A case study of female smallholder farmers in Kilmun, KwaZulu-Natal: Examining the role of indigenous knowledge systems to climate change in increasing agricultural output and food security

By

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Submitted in fulfilment of the requirements for the Degree of

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ABSTRACT

Climate change affects all four dimensions of food security: food availability, food accessibility, food utilisation, and the stability of food systems. Climate change risk reduction is one of the twenty-first century's primary challenges. Climate change is expected to have a severe impact on Africa's food security and ability to achieve the Sustainable Development Goals (SDGs). Its impact on Africa that rely on rainwater agriculture and have little means to mitigate and adapt to climate change is likely to be quite severe. Climate change risk management solutions include both mitigation and adaptation. Climate change and global food insecurity are inextricably linked.

The quantitative data were collected by semi-structured questionnaires, while the qualitative data were collected through a transect walk and PRA tools. The objectives were to (i) ascertain smallholder farmers' perceptions of climate change risks; (ii) ascertain the implications of climate change and variability on agriculture, and (iii) ascertain the critical role of indigenous knowledge systems in agriculture for climate change adaptation.

The findings revealed that indigenous knowledge that has been used and practised sustainably for centuries makes a significant contribution to climate change adaptation and mitigation, as well as food security, according to the researchers. The findings of the study should be of particular relevance to climate change specialists who are already trying to develop a sound response to climate change. In the face of global climate change, policymakers must draw on the most up-to-date information available.

Keywords: Indigenous Knowledge Reducing Risks Food Security Climate Change

DECLARATION

I, Qophelo Sinenhlanhla Dludla hereby declare that:

(i) The research reported in this dissertation, except where otherwise indicated, is my original research.

(ii) This dissertation has not been submitted for any degree or examination at any other university.

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Signed [redacted] Date 29 November 2021

Qophelo Sinenhlanhla Dludla

As the candidate's supervisor, I agree to the submission of this dissertation/thesis.

Signed [redacted] Date 29 November 2021

Mr Denver Naidoo

ACKNOWLEDGEMENTS

I want to express my gratitude to my Lord Jesus Christ for guiding me through my Master's degree; it was not an easy road and I would not have succeeded without him.

I'd want to express my gratitude to Dr Denver Naidoo, who served as my supervisor and guided me during my study. These last couple of years have not been easy for me, but I appreciate your patience with me during moments when I felt hopeless. Your counsel and constructive criticism aided me in overcoming obstacles and will always be appreciated.

The Kilmun smallholder farmers for volunteering their time to assist us in participating in the study.

We would like to express our gratitude to the Shoba family for allowing us to stay in their home during data collection for this research.

Goba Ntombenhle, who has been an integral part of our endeavour as a partner and friend.

Mr P.M. Mpanza, father, I want to express my gratitude for training me to be strong and to dream big. Your prudent guidance has stabilised and moulded me. Without your assistance, I am certain that I would not have passed all of these examinations. You will always be my hero.

Thank you mom, Ms T.T Dludla. You have been nothing short of fantastic, unique, extraordinary, and an incredible role model in my life. I love you so much, without you I am nothing, you are the best.

