; many of us chose to use traditional seeds, which resulted in very low yields due to the seeds' vulnerability to unknown diseases that cause crops to turn yellow and their inability to adapt to climate change.”
5. Informant A: “Financially, we (the DARD) provide infrastructure depending on the commodity the small-scale scale farmer has requested. We have a college where we run courses on farmer development. The other support is extension services where we go out and advise farmers of new developments. “We also partner with research on whatever trails need to be run and check if a commodity is adaptable at that level.”
6. Informant B: “We are greatly impacted by climate change, so it is time for the government to focus on it. Because we rely on farming, the farmers in our village are dissatisfied. However, production is decreasing daily as a result of climate change, making it impossible for us to escape poverty.”
Theme 4: *Constraints to climate change adaptation*
1. Informant C: “I only know about tree planting and traditional farming, which cannot help us effectively adapt to climate change's negative effects because climate change adaptation requires government commitment to empower farmers and position them to take action.”
Theme 5: *Opportunities presented by climate change*
1. Informant D: “I don't know of any climate change policy, and I can say that I'm not sure if such a policy exists. I don't know of any farmers who will tell you anything different, but at my age, I have never seen an extension offer or an environmental officer in my village educating people about the existence of any climate change policy.”
2. Informant D: “The informal market is the only way we can make some extra money; we already know what people will buy so that’s what we grow and sell”. Informant A reiterated that “The informal market is important because with the formal markets the small-scale farmers are not able to make the standards.”
3. Informant K: "I have changed the farming system. I plant yam and sell the extra to make money. A lot of people in the surrounding areas are willing to buy yam and it has a nice market return."

The NVivo program enabled the researcher to examine the coded text "in context" (Schutt, 2011) embedded in its place in the original document. This allowed the researcher to assign and analyze various themes from the responses of the semi-structured interviews. The qualitative data were analyzed using thematic analysis because it allowed the researcher to compare the frequency, relevance, and significance of a theme within the study context (Kabir, 2017). The researcher was able to better comprehend and interpret the collected data as a result of this.

Following the transcription and coding of the interviews, five main themes were identified for this study. Appendix G and I indicates the qualitative codebook of the interviews and frequency of responses. Before similar codes were placed under themes, the transcripts were grouped and carefully examined as part of the theme selection process. Appendix H and J indicate query trees that the researcher used as a mind-map to develop the themes below.

Theme one: Farmer's perception of climate change on food production

The participants described their idea on the notion of climate change and why they thought that it was occurring? Specific attention was paid to which factors cause this, including droughts, heavy rainfall, windstorms, etc. and in which years the farmers perceived these droughts and heavy rainfall to occur. The emerging theme helped the researcher understand factors that most affected farm food production. The goal of the study was to find out if small-scale farmers in Etete were aware of CC policies that could help them adapt. Both small-scale farmers and local government officials were found to be unaware of climate change-related policies, according to the findings.

From a local standpoint Informant G stated that:

> "The past 5 years have significantly impacted our farming as compared to 10 years ago. We are noticing our soils are drier and our rainy seasons are shorter. This is slowly affecting our produce."

Informant A from KZN DARD argued that:

> "As a department we work closely with them and in some areas, there are economic development institutions that also assist in terms of farming…We have offices locally that farmers can go to, and the extension officer will keep in contact for any further questions or help."

Participant H further stated that:

> “Due to the absence of extension officers, I often rely on my neighbor or fellow farmer for advice on which crop will be good to grow this season.”

The response from participant A indicate that there are places to seek help, but this information is not properly communicated by extension officers to make farmers aware of these resources. There are no extension officers in Etete, so if a small-scale farmer needs advice, they need to go to the neighboring town of Stanger that is 10 km from Etete to seek help from the DARD offices. Communication would be more effectively conducted if public notices in newspapers stated that the iLembe District offers extension services. There can also be stationed modular extension offices in various farming districts within iLembe to ensure accessibility. The reason why communication is lacking may be due to accessibility and limited extension officers within the iLembe district to reach areas such as Etete. Informant G and H stated that due to the absence of extension officers many of the neighbors and farmers rely on each other for farming advice.

As indicated in figure 4.11 above some of the study farmers planted drought-resistant crops such as mielies and yams in response to climate change, particularly in response to insufficient and unpredictable rainfall. Participant D stated:

> "My vegetables aren't as green and healthy as they could be, and they always need more water, which I don't have”.

Furthermore, participant G stated,

> "Many farmers in Etete continue to use traditional seeds, which are susceptible to diseases and drought."

Because of a lack of financial resources, small-scale farmers are unable to use high technology to adapt to climate change and increase agricultural production. Appropriate investment of knowledge and infrastructure and access to support services into small-scale farming has the potential to increase agricultural growth and farm income and rural development, in general.

Theme two: Non-climatic risks and their impact on food production

The participants referred to non-climatic impacts as those that affect their ability to grow their food and included factors such as land fertility, size of land and their influence on crop selection. This theme also dealt with factors such as monoculture, lack of land optimization and farmer-to-farmer influence on decision-making. Examples of non-climatic risks that affect farming include pests and diseases, lack of credit, land degradation, inaccessibility, or limited extension services, weed infestation, shortage of farm inputs, etc. Participant C stated that:

> "Because farming inputs are too expensive, I've decided to scale back the farm. I have therefore decided to reduce the size of the farm where I grow spinach and increase the size of the farm where I grow maize and yam, both of which do not require a lot of water or pesticides."

Participant K further stated that:

> "Agricultural inputs are a problem, not necessary insecticides/pesticides but also quality seeds, in order to improve agriculture production, you need to use quality seeds and sometimes you can buy those seeds or you can use the seeds provided by our neighbours or other farmers but when we use them yet do not grow."

Participant H argued that:

> "Because the government does not make an effort to hire environmental staff, there is no climate change strategy. We are unable to inform farmers in villages about climate change and how to adapt to its negative effects because we have a small staff. However, if the government had been serious about putting that strategy into action, they could have hired enough employees to reach farmers in villages and provide them with the necessary education."

According to the responses, low-quality agricultural inputs prevent small-scale farmers in Etete from adapting to the negative effects of climate change. In addition, numerous Etete study participants confirmed that small-scale farmers cannot afford agricultural inputs and that, to make matters worse, there are also counterfeit inputs on the market, making them even more vulnerable to climate change. Crop production is limited, particularly in small-scale irrigation systems, by farmers' lack of knowledge and skills. However, many of the participants claimed that if given

the chance, they would acquire the proper farming skills improve quality of crop output. This will include knowledge on which crops to grow during various seasons, the fertilizers that should be used and the various pruning and maintenance methods to take care of the growing crops.

Theme three: Adaptation to climatic and non-climatic risks

The participants indicated mixed cropping as an adaptation measure for rainfall and building a water harvest water scheme. Some participants practiced seasonal plantation to increase their harvest. The emerging theme helped the researcher understand the various traditional methods that were shared amongst the small-scale farmers. As indicated in figure 4.18 above, lack of high-quality agricultural inputs to help small-scale farmers adapt to CC's negative effects limits their options, Participant E stated that:

> "The availability of agricultural inputs, particularly seeds, is questionable; many of us chose to use traditional seeds, which resulted in very low yields due to the seeds' vulnerability to unknown diseases that cause crops to turn yellow and their inability to adapt to climate change."

Some of the farmers who were interviewed (30%) said that because of climate change, they have decided to change their harvest and the size of their farms. In addition, farmers who were surveyed stated that they have made the decision to alter the method of harvesting in order to obtain funding for their farming endeavors. Participant D further stated that:

> "I changed my farming system, I grow mielies which is most popular and sell them sometimes so that I have some extra money to buy fertilizers and pesticides for other crops that I want to grow such as cabbage and peppers."

In terms of how farmer to farmer relationship influences crop selection, a participant in her 60s commented:

> "I rely on my neighbor who is also a small -scale farmer to help me choose the best crop to grow because there is no one nearby to advise".

These minor changes implemented by the small-scale farmers in Etete assisted towards coping with food insecurity. One of the most important agricultural sector interventions for rural development, food security, poverty alleviation, and the generation of income for new farmers is still the provision of support services. Responses from the interviews indicated that many of

the small-scale farmers were not aware that extension service support was available to them. The survey results from 74 participants indicated that no climate change training was received by any of them and there are no change institutions and organizations in the area. Participant A from KZN DARD stated:

> "Financially, we provide infrastructure depending on the commodity the small-scale scale farmer has requested. We have a college where we run courses on farmer development. The other support is extension services where we go out and advise farmers of new developments. "We also partner with research on whatever trails need to be run and check if a commodity is adaptable at that level."

However, participant J argued that:

> "Due to our reliance on agriculture, farmers in Etete are dissatisfied; however, climate change is causing a steady decline in production, making it impossible for us to escape poverty. Because of how much we are affected by changes in the climate, it is time for the government to focus on climate issues"

Informant B further expressed that:

> "It is time for the government to focus on climate issues because changes in the climate affect us a lot. Farmers in our village are unhappy because we rely on farming."

These responses demonstrate that subsistence farmers were unable to access not only climate change interventions and support systems, but also access to agricultural support systems.

Theme four: Constraints to CC adaptation

Some of the factor that were mentioned by participants were the lack of initiatives and resources to support small-scale farming. This theme helped the researcher identify and quantify their absence and what could be improved to assist the small-scale farmers in Etete. Adaptation remains essentially necessary to reduce the adverse effect of climate change. Participant A from the DARD stated that:

> "I think the farmers have enough knowledge of CC. Sometimes people still want to practice traditional methods, and this affects production."

Participant E argued that:

> "I only know about the tree planting and traditional farming methods, which cannot help us to effectively adapt to negative effects of climate change, because adapting to climate change require government commitment to empower farmers and put them in good position to undertake measures to address it."

The responses to the interviews have placed a greater emphasis on support in rural areas and new methods that can enhance the livelihoods of small-scale farmers. Some of the older female farmers' responses suggested that the region's food production was constrained by general laziness.

By way of example, they commented that:

> "Households cultivate their gardens very well but when it comes to weeding, they become lazy, and without weeding, crop production is reduced".

The goal of the study was to find out if small-scale farmers were aware of CC policies that could help them adapt. According to the study, both small-scale farmers and local government officials are unaware of CC-related policies. Because awareness is related to the availability and accessibility of information that can trigger their perception of those policies, the lack of extension services for small scale farmers plays a significant role in their awareness of CC-related policies.

Theme five: Opportunities presented by CC

Many of the participants were aware of the informal market being their primary source of livelihood. This was focused on those participants who sell surplus commodities to make a living. This presented a market entry for small-scale farmers to improve their income. The study revealed that there is limited awareness to climate change-related policies to both small-scale farmers and government official at local level.

Participant D stated that:

> "I don't know of any climate change policy, and I can say that I'm not sure if such a policy exists. I don't know of any farmers who will tell you anything different, but at my age, I have never seen an extension offer or an environmental officer in my village educating people about the existence of any climate change policy."

However, participant A from KZN DARD argued that:

> "Within the department there are policies that guide us. That touches on small-scale farmers."

The responses to the interview (50%) emphasize the need to improve the knowledge and skills of those most adversely affected by climate change, particularly farming communities that heavily rely on natural resources. The informal market and its significance were well-known to the majority of those who responded.

Participant G stated that:

> "The informal market is the only way we can make some extra money; we already know what people will buy so that's what we grow and sell".

Participant A reiterated that:

> "The informal market is important because with the formal markets the small-scale farmers are not able to make the standards."

However, most farmers (70 %) who had access to market information relied on information from family members, self-research, and other farmers. The farmers said that the information was out of date, sometimes biased, and unreliable, making it doubtful that it would be useful. As discussed in Section 4.4, some of the interviewed farmers had decided to change their farm

size as well as harvesting system due to climate change. Small-scale farmers reported on their decision to either reduce or increase the size of land for cultivation.

Participant D stated that:

> "I have changed the farming system. I plant yam and sell the extra to make money. A lot of people in the surrounding areas are willing to buy yam and it has a nice market return."

The limited scale ranchers need training in different areas of agriculture to increase their efficiency and take-home pay. This might include their accessing and securing marketing channels involving skills such as marketing strategies to allow small-scale farmers to overcome obstacles and move toward commercial agriculture.

4.4 Transect Walk

During the transect walk the researcher noted that the small-scale farmers do not maximize the land by producing a large crop output. Figure 4.15 below indicates the participants responses for land fertility. A total of 84% of the participants indicated that the land is fertile and 16% indicated that the land is very fertile. Figure 4.16 indicates land being under-utilized. This will mean confidence during crop selection within the farmers and improved crop yield as they would select crops based on its suitability for their environment. During the transect walk the farmers mentions that they have chosen to reduce their farm size and harvesting system due to CC. This was a response to the lack of farming input, equipment, or pest control in their crop.

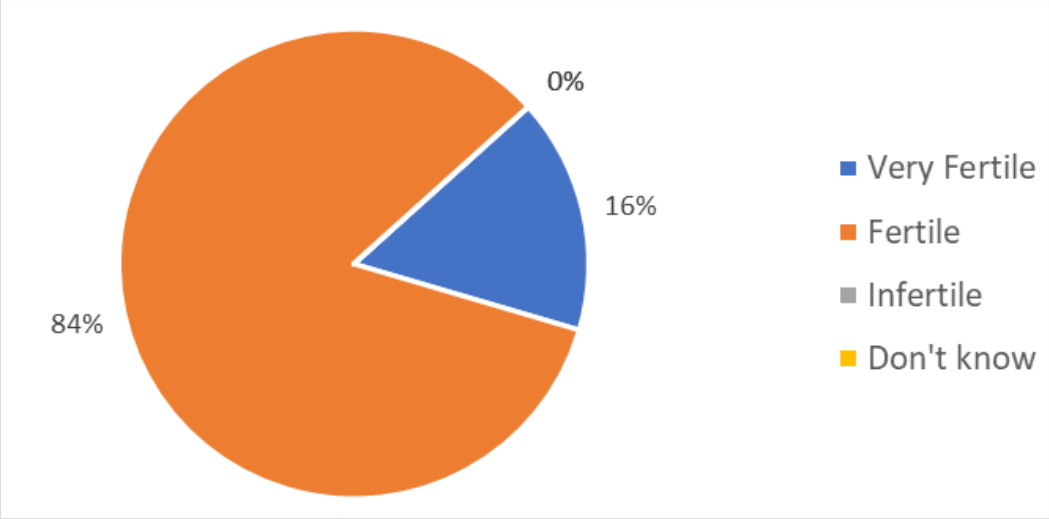


Figure 4.13. Land fertility

Figure 4.14. Example of farmland not used to its full potential

From ethnographic observations many of the small-scale farmers rely on rain harvest tanks in the area. Figure 4.17 indicates the participants responses as to how they get their source of water for farmer. The majority (65%) of the participants indicated rain harvest as a source of water, 24% of the participants indicated rainwater and 7% indicated tanks. From the information gathered from participants, the irregular rainfall has made the access to water difficult, with some stating that people in Etete had to walk approximately 5 km to fill water from springs and other streams when the water from the tanks are finished. Figure 4.18 indicates the rainfall tanks used by the small-scale farmers for their crops in the Etete area. Crop farmers need irrigation equipment, and vegetable farmers especially need it. The farmers' productivity was also found to be limited by the lack of cultivation infrastructure, such as cultivation tools and ploughs.

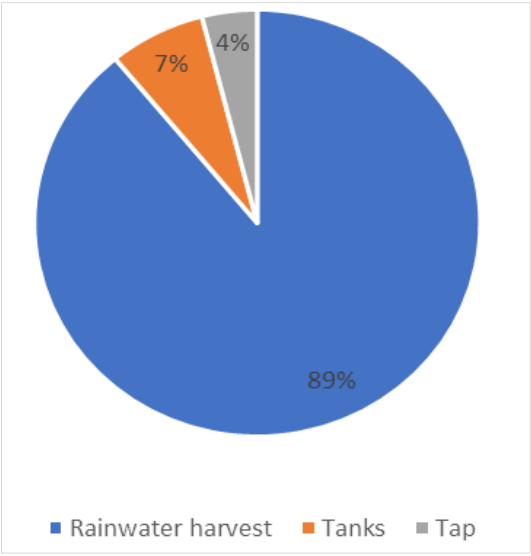


Figure 4.15. Source of water

Figure 4.16. Tanks where households store harvested rainwater in Etete. Source: Researcher (2021).

4.5 Conclusion

This study employed a variety of approaches. The primary data collection methods were key participant interviews, semi-structured interviews, and questionnaires. A total of 84 participants were chosen for the sample using a variety of probability and non-probability sampling methods. The analyst was able to elicit information on local area level mindfulness about environmental change and how this information is divided between individuals in the area thanks to the semi-organized meetings and study surveys' intelligent and adaptable attitude towards their farming. Using the available climate and meteorological data, key participant interviews helped confirm some of the local perceptions of climate change risks and vulnerabilities. The results of the other research methods used in the study communities were confirmed by the survey. The use of well-trained research assistants, close communication with thesis supervisors, strict adherence to standard ethical research policies and COVID protocols, triangulation, detailed field notes, a well-conducted pilot study, and electronic recording of all interviews all contributed to the data's reliability. An initial pilot study of the study communities, detailed field notes, triangulation, electronic recording of respondents, and ongoing consultation with thesis supervisors and other relevant officials all ensured the reliability of the collected data Pie charts, bar charts, and histograms—basic statistical

diagrams—were used to present the collected data. The content analysis was guided by the order of the research questions. Voluntary participation, informed consent, rights to privacy, confidentiality, and the respondents' right to remain anonymous were all strictly adhered to throughout the course of the study. Finally, all relevant institutions and bodies—particularly the university, municipality, and community authorities—were contacted prior to beginning the study to obtain the necessary ethical clearance. The findings of the study indicate that the lack of extension services, limited aware awareness and poor resources farmers' inability to effectively adapt to climate change.

Chapter 5: Discussion

5.1 Introduction

Chapter 5 provides a discussion of the study results presented in Chapter 4. It further addresses the study's objective by providing a critical analysis of the main constraints and opportunities surrounding the way climate change affects the livelihoods of small-scale farmers in rural Etete, KwaZulu-Natal, South Africa. An overview of the various adaptations made by small-scale farmers is provided in this chapter. The results of this study suggest that government policies should consider the challenges and opportunities faced by farmers. Climate change knowledge and awareness at the community, and policy levels must take precedence. Technological advancements such as rainwater harvesting techniques, which are proving to be more efficient for small-scale farmers, must support this. One important finding is that farmers' inability to effectively adapt to CC is exacerbated by the lack of assistance from extension officers. According to Ubisi (2016), a reason for the inability of extension officers to provide sufficient assistance may be attributed to inadequate funding for the agricultural department in South Africa. The aim of the study is to enable small-scale agricultural development and, as a result, contribute to the development of a rural area such as Etete, KwaZulu-Natal.

5.2 Small-scale farmers' understandings of climate change and its impact on their livelihoods in Etete, KwaZulu-Natal

The rainfall patterns in Etete, KwaZulu-Natal, have changed between 2010 and 2020, as discussed in Section 4.2. Small-scale farmers in Etete are aware that the climate is changing because of their experiences and interactions with other farmers. Farmers' perceptions of the effects of CC, which manifest as extreme weather events, are shaped by a complex interplay of internal and external factors. The 36% of participants who were not aware of CC risks and adaptation belonged to a younger age group between the ages of 24 and 34 years and of these participants, some had been farming for less than 5 years or they were more involved in off-farm activities so that they did not pay attention to their farm performance.

Most of the (64 %) farmers who were aware of CC were elderly and poor, and they did not specifically mention temperature as one of the changes in the weather patterns. Instead, they mentioned shorter droughts, unpredictable rainfall, and less precipitation. Age and education, as discussed in section 4.1, emerged as significant variables influencing farmers' understanding and conceptualization of climate change issues. Regarding climate change, younger farmers

with higher levels of education seem to place a higher value on "scientific" knowledge than older, more conservative farmers who place a higher value on "local/traditional" knowledge.

The coping and adaptation strategies of small-scale farmers are influenced by their awareness, resulting from education of the climate change threat. There are signs that access to primary and secondary education has improved (IDP KZN, 2015; StatsSA, 2015) somewhat in Etete over the past 15 years. However, participants in this study emphasized a lack of tertiary education facilities in the area. According to Vincente Vincente (2022), a variety of factors, including assistance from extension officers, investments in training, climate-resistant seeds, and farming equipment, determine the difficulties brought on by CC as well as the capacity to anticipate, endure, and recover from its effects. These results are similar to those reported by Amosi (2018), who found that many farmers in developing nations, including Tanzania, are unaware of macro and micro-climate change adaptation techniques. This researcher argued that small-scale farmers cannot effectively measure CC effects without having access to information and knowledge about CC adaptation. Similar to these findings is a study by Saruchera (2019), which found that farmers in Mphunga group village, Salima district, Malawi are unable to effectively adapt to the effects of climate change due to a lack of knowledge and information.

Most government initiatives aimed to address the issue of limited awareness and a lack of information about CC (KZN IDP, 2018). However, the South African government has not prioritized CC issues, so awareness raising has not been successful in Etete, KwaZulu-Natal, therefore lack of information on CC is still cited as a barrier to effective adaptation (Pillay, 2016; Ubisi, 2016). Most established plans, projects, policies, and strategies will remain unknown to key policy implementers without the political will and commitment of the government, resulting in neither change nor positive outcomes. (Saruchera, 2019). To enhance farmers' capacity to adapt to the effects of CC and enhance agricultural production, it is essential to raise awareness of adaptation measures (Amosi, 2018).

In conclusion, adequate CC knowledge and the availability of information on climate change conditions are essential because effective adaptation to the effects of climate change requires farmers to observe that the climate has indeed changed, to identify available useful adaptation strategies, and to apply those strategies. (Maddison 2006; Saruchera, 2019).

5.2.1 Budgetary constraints and lack of communication

It was reported that the limited budget of the local government made it difficult for efficient CC adaptation efforts (Alberts et al., 2019). Because experts at the district and ward levels have failed to train small-scale farmers on the technologies that could assist them in successfully addressing the impacts of climate change, this explains the low level of knowledge surrounding adaptation technologies that are available to them. As discussed in section 4.3, the response from participant A indicated that there are places to seek help, but this information is not properly communicated by extension officers to make farmers aware of these resources. There are no extension officers in Etete, and if a small-scale farmer needs advice, they will have to go into the neighboring town of Stanger (10 km) to seek help from the DARD offices. If communication were to be properly conducted, it needs to be advertised in public notices in media such as newspapers stating that the iLembe District offers extension services. Likewise, there can be an expansion of offices and availability of extension officers in various farming districts within iLembe to ensure accessibility of knowledge surrounding climate change, its effects on small-scale farmers and what farming options are available at that time to the farmers to improve and increase their farm outputs. The reason why communication is lacking may be due to limited accessibility and numbers of extension officers within the iLembe district that restrict their reach to farmers in areas such as Etete.

These results are comparable to those of a study carried out by Mburu (2015), who found that small-scale farmers in the Yatta District of Kenya faced significant difficulties adapting to the effects of climate change due to financial constraints. The belief that small-scale farmers cannot be trusted to receive loans stems from the fact that their production is unpredictable due to their reliance on rain-fed agriculture, which is also unpredictable, as well as the low price of their agricultural products, both of which combine to reduce their earning potential (Saruchera, 2019). Raghavendra et al. (2020) also stated that lower agricultural prices as a result of import competition increases CC risks for Indian farming communities. In addition, these findings are in line with what Antwi-Agyei et al. (2013) stated as obstacles to adaptation to climate change in sub-Saharan Africa, evidence from their study in northeast of Ghana, where a serious obstacle to effective climate change adaptation was also found to be a lack of financial resources. For the local municipality to fund farming projects, environmental experts must write a current, well-researched climate change proposal that describes practical option open to small-scale farmers designed to increase their farm outputs. Consequently, this will make it

possible for rural areas like Etete to effectively adjust to climate change, increase agricultural output, and attain personal financial as well as food security.

5.2.2 Inadequate inclusion of key policy stakeholder policy formulation processes

As discussed in section 4.8, lack of key policy stakeholders' participation and inclusion has limited awareness of CC-related policies and a sense of ownership of various government projects, which has led to poor implementation. This has led to a lack of awareness of CC-related policies and a lack of ownership of various government projects. In addition, available government policies may be out-of-date, not supported by current research evidence and may not take into account the needs and challenges of local, small-scale farmers. Such policies do not effectively address the needs of small-scale farmers who are directly and profoundly affected by such policies (Alberts *et al.,* 2019). Ampire et al.'s (2017) findings are consistent with this as significant institutional factor poses obstacles to Uganda's CC adaptation. According to these authors, it is difficult for the local population to effectively implement policies that are explained in a format that is not user-friendly for common citizens who are not scientists and are formulated with limited policy actors and scientific outputs. It is essential for key actors, such as small-scale farmers, to participate in the formulation of a governance response to CC in order to take into consideration the viewpoints of marginalized and vulnerable stakeholders.

Due to a top-down strategies implemented by government officials, opportunities, and implementation of strategies for small-scale farmers in South Africa are limited and ineffective. The implementation of this strategy is hierarchical - even though they do not have a complete understanding of how small-scale farmers in rural communities are actually impacted by climate change and so do not necessarily know what adjustment to climate change are required, those individuals at higher government levels are ill-advised in their deliberations on interventions and techniques that they believe will work for small-scale farmers (Adger et al., 2008; Baloyi, 2018). In some cases, local municipalities make plans regarding adaptation strategies to climate change without understanding the underlying factors that affect climate change and so such plans will not be effective or implementable by their farmers (Ubisi, 2016; Jacob, 2015). As a result, it is important to use a participatory strategy that includes small-scale farmers in formulating decisions and policies regarding climate change and determining the most appropriate responses to the effects of climate change. Because farmers are involved in decision-making and will prioritize the most pressing challenges they face, the most effective

strategy may be a bottom-up approach where farmers provide to policymakers the, literally, on-the-ground reality of challenges that they are facing (Tecklewold et al., 2013; Pillay, 2016).

In addition, local government funding for agricultural research should also be available (Pillay, 2016; Amosi, 2018). Research was conducted by Kalinda (2011) and Ubisi (2016) in rural Limpopo Province, South Africa, on the perceptions of the effects of CC on crop yields and household sustenance. According to these authors, CC negatively impacts the livelihoods of small-scale farmers as their crop yields suffer as a result of harsh climate conditions such as drought and irregular rainfall. The small-scale farmers in Limpopo Province were affected by poverty and malnutrition due to their reliance on rainfed agriculture and so they were forced to adjust to the situation by reducing their food intake by changing their diets, taking out loans, and relying on organizations for food aid. Because agriculture is their main source of income, this case highlighted the vulnerability of small-scale farmers to CC.

The shift toward agriculture as the primary source of income for small-scale farmers meant that adjusting to climate change was one of the most significant changes they experienced. Thus, climate change awareness campaigns that fundamentally relied on government officials for climate change data were compromised as such officials, regrettably, lacked the necessary knowledge of climate change to provide the necessary support structures and methods (Morton, 2007; Adger et al., 2013). As a result, small-scale farmers and government officials should strengthen their relationship and ensure that established adjustment strategies are supported and advocated to small-scale farmers so as to reduce their vulnerability to changing weather patterns. There are calls for local government officials to receive training in climate change and adjustment methods so that they can also communicate with farmers and present information to them in order to facilitate efficient adjustment and improve farmers' well-being (Goldblatt, 2010; Jacob, 2015). In order to overcome "the energy crisis" and the illiteracy problem related to climate change, nutrition-related policies and guidelines should be incorporated into climate change education programs (Amosi, 2018; Saruchera, 2019).