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ABBREVIATIONS

COVID-19: Cornavirus

DAFF: Department of Agriculture, Forestry and Fisheries

DEA: Department of Environmental Affairs

FAO: Food and Agriculture Organization

FGDs: Focus Group Discussions

GDP: Gross Domestic Product

GHG: Greenhouse gases

IDP: Intergrated Development Plan

IFAD: International Fund for Agricultural Development

IFPRI: International Food Policy Research Institute

IKS: Indigenous Knowledge Systems

ILM: Ingwe Local Municiplaity

IMDP: Ingwe Municipality Development Plan

IPCC: Intergovernmental Panel on Climate Change

KZN: KwaZulu- Natal

MP: Mpumalanga

NAPA: National Adaptation Plans of Action

NDP: National Development Plan

NEPAD: New Partnership for Africa's Development

PRA: Participatory Rural Appraisal

SA: South Africa

SAWS: South African Weather Services

SHF: Smallholder Farmers

SPSS: Statistical Package for Social Sciences

STATS SA: Statistics South Africa

UN: United Nations

USAID: United States Agency for International Development

USDA: United States Department of Agriculture

WB: World Bank

CHAPTER 1
RESEARCH PROBLEM AND ITS SETTING

1.1 Introduction

Climate change is predicted to exacerbate the difficulty of agricultural growth in Africa. In many situations, weather patterns are becoming less favourable, increasing the unpredictability of agricultural and animal outputs. Extreme events are becoming more frequent and/or more severe as temperatures continue to rise and rainfall patterns continue to alter more than they have already (Woetzel et. al. 2020). Climate change and unpredictability exacerbate the vulnerability of subsistence rain-fed agriculture in South Africa. South Africa's National Climate Change Response Strategy serves as a framework for conducting adaptation programmes in response to the detrimental consequences of climate change and variability. However, this approach accords indigenous knowledge systems (IKS) with a relatively low priority. IKS has demonstrated promise in developing locally relevant and thus sustainable adaptation solutions in a variety of places of the world. This study aims to examine the many indigenous knowledge systems that smallholder farmers (SHF) in Kilmun, KwaZulu-Natal, employ to adapt to climate change and boost agricultural output to ensure food security. This chapter will provide an introduction to the study by first discussing the background and context, followed by the research problem, the research aims, objectives and questions, the significance and finally the limitations.

1.2 Background

Agriculture continues to be critical to Sub Saharan Africa's national economies and people's livelihoods. Sub-Saharan Africa is particularly vulnerable to the negative impacts of climate change because of its heavy dependence on agriculture, which generates a significant portion of the GDP, exports earnings, and jobs (Nelson et al., 2009). However, the industry is extremely sensitive to climate change's consequences due to its substantial reliance on rain-fed agriculture. Climate change is defined as a change in the state of the climate that can be determined (e.g., by statistical tests) through changes in the mean and/or variability of its attributes and that endures for an extended period, generally decades or longer (Trenberth et al., 2007). Climate has experienced significant change over the years. Agricultural production has seen drastic changes due to this issue. Additionally, rural areas are where the majority of the impoverished live and rely on agriculture for a livelihood. According to Schlenker and Lobell (2010), one in three people in Sub-Saharan Africans are known to be suffering from hunger, affecting people from both undeveloped and developing countries, and among them, children and women are the most vulnerable. Climate change represents an unprecedented threat to developing countries. They are not only more vulnerable but also more severely exposed to the extreme phenomena that climate change is likely to accentuate.

It is evident that developing countries, particularly those in Africa, Asia, and Latin America, will be the most affected because of climate change (Nelson et al., 2009). Development of countries in the north are responsible for climate change but, it's the development in the south that is most likely to suffer. The southern population will also have to make the greatest efforts to adapt. According to analysis, developing countries are at a greater disadvantage than industrialised countries when it comes to dealing with climate change (Schelenker and Lobell, 2010). These countries lack high-resolution methods to generate characteristics of weather data (FAO, 2009). The lack of a high-resolution system creates confusion about planting dates and seasons for SHFs, resulting in an even lower food yield for them, causing them to have even more difficulty with budgeting for manure.

Changes in climate, temperature and precipitation levels have left many African farmers uncertain about planting seasons for different crops, (Nelson et al*.,* 2009). This results in the loss of money as many SHFs invest in manures which are usually ultimately washed away when the precipitation seasons change. Climate change not only causes a rise in food prices but also negatively affects trade and food security, (IPCC, 2001). Nelson et al. (2009) also revealed that climate change contributes to water stress in a variety of crops by necessitating the employment of additional irrigation technologies to deal with the effects.

Agricultural smallholders around the world use their IKS, expertise, and experience to counter climate change in varying ecosystems—from harsh to normal (FAO, 2009). Information on IKS usually integrates elements of cultural practices and bio-cultural dynamics, so that awareness can be handed down from one generation to the next (FAO, 2011). These traditions can be used to increase resilience and socio-environmental stability (FAO, 2011).

Scientists have discovered the imperative of employing IKS to combat climate change to foster biodiversity and food security. Around the world, farmers and indigenous people own and possess agricultural knowledge, skills, and indigenous knowledge which were passed down to them by their ancestors (Maddison, 2007). This involves practices like forestry, fishing, planting, and foraging. Researchers, however, are worried that these land-use practices have almost disappeared, as a result of changes in land use, climate change, commercialization of agriculture, and population dynamics (FAO, 2009). Given the broad range of negative effects of climate change, including decreased agricultural yields, replacing inefficient, non-sustainable agricultural practices with local, sustainable knowledge systems appears to be a good way forward for developing countries.

Food insecurity and hunger are also significantly reduced due to the use of indigenous knowledge systems for water protection, soil conservation, biodiversity and land management, biological control of pests and diseases, plant and animal raising, ecological agriculture, and livestock practices (FAO,2009). According to literature, men and women are both required for food security, as both groups have different IKS skills that aid in food security. For this purpose, it is more prudent to integrate the information related to gender among women and men to help in food security, rural growth, and agrobiodiversity (FAO, 2009). IKS is preserved as a community, with information passed on to other generations, entire societies, households, and individuals in written, verbal, and nonverbal ways. This distribution of IKS means that people can look after themselves. The research outlined here aims to identify the significance of indigenous IKS in climate change variability and adaptation for a particular community of rural farmers in KwaZulu-Natal. As indigenous knowledge systems are vital in addressing food insecurity, climate change, and poverty, the agricultural and environmental industries must now recognize this fact.

1.3. Problem statement

African governments are committed to developing strategies to help alleviate food insecurity as agricultural production is an important component of the national economies and the people's livelihoods in Sub-Saharan Africa. In South Africa, agriculture contributes about R131.5 billion to gross farm income (Stats SA, 2016). the agricultural sector continues to offer considerable job opportunities, especially in rural areas and generates substantial foreign exchange (Stats SA, 2016).

The 2030 National Development Plan aims to ensure that rural communities have long-term food security and sustainable agriculture for all. This goal will ensure that at least by 2030 rural communities will have improved food security and growth of sustainable rural enterprises and industries, therefore resulting in rural job creation (NDP, 2017). With regards to agriculture, food security and rural development, about 11.4% of rural households are vulnerable to hunger while 32,3% of the rural population lives below the lower poverty line; and the NDP aims to reduce these values by < 9,5% (rural households vulnerable to hunger) and <22% (percentage of the population living below lower poverty line).

Despite the various scientific initiatives employed to tackle climate change and minimize food insecurity, the agricultural sector is vulnerable to climate change because of its heavy dependence on rain-fed agriculture and the possibility of increased climate change. Literature shows that IKS is ignored in the field of research, which means there is a discrepancy between science and IKS. Food security can be difficult to achieve should the gap be not bridged. A need thus emerges to perform additional research on the IKS used by small-scale farmers to sustain themselves. This also implies that instead of treating science and IKS as two distinct entities, the two must be merged to create feasible solutions to resolve climate change and food insecurity.

In rural areas, traditional environmental protection practices such as community forests, zoning, and fallowing have vanished. The disappearance of these conservation mechanisms results in various populations being unable to produce food year-round, thereby rising food insecurity and poverty for many households (FAO, 2009). An additional factor leading to climate change is the lack of attention paid to indigenous knowledge systems by the western world. It is this that has resulted in imbalances in the environment (Mertz et al., 2009). Due to the widespread usage of synthetic chemicals and pesticides that are not found in nature, the environment's ability to adapt to climate change has been diminished. This study aims to examine the many indigenous knowledge systems that SHFs in Kilmun, KwaZulu-Natal, employ to adapt to climate change and boost agricultural output to ensure food security.

1.4 Research question

What indigenous knowledge systems are SHFs in Kilmun, KwaZulu-Natal, utilising to adapt to climate change and increase agricultural output to ensure food security?

1.5 Overall objective

This study aims to examine the indigenous knowledge systems that SHFs in Kilmun, KwaZulu-Natal, employ to adapt to climate change and boost agricultural output to ensure food security.

1.5. 1. Specific objectives

- To determine what smallholder farmers believe are the risks associated with climate change
- To determine the impacts of climate change and variability on agriculture.
- To explore the importance of indigenous knowledge systems in agriculture to climate change adaptation.