5.2.3 Lack of sufficient technical staff

As discussed in section 4.3.1 According to the findings of this study, the local municipality does not have adequate extension personnel to assist with the implementation of climate change adaptation strategies. The provision of extension services to small-scale farmers and their capacity to obtain climate change funds from donors were compromised in Etete by the absence of technical staff and the general technical inability to write factual, effective proposals

regarding climate change and its effects on small-scale farming. It was discovered that the iLembe District does not have many environmental offices, which makes it difficult for these offices to educate the district as a whole about strategies for coping with climate change. Antwi-Agyei et al.'s (2013) findings are similar to this, who stated that one of the primary obstacles in Sub-Saharan Africa was the fact that extension officers were overwhelmed by the sheer number of communities they served, making it nearly impossible to address the requirements of all farmers. In addition, these results are comparable to those of a different study by Ampaire et al. (2016), who stated that the government and its representatives lack the technical capacity to support climate change adaptation in Uganda. They stated that poor implementation of government plans and policies is the result of a lack of sufficient technical staff, making it challenging to translate government plans into effective action. Biagini et al 2014 reported that adaptation at the local level, obtaining international climate change funding, and local climate change initiatives were compromised due to public officers' lack of technical capacity. Similarly, in rural areas of South Africa like Etete, there is a lack of development in terms of providing small-scale farmers with assistance to develop their farming outputs and production. Small-scale farmers will eventually have to rely on their own awareness and knowledge to adapt to CC, which will not adequately prepare them for its negative effects. (Ubisi, 2016).

5.2.4 Lack of agricultural input, poor market, and irrigation infrastructure

As mentioned in section 4.2, Due to CC, farmers need to use a lot of agricultural inputs to harvest, use better seeds that adapt to the changing climate, and use pesticides or insecticides to avoid diseases brought on by climate change. A lack of agricultural inputs makes it hard for small-scale farmers to afford these inputs, and the availability of fake agricultural inputs makes them even more vulnerable to climate change. In addition to the high cost of production, low product prices discourage farmers from effectively adapting due to a lack of storage facilities, making it difficult for farmers to decide when and how much to sell. (Pillay 2016; Alberts *et al.*, 2019).

Antwi-Agyei et al. (2013) also considered these factors to be major constraints in most Sub-Saharan African countries. According to Komba and Muchapondwa (2015), farmers would prefer to use irrigation as their primary adaptation strategy in response to observed climate change, but financial constraints currently prevent them from doing so. During site observations it was noticed that land was not being used to its maximum potential. According to reports, small-scale farmers decided whether to decrease or increase the amount of land used

for cultivation in response to the effects that changes in climatic conditions would have on agricultural production. Numerous participants revealed that low-income farmers face difficulties adapting to the negative effects of CC because they lack high-quality agricultural inputs like drought-resistant seeds and high-quality fertilizers. According to the study, low-quality agricultural inputs prevent small-scale farmers in Etete from adapting to the negative effects of climate change. In addition, numerous Etete study participants confirmed that small-scale farmers cannot afford agricultural inputs and that, to make matters worse, there are also counterfeit inputs on the market, making them even more vulnerable to climate change. Additionally, many of the participants claimed that if given the chance, they would acquire the skills. Crop production is limited, particularly in small-scale irrigation systems, by farmers' lack of knowledge and skills.

5.3 Adaptation strategies to climate change

Small-scale farmers can effectively respond to CC if they are aware of the reality of long-term climate change and the potential harm to their livelihoods (Ubisi, 2016). Seasonality, wealth status, access to various forms of capital, knowledge, and skills, farming experience, social interactions with fellow farmers and experts, age, gender, and education levels all influence farmers' decisions to invest in adaptation and their options for coping and adapting (Vicente Vincente, 2021). Mixed cropping, a water harvesting plan, and altering plantation dates were among the climate change adaptation strategies in Etete that were discussed in section 4.5. According to Saruchera (2019), the less fortunate farmers are more likely to apply adaptive measures that are straightforward, simple to comprehend, and replicable.

As displayed in Figure 4.14, 38% of the farmers indicated that they depend on their neighbours or farmer for farmer counsel and help. Friends appear to also be behind these networks. It suggests that these communities have a very high level of social capital, and it is likely that, in difficult times, the community works together through the networks of family and friends to adapt. Sharing tools and transportation, among other things, and assisting one another in finding work are examples of the kinds of support that households offer to one another. These findings make it abundantly clear that there is a significant amount of social capital, which is frequently utilized to supplement or substitute for financial capital. The majority of the households in the Etete agreed that small-scale farming can help alleviate poverty; however, in order for small-scale farming to flourish, it is necessary to remove obstacles such as a lack of knowledge about climate change and restricted availability of extension officers (Saruchera,

2019).The literature supports the findings of the study that small scale farming can possibly reduce poverty however, there is a need to eliminate various constraints involving small-scale farming (Saruchera, 2019; Pillay, 2016; Ubisi, 2016).

Small-scale farmers lack knowledge about adaptation technologies because experts at the district and ward levels have failed to train them on the available technologies that could help them successfully address the impacts of climate change (such as the use of demonstration farms (Alberts et al., 2019). It was reported that limited local governmental budget and individual lack of capital were a constraint for effective CC adaptation activities. These results are in line with constraints indicated by Pillay (2016), who found that small-scale farmers in the KwaZulu-Natal communities of Khokhwane, Sizanenjana, and Richmond were unable to adapt to the effects of climate change because of financial constraints. Adding to this is the belief that farmers cannot be trusted to receive loans from financial institutions because their production is unpredictable due to their reliance on rain-fed agriculture and resulting low financial capability among small-scale farmers (Amosi, 2018). The following strategies were used by small-scale farmers to counteract the perceived adverse effects of climate change on agriculture:

- Planting crops that are drought resistant - the results shown in figure 4.14 indicate that some of the farmers who were interviewed planted drought-resistant crops like yam, herbs, and mielies in response to climate change, particularly involving insufficient and unreliable rainfall, and they used seeds that took a relatively short time to mature.
- Intercropping - during the transect walk, the researcher noticed that some farms only have one crop in a single plot. The study found that many small-scale farmers in Etete use this system to adjust to the effects of climate change.
- Crop rotation - during the transect walk and site observation, the researcher also noted that crop rotation farming helps some small-scale farmers adapt to climate change's effects on the spread of pests and diseases.

5.3.1 Planting drought-tolerant and early maturing crops

In the event of unreliable rainfall, a small-scale farmer who has experienced multiple droughts over a long period of time and anticipates droughts in the future may alter crop production practices to manage drought risks (Ubisi, 2016). Coping with the rainy season and selecting the type of crops are both appropriate climate change adaptation techniques. Crops that are

drought-tolerant can withstand conditions associated with low water levels and high temperatures while still retaining their aesthetic and functional qualities (Vincente-Vincente, 2022). A small number of the small-scale farmers who were interviewed said that as an alternative to spinach, which cannot withstand drought, they grow crops like mielies and yams that have these growth characteristics. Due to CC, farmers in Etete have modified the crops they produce. Participants revealed that in the last two decades, they grew more monsoon products such as tomato, eggplant, and beans. However, due to increased drought coupled with erratic rainfall, they now produce more cabbage and mealies, among others - crops that attain maturity within a short timeframe.

According to Mwakalila's (2010) study in Kilimanjaro, approximately 11% of farmers are adapting to short-season rains by using modern short-season seeds. However, the study also found that the majority of residents prefer to grow maize as their primary crop, which is susceptible to drought. This results in reduced production, and the drought-prone crops are only grown as they provide an alternative to seasonal hunger due to crop failure caused by insufficient rainfall. This indicates that small-scale farmers don't know how to increase agricultural production. Similarly, Komba and Mchapondwa (2015) found that farmers and/or households with higher levels of education tend to use drought-resistant crops more frequently. Due to a lack of knowledge as to how to effectively adapt to the effects of climate change, small-scale farmers grow maize, which is vulnerable to climate change, and they also grow cassava, millet, and sorghum as alternatives to ensure food availability. According to Kurukulasuriya and Mendelsohn (2006), a lack of awareness is to blame for small-scale farmers' poor crop selection. Given the unpredictability and variability of rainfall, crop selection is significant to small-scale farmers as they rely solely on agriculture that is fed by rain, and so inappropriate crop selection results in low production.

Farmers in Etete used to make money by selling the majority of their maize, so this will allow them to save maize for household consumption and provide them with an alternative cash crop. However, logistical issues impede these efforts; farmers in Etete reported that free drought-tolerant seeds are always distributed after the first rains, and there is a lack of ownership of the campaign. According to one extension officer, farmers who received free seeds used them in different ways; some ate or sold them; once they realize that there is a problem, they use deceptive methods to convince them that the seeds contain poisons, so when they eat or sell them to people, they could die.

5.3.2 Intercropping

As discussed in section 4.5, the farmers cultivate four distinct crops on a single plot of land based on which crop will perform best in each month and climate. It is a farming method in which farmers cultivate multiple crops in the same field. It is a tried-and-true risk management tactic that is primarily employed by farmers. If one crop fails, the family's needs will be met by the other. On the other hand, some experts think that intercropping is an old farming method and that the best farming method is monocropping, in which farmers grow one crop in a field. During the conversations with farmers on the transect walk, it was noted that farmers are aware of the advantages of combining crops, with many combining maize's, a cereal crop, with beans or groundnuts. Others combine sunflower with maize to meet two distinct requirements: sunflower for cash and maize for food.

The same findings were reported: farmers spread risks on the farm by cultivating a variety of crops (Saruchera, 2019; Alberts et al., 2019; Vincente Vincente, 2021). According to Shayo, (2006), it is common to find more than five different crops being grown in a piece of land in the common drought-prone areas. According to the findings, indigenous knowledge system-based climate change support and interventions should be taken into consideration to empower farmers with the capacity to overcome CC challenges. The interview results indicated that, 60% of participants said that their neighbour-neighbour support system was still working for them because it helped them understand weather and climate patterns and decide on crops and farming practices. It was discovered through observation that many of the neighbours and farmers who offer guidance to others are significantly older and have been farming for more than ten years. Small-scale farmers are aware that the climate is indeed changing because of these experiences and interactions with other farmers.

5.3.3 Irrigation

According to the information gathered from participants in Section 4.4, the irregular rainfall has made it difficult to obtain water as when the water from the tanks was finished, people in Etete had to walk approximately 5 kilometers to fill up with water from springs and other streams. From ethnographic observations many of the small-scale farmers rely on rain harvest tanks in the area. Figure 4.17 indicates the participants responses as to how they get their source of water for farmer. The majority (93%) of the participants indicated rain harvest as a source of water and 7% indicated tanks. The rainfall tanks in the study area are depicted in Figure 4.17. From the information gathered from participants, the irregular rainfall has made the

access to water difficult, with some stating that people in Etete had to walk approximately 5 km to fill water from springs and other streams when the water from the tanks are finished. Crop farmers need irrigation equipment, and vegetable farmers especially need it. Additionally, it was discovered that the farmers' productivity was hampered by a lack of cultivation infrastructure, such as ploughing implements and cultivation tools (Amosi, 2018).

According to Mwakalinga, (2010), poorly constructed and sporadic infrastructure is typical of traditional irrigation systems, which typically result in significant water losses and low crop productivity. According to the interviews, it was difficult to engage in irrigation activities due to a lack of irrigation infrastructure, and it was difficult to secure farms close to water sources. As a result, many farmers only use rain-fed agriculture. The findings of this study are similar to those of Ndaki (2014), who stated that many farmers in Tanzania depend on agriculture that is fed by rain, making them more susceptible to climate change (drought), changes in the weather, and especially uneven rainfall distribution, which results in low agricultural production. Increased production has been hampered significantly by an excessive reliance on rainfall. Komba and Mchapondwa (2015) say that irrigation is the most common way farmers would want to adapt to CC but they are currently limited by circumstances. Because water is a fundamental need, crop farmers need irrigation equipment for vegetable farming. It was discovered that the farmers' productivity was limited in Etete due to the absence of cultivation infrastructure, such as ploughing implements and cultivation tools.

5.4. Support systems to enable farmers in Etete to adapt to climate change.

As discussed in Section 4.6 the small-scale farmers in Etete are not in contact with a range of experts who interface with them to offer relief aid, community development and support services or to undertake research and provide assessments in the aftermath of floods and droughts. They were not aware that these services in the form of extension officers were available. However, when an interview was conducted with participant A from the DARD, it was noted that these services are free and offered in the area. But this was not communicated effectively. The FAO (2020) noted that assisting small-scale farmers can contribute to a nation's economic expansion and food security and the present study support this. This makes it abundantly clear that various forms of assistance are required for the success of small-scale farming. Market access is an aspect of this assistance. The G8 summit (2009) stated that small-scale farmers need better access to markets, and this suggests that small-scale farming can

reduce poverty if rural small-scale farmers are assisted in gaining access to dependable market outlets.

Low participation and a limited inclusion of key policy stakeholders have led to poor implementation due to a lack of awareness of climate change-related policies and a lack of ownership of various government projects. During COVID-19, it was discovered that not enough extension officers were available to assist in the implementation of the adaptation strategy (KZN IDP, 2021). Most of the policies examined were created in the 1990s and early 2000s, when the government did not pay much attention to the problem of climate change. For instance, the goal of agricultural policy is to create an efficient, profitable, and competitive agricultural industry that improves farmers' livelihoods, achieves broad-based economic growth, and reduces poverty (FAO, 2018). Additionally, climate change adaptation planning is not adequately incorporated into existing policies. In this regard, adaptation planning as well as a review and revision of those policies are required so that they can support small-scale farmers in effectively adapting to the effects of climate change and meet the requirements of addressing them (FAO. 2018; Amosi, 2018).

As it was indicated by the small-scale farmers in figure 4.11, there is a problem of rainfall variability in Etete. For example, extended periods of no rainfall or too much rainfall is among the major factors which pushes farmers towards making use of crop varieties and monoculture. Key participants who were interviewed expressed their desire for the government to develop a strategy that includes concrete actions to facilitate the implementation of the Climate Change Policy. This will enable the small-scale farmers to be self-sufficient and effectively adapt to climate change. The goal of the study was to find out if small-scale farmers were aware of climate change policies that could help them adapt. According to the study, both small-scale farmers and local government officials are unaware of climate change-related policies. Because awareness is related to the availability and accessibility of information that can trigger their perception of those policies, the lack of extension services for small scale farmers plays a significant role in their awareness of climate change-related policies (Alberts et al., 2019, Vincente Vincente, 2021).