1.6. Importance of the study

Smallholder farmers will determine the future of food security, hence they must be taught in-depth about the understanding and knowledge of scientific measures to mitigate against climate change to promote sustainable food security. While there has been much research on IKS and scientific measures to adapt to climate change and food insecurity, there has been little transferral and sharing of knowledge between scientists and SHFs to come up with solutions that are multi-disciplinary and more effective.

Semi-structured surveys that were used as questionnaires suggest that farmers are well aware of the issues caused by climate change, especially in agriculture, even though they might not be well familiar with the term "climate change". It is however unclear how much the government invests into supporting and equipping SHFs to be able to adapt and mitigate against climate change. To fully understand the impact climate change has on agricultural production at a small scale level, it is important to gain SHFs' knowledge of IKS and climate change and the SHFs perceptions of the agricultural policies of Africa.

1.7. Limitations of the study

Despite all the shortcomings and limitations, the research was carefully and thoroughly conducted. This study was limited to a small group of farmers and those groups were not an exact representation of the entire population. Respondents provided different views making it difficult to draw comparisons. Data collection and analysis depended on the skills of the researcher (focus groups, conducting interviews and making an observation) making the information gathered biased. IKS may vary in different geographical areas owing to factors such as population dynamics, environmental and biological processes, modernization, and educational systems, and so findings and recommendations cannot be generalised.

1.8 Definition of terms

Adaptation methods:s are those strategies that enable the individual or the community to cope with or adjust to the impacts of the climate to reduce vulnerability (Nyong et al*.,* 2007).

Climate change*:* for this study climate change will be defined as *uncertain* changes in weather patterns. Resulting in extreme weather events such as drought, floods, hailstorms, reduced and increased rainfall, and heavy winds occurring over a long time.

Food Security: is a state when all people at all times have access including physical, social and economic access to safe, sufficient and nutritious food essential for an active and healthy lifestyle FAO (2009) cited in (McDonald, 2010).

Indigenous Knowledge Systems: IKS refers to the composite set of knowledge and technologies existing and developed around specific conditions of populations and communities indigenous to a particular geographic area (Grenier, 1998).

Mitigation strategies: are procedures or activities that help prevent or minimise the process of climate change (Nyong et al*.,* 2007). Examples of mitigation include reducing emissions

Smallholder farmers: are farmers who grow food mainly for household consumption and sell their surplus to generate an income.

1.9. Assumptions

The following assumptions are made regarding this study:

- The tool chosen will generate trustworthy replies.
- Respondents will have a thorough understanding of the questions they will be asked.
- The participants will communicate their knowledge openly and candidly.
- The study's participants voluntarily supplied information to the researcher to address the research question.

1.10.Organization of the thesis

Chapter 1: representation of the introduction, and background of the study, problem statement, overall objectives & specific objectives, the importance of the study, limitations of the study, assumptions and the organization of the thesis.

Chapter 2: is a literature review of the use of IKS in climate change adaptation that has been used by previous researchers in their studies. Examples include the use of IKS in the control of pests and diseases, pre and post-harvesting, food storage, water conservation, soil conservation.

Chapter 3: Describes the study area and the methodology that was used to collect and analyse data.

Chapter 4: representation of the results and discussions on the use of IKS in climate change adaptation and mitigation strategies among SHFs in Kilmun.

Chapter 5: provides a summary of the conclusions and recommendations.

1.11. Summary

Climate change is a serious problem especially for African SHF. It hinders agricultural growth and promotes food insecurity at a household and national level. According to Woetzet et al. (2020) more frequent and more severe temperatures and extreme environmental events are continuing to occur and are predicted to be worse in the near future. Most African countries such as the Sub-Saharan Africa are negatively affected by climate change because of their heavy dependence on rain fed agriculture, which generates a significant portion of the GDP, exports earnings and jobs, (Nelson et al., 2009).

The aim of this study is to figure out solutions to adapt and mitigate against climate change in order to improve food security at a houseld and national level. A multi disciplinary approach of IKS and scientific knowledge is strongly recommended by literature referenced in this chapter and throughout the thesis as both schools of work have shown to be effective in the adaptation of climate change over the years.