The goal of the study was to find out if small-scale farmers were aware of climate change policies that could help them adapt. According to the study, both small-scale farmers and local government officials are unaware of climate change-related policies. Because awareness is related to the availability and accessibility of information that can trigger their perception of

those policies, the lack of extension services for small scale farmers plays a significant role in their lack of awareness of climate change-related policies. The findings indicate that climate change's ongoing effects directly disturb small-scale farmers, but they are unaware of climate change-related policies. The availability of the documents can be used to assess this - the government has failed to distribute policy documents to farmers in rural areas so they can be informed to climate change.

All the small-scale farmers who were questioned stated that they were unaware of any climate change policies that could assist them towards effectively adapting to CC. The farmers of Etete have been given a chance by climate change to switch their crops to mielies and yam, which will allow them to sell in the informal market for more money than when they were growing vegetables. According to the South African Department of Agriculture and Land Reform, South Africa produced just over 63,100 tons of yam in 2010, but in 2011, production output decreased by 11.7% compared to the 2010 season. In 2013, yam production output increased significantly by 205.5%, reaching a 10-year high. Production output increased by 20% in 2018 compared to the previous year (2016). South Africa's yam production output significantly increased in 2018 by 16.5% compared to 2017. South Africa’s yam production output grew by 2.7% during 2019 when compared to the previous year (2018) production output (Department of Agriculture and Land Reform, 2020).

The study also looked at participants' understanding of their livelihood assets and their relationship to an institutional framework of appropriateness training for adapting to climate change. Many of the study participants stated that they rely of other farmers for advice or help because they were unaware if government offered any help. However, as stated above, the participant from the KZN DARD responded that there is help but it not efficiently communicated to rural areas such as Etete, KwaZulu-Natal. Another opportunity that climate change provided was to help emphasize the importance of traditional knowledge systems, especially as some farmers were extremely knowledgeable on the types of crops to cultivate that would likely yield a good harvest.

As discussed in Section 4.3, some of the interviewed farmers had decided to change their farm size as well as harvesting system due to climate change. Small-scale farmers reported on their decision to either reduce or increase the size of land for cultivation. The limited scale ranchers need training in different areas of agriculture to increase their efficiency and take-home pay. This might include their accessing and securing marketing channels involving skills such as

marketing strategies to allow small-scale farmers to overcome obstacles and move toward commercial agriculture. The South African government needs to think about supporting policies and regulations that are necessary to encourage growth among emerging farmers for small-scale farmers to stand up to competition on a local and international scale. Small-scale farmers should be protected by the laws and policies enacted by the local government. Finally, the current research suggests that the government provide scheduled workshops to all farmers in order to provide them with marketing knowledge.

5.5 Constraints to climate adaptation

Because water is a necessary component of crop and livestock production, the FAO (2020) discovered that increasing access to water has an impact on agricultural productivity. Another issue facing farming in Etete was insufficient rainfall. As a result, households end up producing less food due to a lack of water in rural areas, which makes farming more difficult. Despite significant advancements since 1994, there is still much room for improvement. Most people in Etete rely on water tanks, even though most people have a variety of options for collecting water, as discussed in Section 4.3. According to the Department of Environmental Affairs and Tourism (DEAT, 2018), CC has and continues to alter the magnitude and distribution of weather events that result in prolonged droughts and flooding. Because they are directly dependent on the natural environment for support, particularly in rural areas, the population of South Africa is adversely affected by the impact of CC on sources of livelihood. Constant shifts in global, continental, and national climatic conditions will put sustainable livelihoods in predominantly rural provinces like KwaZulu-Natal in jeopardy, according to the KZN IDP (2020).

Due to CC, farmers must use a variety of agricultural inputs to harvest, use improved seeds that are more resistant to CC, and use pesticides or insecticides to avoid diseases brought on by climate change. A lack of agricultural inputs is to blame for the high cost of agricultural inputs for small-scale farmers, making them even more susceptible to climate change in Etete. According to the present study, both small-scale farmers and local government officials are unaware of climate change-related policies. Because awareness is related to the availability and accessibility of information that can trigger their perception of those policies, the lack of extension services for small scale farmers plays a significant role in their awareness of CC-related policies.

This shows that limited scale ranchers are upset by progressing impacts of changes in environment anyway they don't know about environmental change-related strategies. The availability of documents can be used to assess this but the government has failed to distribute policy documents to farmers in rural areas so they can be informed. All the small-scale farmers who were questioned stated that they were unaware of any climate change policies. These findings demonstrate that subsistence farmers were unable to access not only climate change interventions and support systems, but also agricultural support systems. This further indicated that the Department of Agriculture and the local farmers do not communicate effectively. The more senior officials are under the impression that the local farmers are aware of what resources are available to them but the results from the study area indicate otherwise. Participant H suggested that there should be more agricultural training, that young people should get involved in agricultural activities, and that the government should give the Etete residents more support by helping them get access to market outlets and improving the infrastructure.

The small-scale farmers in Etete suggested the following aspects of a policy to take into consideration:

- it ought to give the local government the authority to include the issue of climate change in their strategic plan and allocate funds for its implementation.
- it ought to specify concrete action plans that can be carried out.
- it ought to provide farmers, who make up the majority of the local community, with the ability to be empowered by securing an internal market for their products.
- it ought to establish a financial system in which farmers will have access to loans with low interest rates.
- it should develop the capacity of individuals who will effectively play a role in ensuring on the other hand, small-scale farmers were of the opinion that they should be involved in the process of formulating those policies.

5.6 Conclusion

According to the IPCC (2020), the evidence for global warming resulting from anthropogenic causes is unequivocal. Despite the challenges they face in earning a living and increasing poverty, small-scale farmers are looking into local strategies and building social networks to survive the negative effects of climate change. Small-scale farmers in rural Etete, KwaZulu-Natal, South Africa, were questioned in this study to find out how CC affects their ability to sustain their livelihoods. The inability of farmers to effectively adapt to CC is exacerbated by the lack of assistance from extension agents, which is a key finding. According to Ubisi (2016),

inadequate funding for the South African Department of Agriculture may be to blame for the extension officers' inability to provide sufficient assistance.

Farmers may have improved chances of securing their livelihoods and investing in CC adaptation thanks to the new land tenure systems (DARD, 2018), which have legally enhanced tenure security and empowered women. According to the study, water gathering techniques and the creation of small-scale irrigation systems should be added to rain-fed agriculture to allow small-scale farmers to irrigate their crops in the event of irregular and insufficient rainfall. The iLembe District Municipality should help the small-scale farmers who are struggling financially by organizing them into groups so that they can be considered for low-interest agricultural loans, which will help them cope with the effects of CC by using modern farming technology. Teaching small-scale farmers which crops to produce that uses less water could be a different approach. There is no question that the local infrastructure's upgrading will likely have a good effect on small-scale farming. The study revealed that the poor state of the roads made it extremely difficult to enter and exit Etete, especially in time where water trucks are needed. Poor access to market outlets within and outside of this area is made worse by this. This emphasizes the significance of improving the region's road conditions. The findings of the study indicate that the lack of extension services, limited aware awareness and poor resources is causing farmers' inability to effectively adapt to CC.

Chapter 6: Summary, recommendations, and conclusions

The goal of this study was to find out how small-scale farmers in the Etete area of KwaZulu-Natal Province perceive and respond to climate change and how it affects them and their food production. The following section provides a summary of the primary findings.

6.1 Summary of key findings

According to the small-scale farmers in Etete, KwaZulu-Natal, there are several factors that are hindering the effective adaptation by farmers to the effects of CC. These include a lack of agricultural inputs, poor infrastructure, inadequate human and financial resources, inadequate working facilities, inadequate inclusion of key policy stakeholders in the policy formulation process, limited awareness and lack of CC information, inadequate agricultural inputs, and political interference.

Small-scale farmers in Etete are unaware of CC-related policies, which reflects their:

- Inadequate participation in the policy-making process
- Inadequate provision of extension services
- Inadequate distribution of policy documents to lower-level government agencies, such as local governments.

The ability of small-scale farmers to effectively adapt to the effects of CC was said to be limited by the following elements:

- the absence of a CC policy to direct the activities for adaptation.
- a lack of irrigation infrastructure and a market.
- a lack of agricultural inputs.
- a lack of capital.
- a limited level of technological awareness regarding how to effectively adapt to CC.
- inadequate policies that address adaptation to CC and assist small-scale farmers in effectively coping with the negative effects of climate change.

Many of the people who took part in the survey said that they used to grow vegetables that needed a lot of water, such as spinach, beans, and tomatoes, but now they must grow alternatives that use less water, like mealies and yam.

6.2.1 Study conclusion 1

Study conclusion 1 addressed study objective 1 that was to determine the impacts of CC faced by small-scale farmers in Etete, KwaZulu-Natal.

In addressing this study objective, the following can be drawn from the outcomes of Chapter 4. According to the findings, crop yields in Etete have been decreasing over time. In previous years, many of the respondents experienced drought conditions that also reduced the quantity and quality of their crops. Some yields produced crops that were drier and smaller, lowering their food security status. As a result, many respondents have reported experiencing a food shortage at the end of the month. The length of this food shortage is around a week. Many respondents report experiencing food insecurity because of decreased rainfall and a lack of government involvement.

According to 64% of participants who practice small-scale farming stated that, the closest and most dependable network of support that they still had in place was neighbour-to-neighbour since it helped them understand weather and climatic patterns and make judgments regarding crops and farming methods. The findings suggest that to equip farmers with the skills they need to face the challenges of CC, it is necessary to consider the local indigenous knowledge system support and interventions. It was discovered through observation that many of the neighbours and farmers that offer guidance to each other are much older and have been farming for more than ten years. Due to these encounters, along with their interactions with other farmers, the small-scale farmers in Etete recognise that the climate is indeed changing.

The small-scale farmers in Etete, as mentioned in chapter 4.6, are not in touch with a variety of professionals who interact with them to offer humanitarian aid, community development, and extension support services, as well as to carry out research and provide evaluations in the wake of floods and droughts. They were unaware that extension officers, who provide these services, were available. However, it was discovered during an interview with participant A from the DARD as discussed in Section 4.6 that these services are available and free of charge in the neighbourhood. But the message wasn't delivered clearly.

The government's efforts to combat climate change through the establishment of extension officers have been constrained by a number of obstacles, which has resulted in the inefficient and haphazard implementation of strategies for adaptation (Pillay, 2016; Amosi 2018). Lack of financial and human resources, a lack of knowledge about climate change, a lack of agricultural inputs, a lack of irrigation infrastructure and a market, inadequate inclusion of key

policy implementation actors, and political interference were identified as obstacles to the implementation of effective adaptation strategies (Alberts et al.,2019). Most government initiatives around climate change aim to address the issue of poor CC-awareness and a lack of climate change information (KZN IDP, 2018). However, a lack of CC information is still cited as a barrier to effective adaptation efforts because the local iLembe municipality has not prioritized climate change issues. As a result, awareness raising has not been successful in Etete, KwaZulu-Natal. Without the political will or the commitment of the government, the majority of established plans, projects, policies, and strategies will remain unknown to key policy implementers, resulting in neither positive changes nor outcomes (Saruchera, 2019). Knowledge on adaptation techniques is significant for upgrading farmers capacity to adjust to impacts of climate change as well as working on farming opportunities.

Farmers must first observe that the climate has changed and then identify and implement effective adaptation strategies in order to successfully adapt to the effects of CC. Therefore, a sufficient comprehension of climate change and current conditions is required (Maddison, 2006; 2019, Saruchera). Asking small-scale farmers what they meant when they said "climate change," whether they had noticed changes in rainfall and temperature over the past ten years, and whether they believed these changes had an effect on their livelihoods, food production, and food security, were crucial to achieving this objective. According to Amosi (2018), the lack of awareness that small-scale farmers typically have regarding climate change-related policies leads to their ineffective implementation. This is because farmers do not perceive that the policies' formulation is beneficial to them. Low policy awareness is caused by key policy actors' insufficient participation in policy formulation and implementation. (Pillay, 2016; Ubisi, 2016).

Policies that help small-scale farmers effectively adapt to the negative effects of climate change and address adaptation to CC are inadequate (Vincente Vincente, 2021). The predicament becomes even more dire when one considers that small-scale farmers heavily rely on the climate to support themselves (Alberts et al.,2019). According to Amosi (2018) and Vincente-Vincente (2022), a variety of factors influence an individual's capacity to anticipate, endure, and recover from the effects and risks posed by climate change. These include having access to expert-provided advisory support services and technologies, socio-cognitive abilities, and material resources. "Relationships and collaborations between farmers and power structures, institutions, and other external contacts also influence their adaptive choice and capacity,"

states Berkhout (2012:101). Many small-scale farmers in Etete lacked formal education, and most respondents were female. Most farmers (64%) were aware of what climate change is and how it affects their farming activities. However, they were unaware of the interventions and support systems that could help them adapt to CC successfully.

The above conclusion supports the assertion that study objective 1 was suitably addressed in this study.

6.2.2 Study conclusion

Conclusion 2 relates to study objective 2, assess the perceptions about the availability and accessibility of climate change related interventions and support systems amongst small scale farmers' in Etete, KwaZulu-Natal.

This objective involved an investigation as to whether small-scale farmers in Etete use any climate change adaptation techniques. Traditional knowledge is a large part of the mitigation and adaptation strategies used by small-scale farmers. Participant H proposed that additional government support should be provided through various interventions, such as upgrading infrastructure and assisting the population of Etete in gaining access to market outlets, as well as increased agricultural training and youth participation in agricultural operations. The following suggestions were made for the local policy to take into consideration: it should give the local government the authority to include the issue of climate change in their strategic plan and allocate funds for its implementation; it should specify concrete action plans that can be carried out; it should establish an efficient method of communication; and it should primarily empower the local community. Small-scale farmers, on the other hand, believed they ought to participate in the process of formulating those policies. To empower them to effectively adapt to the effects of climate change, they recommended that the policies reflect their needs and environment. Additionally, they recommended that the policies be distributed through their village assemblies and written in a manner that is friendly and easy for them to understand.

The small-scale farmers in Etete suggested the following aspects of a policy to take into consideration:

- it ought to give the local government the authority to include the issue of CC in their strategic plan and allocate funds for its implementation.
- it ought to specify concrete action plans that can be carried out.

- it ought to provide farmers, who make up the majority of the local community, with the ability to be empowered by securing an internal market for their products.
- it ought to establish a financial system in which farmers will have access to loans with low interest rates.
- it should develop the capacity of individuals who will effectively play a role in ensuring on the other hand, small-scale farmers were of the opinion that they should be involved in the process of formulating those policies.

The above conclusion supports the assertion that study objective 2 was suitably addressed in this study.

6.2.3 Conclusion 3

Study conclusion 3 relates to study objective 3 that is to determine the small-scale farmers CC adaptation strategies and what informs them.

This objective was derived to investigate what techniques are undertaken by small-scale farmers in Etete, KwaZulu-Natal.

According to the findings in section 4.6 and as stated by the FAO (2020), assisting small-scale farmers can boost an economy and increase food security in a nation. Supporting small-scale farming can contribute to lowering poverty. This demonstrates unequivocally that small-scale farming needs various forms of assistance to succeed. Accessing markets should be one of the services offered. Small-scale farmers require better access to markets, as noted by the G8 Summit in 2009. This suggests that small-scale farming can reduce poverty if rural small-scale farmers are encouraged to be more self-sufficient. Experts at the district and ward level have failed to train small-scale farmers on the available technologies that could help them to successfully address CC impacts (such as the use of demonstration farms), which accounts for the low level of knowledge surrounding adaptation technologies among small-scale farmers. It was reported that limited local governmental budget and individual lack of capital were a constraint for effective climate change adaptation activities.

These results are in line with constraints indicated by Pillay (2016), who found that small-scale farmers in the KwaZulu-Natal communities of Khokhwane, Sizanenjana, and Richmond were unable to adapt to the effects of CC because of financial constraints. Adding to this is the belief that farmers cannot be trusted to receive loans from financial institutions because their production is unpredictable due to their reliance on rain-fed agriculture and resulting low

financial capability among small-scale farmers (Amosi, 2018). The following strategies were used by small-scale farmers to counteract the perceived adverse effects of CC on agriculture:

• Planting crops that are drought resistant - the results shown in figure 4.14 indicate that some of the farmers who were interviewed planted drought-resistant crops like yam, herbs, and mielies in response to CC, particularly involving insufficient and unreliable rainfall, and they used seeds that took a relatively short time to mature.

• Intercropping - during the transect walk, the researcher noticed that some farms only have one crop in a single plot. The study found that many small-scale farmers in Etete use this system to adjust to the effects of CC.

• Crop rotation - during the transect walk and site observation, the researcher also noted that crop rotation farming helps some small-scale farmers adapt to CC effects on the spread of pests and diseases.

The above conclusion supports the assertion that study objective 2 was suitably addressed in this study.

6.3 Key Recommendations

6.3.1 Improving water supply.

According to the study, water gathering techniques and the creation of small-scale irrigation systems should be added to rain-fed agriculture to allow small-scale farmers to irrigate their crops in the event of irregular and insufficient rainfall. The iLembe District Municipality should help the small-scale farmers who are struggling financially by organizing them into groups so that they can be considered for low-interest agricultural loans, which will help them cope with the effects of CC by using modern farming technology. Teaching small-scale farmers which crops to produce that uses less water could be a different approach. There is no question that the local infrastructure's upgrading will likely have a good effect on small-scale farming. The study revealed that the poor state of the roads made it extremely difficult to enter and exit Etete, especially in time where water trucks are needed. Poor access to market outlets within and outside of this area is made worse by this. This emphasizes the significance of improving the region's road conditions.

6.3.2 Employing more extension officers.

In addition to advising small-scale farmers on how to effectively adapt to CC, the Ministry of Agriculture should make sure that extension officers provide the appropriate quantity of required subsidized inputs at the appropriate time to alleviate the issue. Because there are no extension officers in Etete, small-scale farmers will have to travel 10 kilometres to the DARD offices in Stanger for assistance. Public notices in the newspaper announcing that the iLembe District provides extension services are necessary for effective communication. To ensure accessibility, modular extension offices could also be stationed in various iLembe farming districts. Accessibility issues and the inability of extension officers in the iLembe district to reach areas like Etete may be to blame for the lack of communication.

6.3.4 Policy formulation

Insufficient policy actors, limited policy awareness and ownership, financial constraints, insufficient human resources, inadequate working facilities, and political interference all contributed to the ineffective implementation of climate change-related policies. A national climate change policy should be developed by the government to make it easier for development stakeholders to plan and carry out adaptation measures that help small-scale farmers adapt to the effects of climate change. The formulation process ought to make sure that all the key stakeholders in the policy are involved to accommodate the viewpoints and opinions of various groups and to foster a sense of ownership. This will ensure that the policy is effectively implemented. Through the creation of partnerships, programs, and initiatives, this can be accomplished. In 2014, van der Byl stated that “The potential to transform rural areas can be realized through partnership.” Policy documents should be written in a way that is friendly to the non-scientific community and sent to lower governmental agencies that local communities can access by the government. This will ensure that those policies are easily accessible and will educate local communities about them, making it simpler to implement those policies. Furthermore, the public authority should give responsibility in open workplaces and execute the decentralization arrangements practically speaking to gather information on political obstruction to guarantee that strategy is successfully carried out. In addition, the government needs to set aside money for CC adaptation efforts, make investments in the training of staff members who will be able to carry out implementation efforts, and train staff members who will be able to write technical proposals to secure funding from international donors.

6.4 Final comments

This study demonstrated that small-scale agriculture in Etete could be divided into two categories: subsistence farmers who produced for household consumption and rarely sold; than those who farmed not only for their own consumption but also for the sale of surplus produce. On the other hand, most small-scale farmers were unaware of CC or the available interventions. Subsistence farmers, particularly women, were found to be most vulnerable to CC due to their extreme reliance on rainfall and lack of adaptability. The farmers also lacked access to extension services and fundamental farm inputs. The small-scale farmers were impacted by prolonged droughts, decreased precipitation, and soil erosion. Most small-scale farmers in Etete relied on their indigenous knowledge for their farming practices to mitigate these effects due to a lack of climate information. Additionally, it was observed that some farmers, particularly food producers, were making progress toward adaptation by adopting mixed cropping, intercropping, and crop diversification, as well as altering their planting dates. However, due to a general lack of knowledge, expertise, and information regarding climate change issues, many farmers, primarily subsistence farmers, have not adapted. It is necessary to raise awareness of the consequences of CC and to take into consideration indigenous knowledge system-based CC support systems and interventions to empower farmers to overcome obstacles. This will enable small-scale farmers to effectively adapt to climate change.

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Appendix A - Letter of consent

A Climate Change and Sustainable Livelihood Analysis of Small-Scale Farmers in Rural Etete, KwaZulu-Natal, South Africa.

You are requested to participate in a research study conducted by Vikasa Chetti, who is studying towards a Master's degree in Environmental management at the University of South Africa. The aim of this research is to critically analyze and determine the main constraints and opportunities on how climate change and sustainable livelihoods affect small-scale farmers in rural Etete, KwaZulu-Natal, South Africa.

Your participation would be extremely beneficial to this study and is completely voluntary. If you do wish to participate, it will involve the answering of a questionnaire survey which consists of open and closed ended questions regarding the research at hand.

The questionnaire will take approximately an hour to complete. There are no known hazards and discomfort associated with this research. However, if at any point during the interview you feel uncomfortable you may withdraw from the study. In addition, your responses will be kept confidential, and a pseudonym can be used, to protect you.

Information and responses will be collected using an audio recording device with your permission. The data and information that is collected from this study will be used for the sole purpose of this research and will thereafter be disposed of in the correct manner.

Please note that your participation in this study is completely voluntary and there is no payment or incentives will be rewarded for participation.

For any further questions or queries, please contact:

Professor Llewellyn Leonard :	011 471 2311 *Or* 079 244 2087 llewel@unisa.ac.za
Vikasa Chetti (Researcher):	081 411 8645 *Or* 032 5522 310 Vikasa.chetti11@gmail.com
Dr. Eromose Ebhuoma :	Eromose2012@gmail.com

I……(full name), hereby confirm that I fully understand the nature of this project, and the content of this research project. I consent to participate in this research project. I understand that I am at liberty to withdraw form this study at any point during the survey questionnaire.

Participant signature_____

Date_____

Appendix B - Participant consent form

UNISA university of south africa

PARTICIPANT INFORMATION SHEET

Ethics clearance reference number:
Research permission reference number:

January 13, 2020

Title: Small- Scale farmers perception and adaptation to climate change interventions and sustainable livelihoods in Rural Etete, KwaZulu-Natal, South Africa.

Dear Prospective Participant.

My name is Vikasa Chetti and I will be undertaking a research study under the supervision of Professor L Leonard and Dr. Eromose Ebhuoma in the Department of Agriculture and Environmental Sciences. My research is towards a MSc Degree in Environmental Management at the University of South Africa. We are inviting you to participate in a study entitled Small-Scale farmers perception and adaptation to climate change interventions and sustainable livelihoods in Rural Etete, KwaZulu-Natal, South Africa.

WHAT IS THE PURPOSE OF THE STUDY?

- The aim of this research is to critically analyze and determine the main constraints and opportunities on how climate change and sustainable livelihoods affect small-scale farmers in rural Etete, KwaZulu-Natal, South Africa.
- To identify what systems and government interventions impact the livelihoods in rural Etete, how are farmers utilizing them and acknowledging the data, advice and support they have been offered such as extension services, farm support programmes for local farmers such as the BEEE (black farmers empowerment programmes).
- To analyze CSA adaptation techniques used by small scale farmers.
- To establish the constraints or factors undermining the ability of small-scale farmers to adjust to climate change.
- To establish the factors that influence small-scale farmers' adaptation choices in rural Etete, KwaZulu-Natal.

/

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WHY AM I BEING INVITED TO PARTICIPATE?

You have been invited to participant in this study due to the geographic proximity of the town to the researcher. In developing countries, particularly in the agrarian areas in which small-scale agriculture constitutes the direct source of sustaining a livelihood for most households, the high temperatures have adversely compromised agricultural activities. The overwhelming dependence on small-scale agriculture in rural areas such as Etete, KwaZulu-Natal is due to increased poverty and lack of job opportunities (Tshuma, 2014; IPCC, 2011; Duba, 2009), therefore highlighting the significance of small-scale agriculture in rural spaces. By focusing on rural Etete, KwaZulu-Natal, South Africa, this study aims to establish the constraints that limit small-scale farmers from adapting effectively to climate change.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

This study involves questionnaires and a semi-structured interview which encompass questions pertaining to participants perspectives on how small-scale farming and climate change affect the livelihoods of participants. This questionnaire will take an approximately 20 minutes to complete. The interview will take approximately 15 minutes to complete.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participation is voluntary and there is no penalty or loss of benefit for non-participation. You are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. It will not be possible to withdraw once you have submitted the questionnaire anonymously.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

Should the participants perspectives on the benefits and challenges of small-scale farming be identified, the research participants will be able to clearly delineate the aforementioned to improve sustainable livelihoods.

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ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

The data collection will be undertaken by the researcher and two field workers. The field workers in this study reside in Etete, KwaZulu-Natal (They assisted the researcher in a prior study in the area). The field workers will assist by filling out the questionnaires on behalf of participants. This will maintain COVID-19 protocols and there will not be any physical contact with participants. Interviews will be done by the researcher and the interviews will be recorded. The researcher will arrange interviews will potential interviewees either face-to-face or telephonic – depending on preference of the informant. Due to the current pandemic, informants may be more comfortable with telephonic interviews. Telephonic interview will be recorded to gather the level of details needed by the researcher for data analysis and the use of potential informant quotations in the results. If there are face-to face interviews, risks will be mitigated by the adherence to social distancing, utilization of masks, sanitizers, and glove.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Your name will not be reordered anywhere and no one, apart from the researcher will know about your involvement in this research. Your answers will be given a code number, or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard maintained by the researcher. For future research or academic purposes, electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. Information will be destroyed if necessary, hard copies will be shredded and electronic copies will be permanently deleted from the hard drive of the computer using a relevant software program.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

No payments will be made to participants.

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HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Health Research Ethics Committee of the College of Agriculture and Environmental Sciences, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Vikasa Chetti on 081 411 8645. Should you have concerns about the way in which the research has been conducted, you may contact Professor L Leonard on 011 471 2311, or llewel@unisa.ac.za. Contact the research ethics chairperson of the CAES General Ethics Review Committee, Prof EL Kempen on 011-471-2241 or kempeel@unisa.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.

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081 411 8645

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CONSENT TO PARTICIPATE IN THIS STUDY

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits, and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

Participant Name & Surname…… (please print)

Participant Signature……Date……

Researcher's Name & Surname……(please print)

Researcher's signature……Date……

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Appendix C - Field worker consent form

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FIELD WORKER INFORMATION SHEET

Ethics clearance reference number:
Research permission reference number:

January 13, 2020

Title: Small- Scale farmers perception and adaptation to climate change interventions and sustainable livelihoods in Rural Etete, KwaZulu-Natal, South Africa.

Dear Prospective Participant.

My name is Vikasa Chetti and I will be undertaking a research study under the supervision of Professor L Leonard and Dr. Eromose Ebhuoma in the Department of Agriculture and Environmental Sciences. My research is towards a MSc Degree in Environmental Management at the University of South Africa. We are inviting you to participate in a study entitled Small-Scale farmers perception and adaptation to climate change interventions and sustainable livelihoods in Rural Etete, KwaZulu-Natal, South Africa.

WHAT IS THE PURPOSE OF THE STUDY?

- The aim of this research is to critically analyze and determine the main constraints and opportunities on how climate change and sustainable livelihoods affect small-scale farmers in rural Etete, KwaZulu-Natal, South Africa.
- To identify what systems and government interventions impact the livelihoods in rural Etete, how are farmers utilizing them and acknowledging the data, advice and support they have been offered such as extension services, farm support programmes for local farmers such as the BEEE (black farmers empowerment programmes).
- To analyze CSA adaptation techniques used by small scale farmers.
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WHY AM I BEING INVITED TO PARTICIPATE?

You have been invited to assist in this study due to the geographic proximity of the town to the researcher. In developing countries, particularly in the agrarian areas in which small-scale agriculture constitutes the direct source of sustaining a livelihood for most households, the high temperatures have adversely compromised agricultural activities. The overwhelming dependence on small-scale agriculture in rural areas such as Etete, KwaZulu-Natal is due to increased poverty and lack of job opportunities (Tshuma, 2014; IPCC, 2011; Duba, 2009), therefore highlighting the significance of small-scale agriculture in rural spaces. By focusing on rural Etete, KwaZulu-Natal, South Africa, this study aims to establish the constraints that limit small-scale farmers from adapting effectively to climate change.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

This study involves survey questionnaires and semi- structured interviews which encompass questions pertaining to employees' perspectives on how small-scale farming and climate change affect the livelihoods of participants. You will be assisting towards filling out the questionnaires on behalf of participants and assisting in site photography. This questionnaire will take an approximately 20 minutes to complete. The semi-structured interview will take approximately 15 minutes to complete.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

You will be remunerated for your assistance in the study. You are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

You will be remunerated for your assistance in the study.

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ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

The data collection will be undertaken by the researcher and two field workers. The field workers in this study reside in Etete, KwaZulu-Natal (They assisted the researcher in a prior study in the area). The field workers will assist by filling out the questionnaires on behalf of participants. This will maintain COVID-19 protocols and there will not be any physical contact with participants. Interviews will be done by the researcher and the interviews will be recorded. The researcher will arrange interviews will potential interviewees either face-to-face or telephonic – depending on preference of the informant. Due to the current pandemic, informants may be more comfortable with telephonic interviews. Telephonic interview will be recorded to gather the level of details needed by the researcher for data analysis and the use of potential informant quotations in the results. If there are face-to face interviews, risks will be mitigated by the adherence to social distancing, utilization of masks, sanitizers, and glove.

CONFIDENTIALITY OF DATA?

You will be required to sign an agreement to keep all data collected on site confidential. No data is permitted to be shared with third parties without consent of the main researcher.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard maintained by the researcher. For future research or academic purposes, electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. Information will be destroyed if necessary, hard copies will be shredded and electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software program.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

You will be remunerated for your assistance in the study.

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HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Vikasa Chetti on 081 411 8645. Should you have concerns about the way in which the research has been conducted, you may contact Professor L Leonard on 011 471 2311, or llewel@unisa.ac.za. Contact the research ethics chairperson of the CAES General Ethics Review Committee, Prof EL Kempen on 011-471-2241 or kempeel@unisa.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.

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CONSENT TO PARTICIPATE IN THIS STUDY

I, _____ (field worker's name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that I will be remunerated for my assistance in the study. I am also aware that I have signed a confidentiality agreement and will not share any data obtained on site to any third-party personnel or organizations.

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

Field Worker Name & Surname…… (please print)

Field Worker Signature……Date……

Researcher's Name & Surname……(please print)

Researcher's signature……Date……

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Appendix D - Survey questionnaire

Name of Interviewer : .....

Date : .....

Province : .....

Municipality : .....

Farm/Village name : .....

Contact details : .....

All the data indicated here will be treated as STRICTLY CONFIDENTIAL. Data gathered by this tool shall be used solely for the purpose of this intended evaluation and nothing else. Personal details and socio-economic details of respondents shall be kept confidential and no mention of names shall be made in the final report that shall be compiled.

For purposes of record, it is hereby required that consent is given by means of signing the declaration below by the respondent prior to the beginning of the application of the application.

I..... (Surname & Initials) hereby declare that I understand the purpose of the interview and grant the permission for it to be conducted with me as a respondent.

Signature .....Date .....

Section A: Socio-economic demographics

1. Gender

0-Male	1- Female

2. Age:

3. Marital Status

0=Single	1=Married	2=Widowed	3=Divorced

4. Are you the household head?

0=Yes	1=No

5. Level of education

0=No Formal education	1=Primary	2=Secondary	3=Tertiary

6. Are you still in good health?

0=Yes	1=No

7. Total household income per month

0=Below R800	1=R801 – R1500	2=R1501-R3500	3=Above R3500

8. Which of the income sources is the major source of income

0=Pension	1=Farming	2=Part-time job	3=Full-time job	4=Remittances	5=Social grant

9. Do you belong to any social network?

0=Yes	1=No

10. Which social networks do you use more frequently?

0= Facebook	1= Twitter	2= WhatsApp	3= Other

11. Do you belong to any social group/s?

0=Yes	1=No

12. If yes name them.....

13. Means of land ownership

0=Allocated(communal)	1=Inherited	2=Borrowed	3=Rental	4=Bought

14. How long have you been farming?

0=Less than 5yrs	1=6 to 10years	2=11 to 20years	3=Over 20 years

15. What is the total hectare of your land?

0= Less than 1 ha	1= greater than 1 and less 2.5ha	2= Greater than 2.5

16. Size of the land usually cultivated?

0= Quarter of the land	1= Half of the land	2= Total area

17. How do you perceive your land's fertility?

0= Very fertile	1= Fertile	2= Infertile	3= Don't know

18. What is the location of your land?

0= Upper land	1= Low land	2= Plain	3= River valley

19. What is the land used for in the previous year?

0= Cropped	1= Grazing	2= Fallow	3= Other

20. What is the farm produce used for from your land?

0= Home consumption	1= Sales	2= Animal feed

21. What proportion of the produce is consumed by household?

0= Quarter of produce	1= Half of the produce	2=All of the produce

22. What is the estimated proportion of produce sold?

0= Quarter of produce	1= Half of the produce	2=Sell everything	3= Don't sell

23. To whom do you sell?

0= Local People	1= Agent	2= Commercial Market	3=Other

24. If other specify .....

25. What crops do you grow at present? (Rank levels of crops grown in the second column – 1 for mostly grown crop)

Crop	Rank

How do you select the crop(s) to grow?

	Reason	Rank
1	Early maturity	
2	Resistance to disease	
3	Resistance to drought	
4	High yield potential	
5	Easy market access	
6	Easy management of crop	
7	Human consumption	
8	Other	

26. Who mainly influences your crop selection?

0= Extension officers advise	1= Farmer to farmer advise	2= NGOs advises	3= Myself	4= Indigenous Knowledge	5=Other specify

27. What is your source of water for crop irrigation?

0= Rain-fed	1= Tanks	2= Tap	3= Rain harvest	4= River	5= Dam

28. Have you ever heard about climate change?

0=Yes	1=No

30. What is your most reliable source of information on climate change?

0=Radio	1=Internet	2=TV	3=Farmer to Farmer	4=Family member	5=Extension officers	6= Other

31. What major changes in weather have you observed in your community over the last 10 years?

0= Floods	1= prolonged droughts	2= very hot seasons	3= very wet seasons	4= Unpredictable rainfall patterns	5=haven't observed any changes

32. If it's a combination, please specify.....

33. What is the main impact of these changes on the local community?

0= Crop failure	1= Infrastructure	2= Livestock deaths	3= Human disease outbreak	4= Food insecurity	5= Other

34. Have you experienced low crop yields over the past 10 years?

0=Yes	1=No

35. How severe has the loss been over the past 10 years?

0= Very severe	1= Moderately severe	2= Not severe

36. At what stages do you usually lose your crops?

0= Germination stage	1= Vegetation stage	2= Reproduction stage	3=Seed formation stage

37. What do you think are the causes of the yield decline?

0=Natural causes (droughts, hails, floods)	1= Pest damage	2=Disease outbreak	3= Lack of farm inputs	4= Lack of water

38. If it's a combination, please specify the causes.....

39. What support systems have you used to cope with the challenge and who provides them?

_____

_____

_____

40. Have you been trained on climate change interventions?

0=Yes	1=No

41. Are there institutions/organisations that are working with you to provide climate change support?

0=Yes	1=No

42. If Yes please provide the institutions/organisations names and support they provide.

Institutions/organisations	Support provided

43. Tick the most reliable institution/organisations that provides climate change support?

0=Extension officers	1=Farmer organisations	2=Social groups	3=NGOs	4=Family member	5=Media

44. Extension officers are knowledgeable about climate change support interventions

0=strongly agree	1=agree	2=neutral	3=disagree	4=strongly disagree

45. Extension officers are resourceful with climate change support interventions

0=strongly agree	1=agree	2=neutral	3=disagree	4=strongly disagree

46. Do you have any insurance protection against floods?

0=Yes	1=No

47. Do you have any insurance protection against hot temperatures warning?

0=Yes	1=No

48. If you do not have any insurance protection how do you usually cope?

_____

_____

_____

_____

49. Have you ever experience shortages of agricultural-based food items at your household?

0=Yes	1=No

50. If yes, what were the reasons for the food shortages?

0= Price increase	1= Droughts	2=Floods	3= Lack of farm inputs

51. Which months did you experience shortages of agricultural-based foods the most?

0= Dec-Feb	1= March-May	2= June-Aug	3= Sep-Nov

52. How did you cope with these shortages?

0= Eat less food	1= Change diet	2= Borrowed money	3=Received food from relatives	4= Sent older children away to work

53. Have you made any adjustment in your farming practices to climate change?

0=Yes	1=No

54. What adaptation measures have you used to deal with the changes in temperatures?

0=Crop and variety diversification	1=Changing dates of planting	2=Build water harvest scheme	3= Mixed Cropping	4= Other

55. What made you choose the adaptation measures that you selected above?

_____
_____
_____

56. Any other specify

_____

57. What adaptation measures have you used to deal with the changes in rainfall?

0=Crop and variety diversification	1=Changing dates of planting	2=Build water harvest scheme	3= Intercropping

58. What made you choose the adaptation measures that you selected above?

_____
_____
_____

59. If you did not adapt what made you not to adopt adaptation measures?

0=Lack of information	1= Lack of inputs	2=Drought/Water shortage	3=Do not see the need	4=Poor health

60.Was the weather forecast used as a measure to determine when to begin plantation and the what type and quantity of food to produce.

_____
_____
_____

61. How do you feel about dealing with climate change challenges?

0= Fearful/afraid	1= Helpless	2= Assumed	3= Powerless	4= Encouraged

62. Can further explain your choice of answer?

_____
_____
_____
_____
_____

Appendix E - Site observation

Site 1

Elements under observation	Observations
Farming system	Good Farming System
Crop management system	Poor
Soil type	Good/ Fertile soil
Farm size	Relatively good size for household farming
Crops planted	Good but more household crops can be added.
Access to agricultural–based resources	Scale: Poor ✖ Bad Good

Site 2

Elements under observation	Observations
Farming system	Poor Farming System
Crop management system	Poor
Soil type	Good/ Fertile soil.
Farm size	Adequate Farm size.
Crops planted	Land not used to full potential.
Access to agricultural–based resources	Scale: Poor ✖ Bad Good

Site 3

Elements under observation	Observations
Farming system	Good Farming System.
Crop management system	Good
Soil type	Good/ Fertile soil.
Farm size	Adequate Farm size.
Crops planted	A variety of crops planted (Mielies, pepper, Sweet potatoes)
Access to agricultural–based resources	Scale: Poor ✖ Bad Good

Site 4

Elements under observation	Observations
Farming system	Poor Farming System
Crop management system	Poor
Soil type	Good/ Fertile soil.
Farm size	Adequate Farm size.
Crops planted	Land not used to full potential.
Access to agricultural–based resources	Scale: Poor ✖ Bad Good

Site 5

Elements under observation	Observations
Farming system	Good Farming System
Crop management system	Adequate
Soil type	Good/ Fertile soil.
Farm size	Adequate Farm size.
Crops planted	Land not used to full potential.
Access to agricultural–based resources	Scale: Poor ✖ Bad Good

Site 6

Elements under observation	Observations
Farming system	Good Farming System
Crop management system	Adequate
Soil type	Good/ Fertile soil.
Farm size	Adequate Farm size.
Crops planted	Land not used to full potential.
Access to agricultural–based resources	Scale: Poor ✖ Bad Good

Appendix F - Semi-structured interview

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SEMI-STRUCTURED INTERVIEW

Section A: General Livelihood Background Information

1. What is your relationship with the farmers, and for how long has this been going?

2. What type of support aid do you receive with regards to your farming structure?

3. What are the most pressing livelihood issues for the local community?

4. What is important to know about the local people, their general environment, and livelihoods?

5. What is being done, and by who, to address the pressing issues faced by the local community/famers?

6. Who advises farmers on which crops and varieties to grow, and when in the year they should do so?

Section B: Livelihood Analysis and Agricultural Markets

7. What are the local community's livelihood priorities, aspirations, and livelihood strategies?

8. What markets are important for the livelihoods of the community?

9. What happens to the excess agricultural household commodities? Where are the constraints if excess household produce needs to be sold to make a living?

Section C: Policy and Sustainable Livelihoods Issues

10. Are you aware of any measures (structures, processes & resources) and procedures that are in place to implement the policies?

11. In what form (or shape) do the above institutions and organizations (such as workshops and BEE programmes) exist at the local level?

12. What resources (local programmes/sources) are the community dependent on to sustain a living? How effectively/reliable is it?

Section D: Governance Issues

13. What suit of basic services are communities entitled to from the local municipality and government departments? What services are they receiving?

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14. How effective and responsive is the iLembe District Municipality in providing community services and facilitation in a coordinated and accountable manner?

15. How actively and effectively are local communities involved in planning and managing their own development (e.g., access to inputs and basic services; fair prices and marketing of produce; village development action plans, village environmental action plans)?

Section E: Climate Change Awareness

16. What is your assessment of the farmers' understanding of climate change? How are they interpreting it? What is the evidence of climate change in their context?

17. What are some of the impacts of climate change in Etete, KwaZulu-Natal?

18. What adaptation strategies are farmers adopting and using in responding to climate change impacts?

19. What informs these strategies? How effective are they? How do you determine their effectiveness?

20. What are the existing social groups, networks, clubs/associations, and organizations (formal and informal) that farmers belong to in Etete, KwaZulu-Natal?

21. E10. What other programs and initiatives (e.g., farm radio/TV programs, print media, BEE programmes) are helping the farmers to understand and deal with climate change issues effectively in Etete, KwaZulu-Natal?

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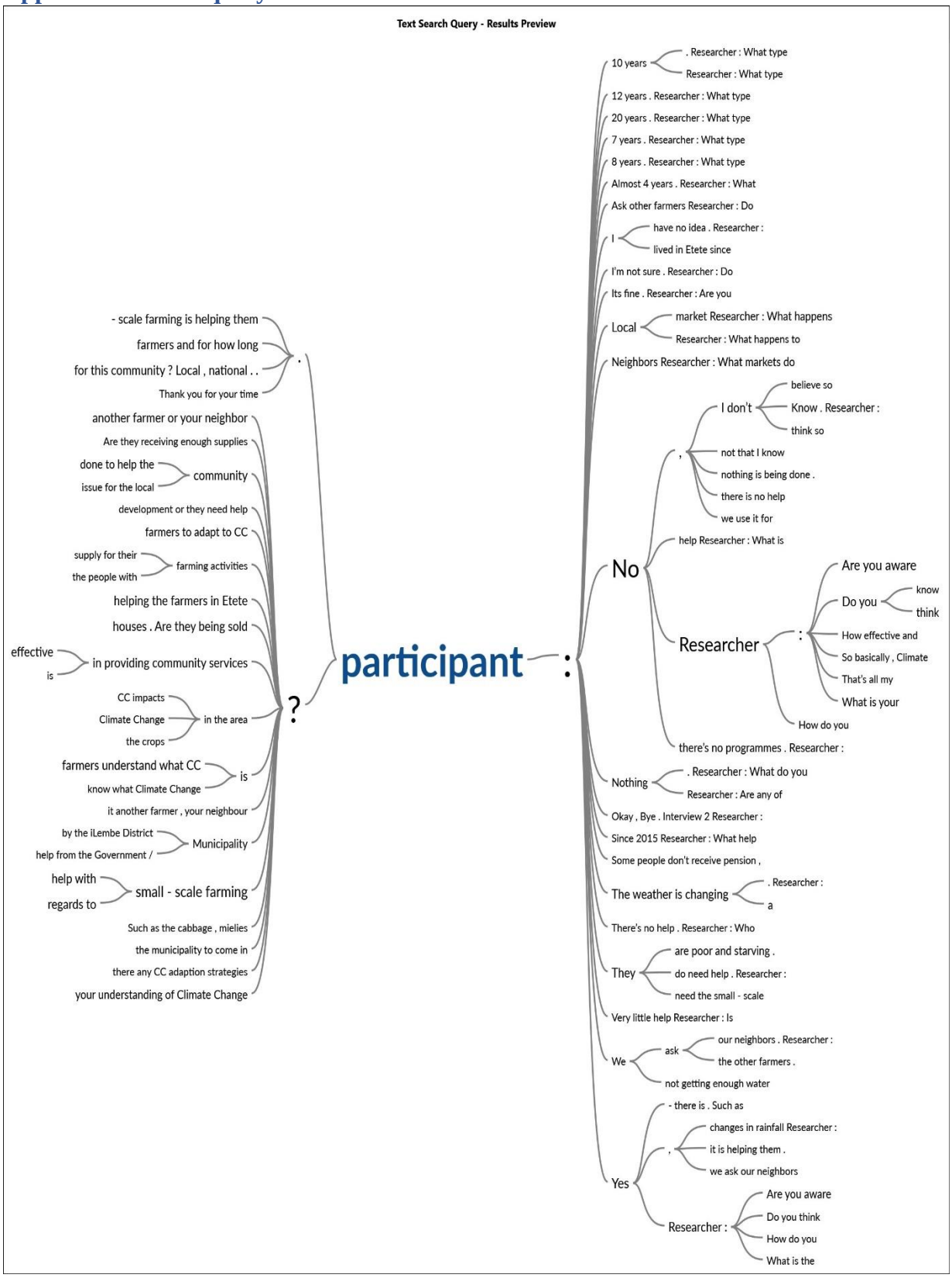
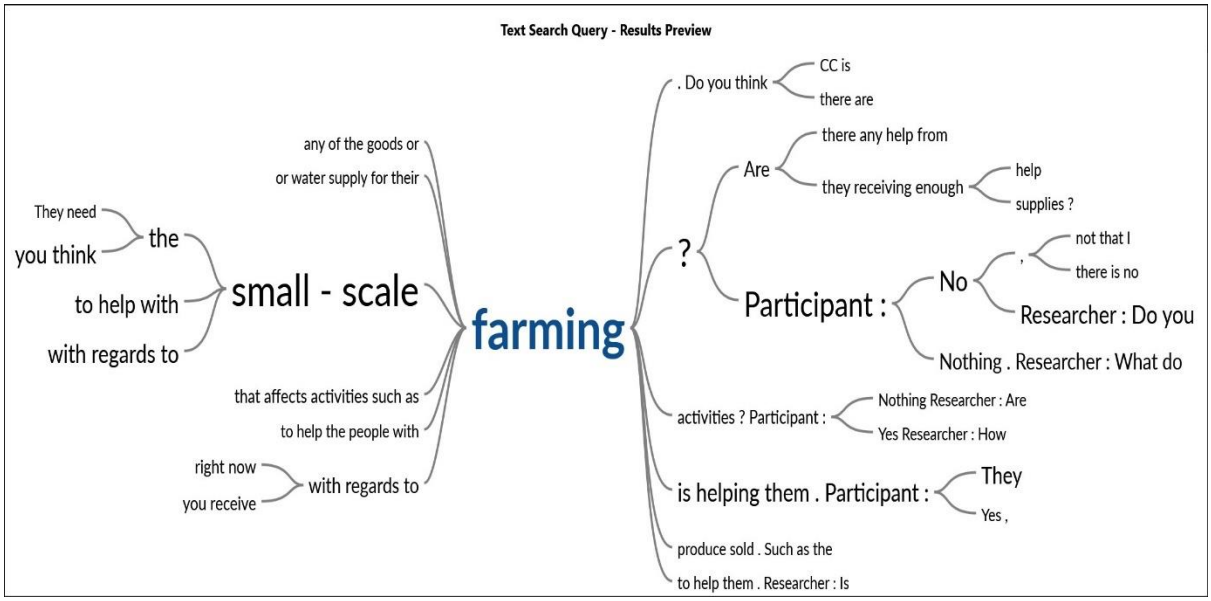
Appendix G - Qualitative data codebook

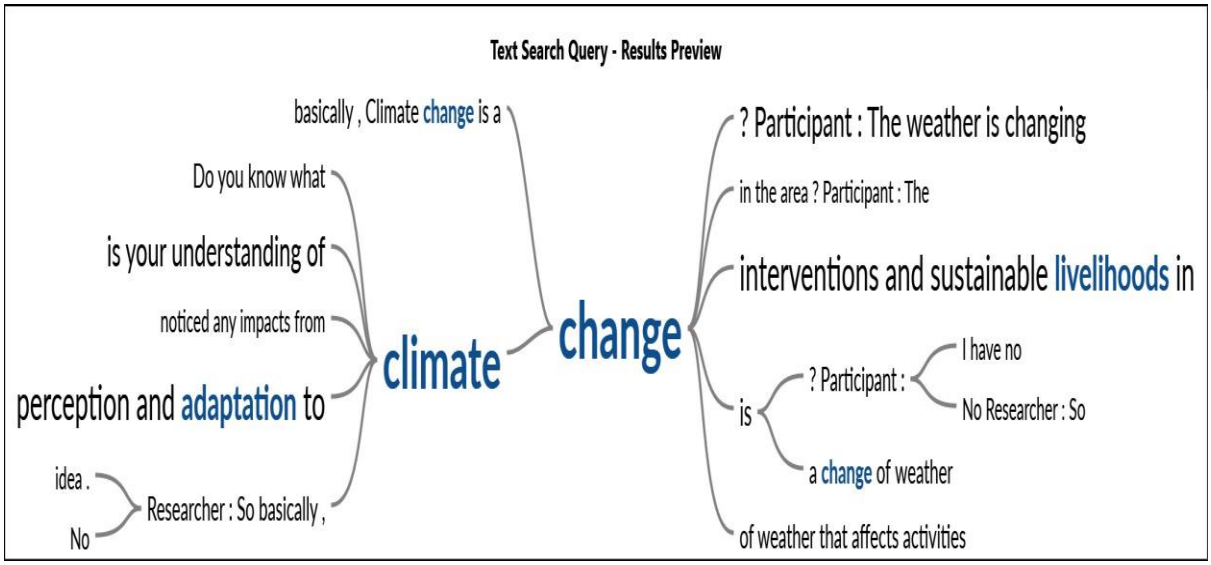
Name	Description	Sources (# No. of interviews)	References
Basic community services	Services the community needs.	9	3
Is the community receiving aid	Types of aid.	9	7
CC	Knowledge of CC.	9	6
Climate Change awareness	Knowledge of CC.	9	5
CC Adaption Strategies	Any know strategies in Etete.	9	6
CC Impacts	Types of CC impacts.	9	3
Community initiatives	Any initiatives in the area.	9	8
Crop selection	Crop selection influences.	9	5
Influences on crop selection and plantation seasons	Crop selection influences.	9	4
Farming produce	Excess farming produce.	9	7
iLembe District Municipality	Role of the iLembe District Municipality.	9	11

Name	Description	Sources (# No. of interviews)	References
Livelihood Issues	Main issues impacting the Etete community.	9	9
Local community capability	Can the local community manage their own resources?	9	1
Market awareness	Market knowledge.	9	7
Other farmers knowledge of CC	Opinion of other farmers knowledge of CC	9	7
Policy knowledge	Policy knowledge	9	7
Small-scale farming	Is this practice advantageous to the local community?	9	6
Support aid	Types of support aid received.	9	10
Years knowing farmers	Period the small-scale farmers know each other in Etete.	9	9

Appendix H - Text query trees




Text Search Query - Results Preview
farming
small - scale
They need
you think
the
to help with
with regards to
any of the goods or
or water supply for their
that affects activities such as
to help the people with
right now
you receive
with regards to
. Do you think
CC is
there are
?
Are
there any help from
they receiving enough
help
supplies ?
Participant :
No
,
not that I
there is no
Researcher : Do you
Nothing . Researcher : What do
activities ? Participant :
Nothing Researcher : Are
Yes Researcher : How
is helping them . Participant :
They
Yes ,
produce sold . Such as the
to help them . Researcher : Is

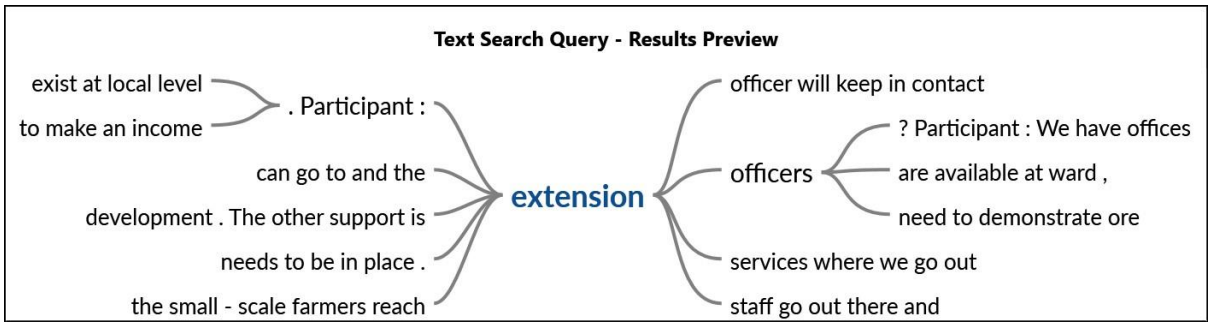

Text Search Query - Results Preview
climate
change
basically , Climate change is a
Do you know what
is your understanding of
noticed any impacts from
perception and adaptation to
idea .
No
Researcher : So basically ,
? Participant : The weather is changing
in the area ? Participant : The
interventions and sustainable livelihoods in
is
? Participant :
I have no
No Researcher : So
a change of weather
of weather that affects activities

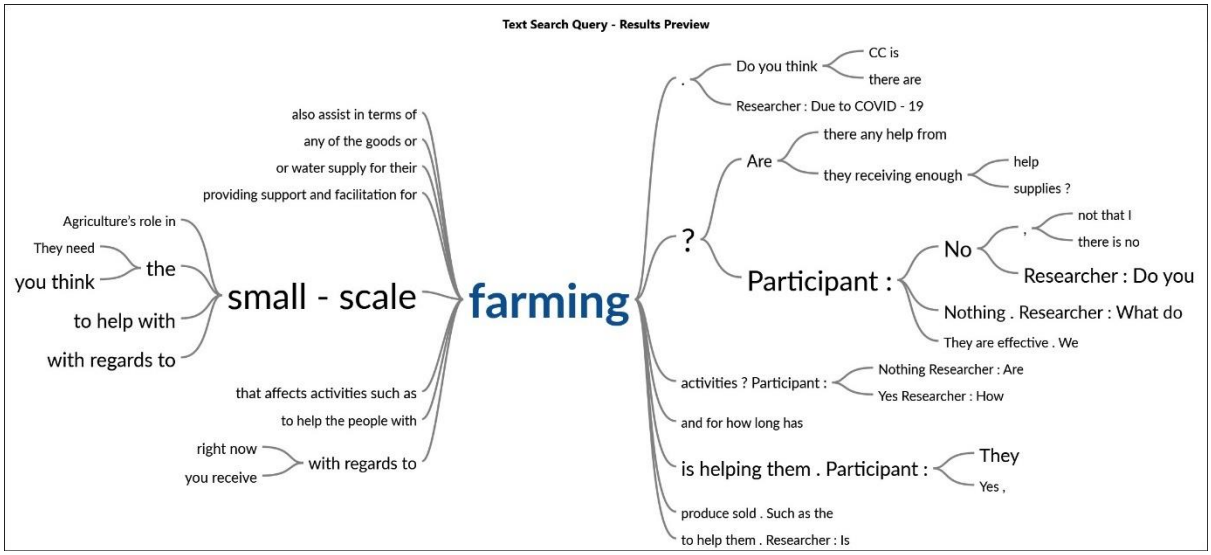
Appendix I - Qualitative data codebook (Dard interview)

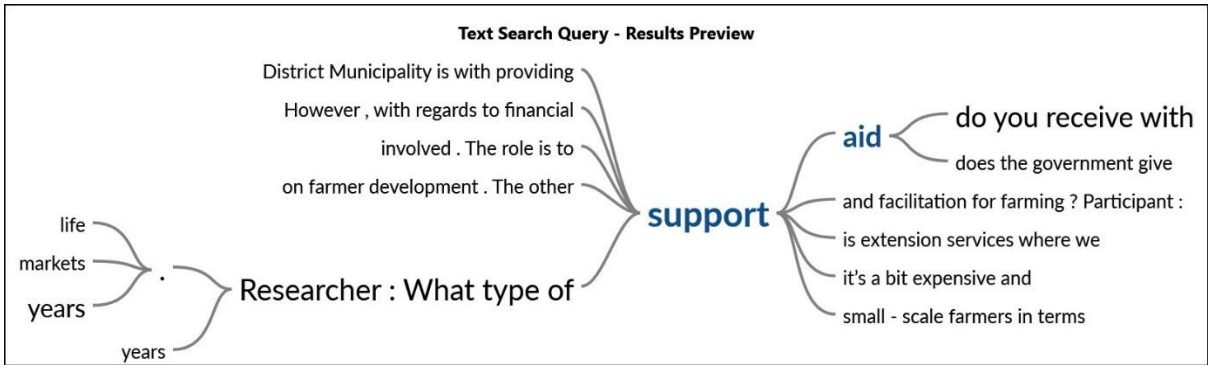
Name	Description	Files	References
CC	Assessment on the local small-scale farmers understanding of CC and how they are adapting to it? Do you think they have enough knowledge of CC.?	1	1
CC Adaptation	What adaption techniques do you think small-scale farmers should be adopting?	1	1
COVID-19	Due to COVID-19 a lot of farmers have been impacted with their supplies- so who advises farmers on which crops to grow and when in the year they should do so.	1	1
Department of Agriculture	What is the Department of Agriculture's role in small-scale farming and for how long has this been going on?	1	3
Farming Constraints	What are some of the constraints if local excess produce needs to be sold.	1	1
iLembe District Municipality	How effective and responsive do you think the iLembe District Municipality is with providing support and facilitation for farming?	1	1

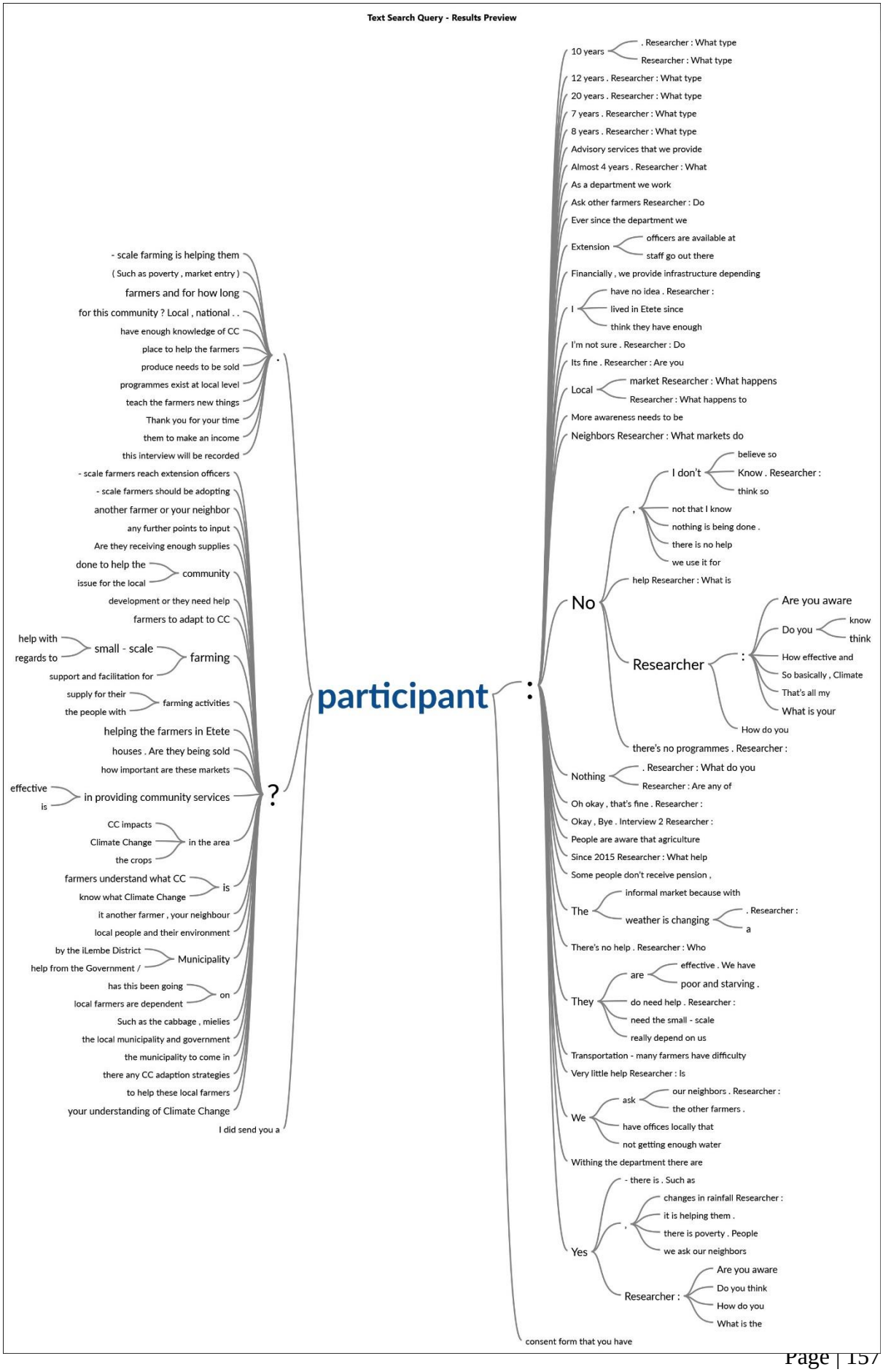
Name	Description	Files	References
Livelihood Issues	What are some of the livelihood issues for local communities such as Etete (Such as poverty, market entry)?	1	2
Markets	What markets do you think are important for these communities and how important are these markets?	1	1
Policies	Are you aware if there are any policies in place to help the farmers?	1	1
Small-scale farmers	What resources do you think the local farmers are dependent on?	1	1
Support aid	What type of support aid does the government give out to the farmers- such as financial aid or classes to teach the farmers new things.	1	3

Appendix J - Text query trees (Dard interview)

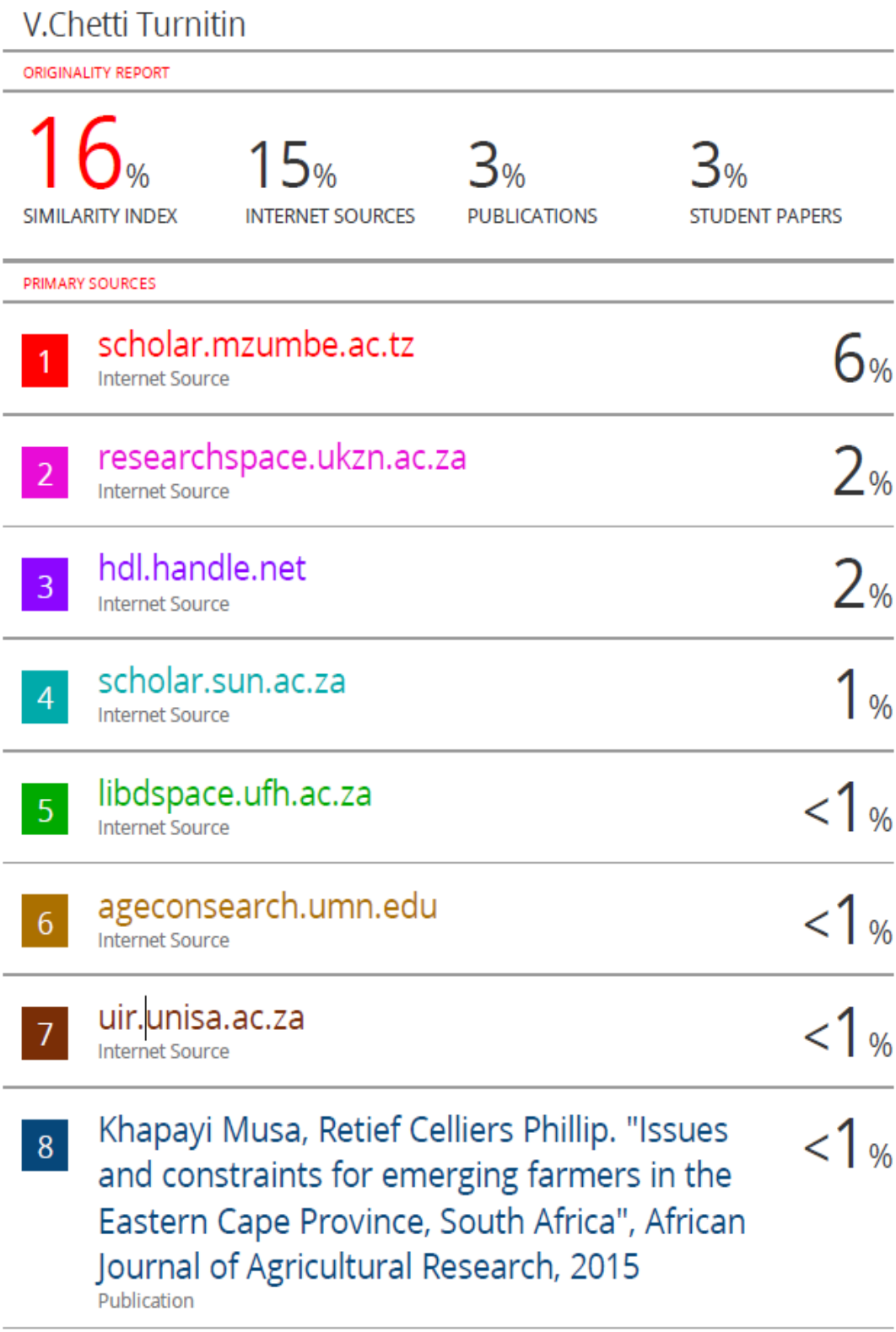







Text Search Query - Results Preview
participant
.
- scale farming is helping them
(Such as poverty , market entry)
farmers and for how long
for this community ? Local , national . .
have enough knowledge of CC
place to help the farmers
produce needs to be sold
programmes exist at local level
teach the farmers new things
Thank you for your time
them to make an income
this interview will be recorded
?
- scale farmers reach extension officers
- scale farmers should be adopting
another farmer or your neighbor
any further points to input
Are they receiving enough supplies
done to help the
issue for the local
community
development or they need help
farmers to adapt to CC
help with
regards to
small - scale
farming
support and facilitation for
supply for their
the people with
farming activities
helping the farmers in Etete
houses . Are they being sold
how important are these markets
effective
is
in providing community services
CC impacts
Climate Change
the crops
in the area
farmers understand what CC
know what Climate Change
is
it another farmer , your neighbour
local people and their environment
by the iLembe District
help from the Government /
Municipality
has this been going
local farmers are dependent
on
Such as the cabbage , mielies
the local municipality and government
the municipality to come in
there any CC adaption strategies
to help these local farmers
your understanding of Climate Change
I did send you a
:
10 years
. Researcher : What type
Researcher : What type
12 years . Researcher : What type
20 years . Researcher : What type
7 years . Researcher : What type
8 years . Researcher : What type
Advisory services that we provide
Almost 4 years . Researcher : What
As a department we work
Ask other farmers Researcher : Do
Ever since the department we
Extension
officers are available at
staff go out there
Financially , we provide infrastructure depending
I
have no idea . Researcher :
lived in Etete since
think they have enough
I'm not sure . Researcher : Do
Its fine . Researcher : Are you
Local
market Researcher : What happens
Researcher : What happens to
More awareness needs to be
Neighbors Researcher : What markets do
No
I don't
believe so
Know . Researcher :
think so
,
not that I know
nothing is being done .
there is no help
we use it for
help Researcher : What is
there's no programmes . Researcher :
Researcher
:
Are you aware
Do you
know
think
How effective and
So basically , Climate
That's all my
What is your
How do you
Nothing
. Researcher : What do you
Researcher : Are any of
Oh okay , that's fine . Researcher :
Okay , Bye . Interview 2 Researcher :
People are aware that agriculture
Since 2015 Researcher : What help
Some people don't receive pension ,
The
informal market because with
weather is changing
. Researcher :
a
There's no help . Researcher : Who
They
are
effective . We have
poor and starving .
do need help . Researcher :
need the small - scale
really depend on us
Transportation - many farmers have difficulty
Very little help Researcher : Is
We
ask
our neighbors . Researcher :
the other farmers .
have offices locally that
not getting enough water
Withing the department there are
Yes
- there is . Such as
,
changes in rainfall Researcher :
it is helping them .
there is poverty . People
we ask our neighbors
Researcher :
Are you aware
Do you think
How do you
What is the
consent form that you have

Appendix K - TurnItIn report



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