This chapter provides an introduction, background of the study, problem statement, overall and specific objectives, the importance of the study, limitations of the study, assumptions and the organization of the thesis.

CHAPTER 2
LITERATURE REVIEW

2.1. Introduction

The food insecurity crisis has been affecting people worldwide. With increasing globalisation, first world countries are getting, even more, richer while third world countries are left behind without the necessary sophisticated machinery to help them cope with the changing climate (Nelson et al.,2009). Compared to other African countries South Africa is well-off but for more than 20 years South Africa has been experiencing food insecurity, even though at a national level the country seems to be food secure, however, this is not the case in many households in rural communities (Ndwandwe, 2013). According to Ndwandwe (2013) many South African researchers have realised the importance of the placement of policies that will help all people to be food secure, whether at a national or a household level, since literature has proven that in some parts of South Africa food availability and accessibility are still an issue (Nelson et al., 2009).

Even though many of these communities are food insecure they rely on their traditional knowledge to deal with climate change, food availability and food accessibility crisis (Ndwandwe, 2013). This review of the literature discusses the critical role of indigenous knowledge systems (IKS) in addressing climate change, soil conservation, and pest control, as well as how IKS may be utilised as a sustainable agricultural technique toward food security. For a long time, scientists overlooked the significance and utility of IKS when addressing climate change, agroforestry, and other environmental issues (FAO, 2009). IKS were not considered science, but rather as rural people's knowledge (FAO, 2009). Scientists have just recently begun to recognise the critical nature of IKS in relation to Climate Sciences.

IKS (sometimes referred to as traditional knowledge) is the wisdom, practises, and knowledge that indigenous people have gained through years of experience and have passed down orally, through drawings, or writing (Lal & Verma,2008). This knowledge has been used to deal with many environmental aspects including climate change and variability. Additionally, it has been utilised to ascertain the changes in nature that distinguish the previous season from the current and subsequent seasons (FAO, 2009). Even though IKS is new to Climate Sciences, it has long been used in traditional medicine, agroforestry, customary resource management, impact assessment, biodiversity conservation, and preparing and responding to natural disasters (FAO, 2009). This is because rural and indigenous people are very careful and highly observant about the changes that take place around them in nature (FAO, 2009). Being this observant teaches indigenous people different skills and techniques to use to adapt to the changes around them.

Although IKS has proven over the years to be sustainable and useful to smallholder farmers (SHFs), they have been neglected in mainstream research and development (Lal & Verma, 2008) Government policies also limit SHFs' options and reduce choices by restricting indigenous people to access traditional territories, by counterproductive policies including ones that promote sedentarization (Lal & Verma,2008). These policies also limit harvesting opportunities, deplete transmission of traditional attitudes, values, beliefs and knowledge, impoverished crop and herd diversity and substitution of indigenous people's livelihoods (Lal & Verma, 2008). For the reasons mentioned above new policies in climate sciences and other related fields should be implemented because literature has provided proof that chemicals and pesticides are unnatural and are likely to be unsustainable therefore are one of the many culprits that promote climate change, poverty, food insecurity and natural disasters (Lal & Verma, 2008). The truth is that resilience towards climate change is embedded in IKS, which is the reason why scientists and indigenous knowledge holders are now cooperating to create new information that would not have been obtained by either group alone (FAO,2009).

2.2 Contextualisation of food security and climate change

Climate change challenges and their influence on food security are becoming more recognised throughout the world, including Africa. Africa is highlighted as the most climate-vulnerable continent (Bwalya 2013). Numerous studies demonstrate that climate change has a detrimental effect on agricultural land, hence jeopardising food security. According to Liliana (2005), by 2025, almost two-thirds of Africa's arable land is anticipated to be destroyed due to a lack of rainfall and drought. South Africa is not exempt from these consequences. It is worth emphasising that the global population continues to grow, and the rates at which climate change and agricultural and food production have increased have not been equal. According to the World Food Programme's (2016) report, crop production yield per hectare is increasing at a slower rate than global population growth, implying that food production, which has previously been unable to meet global demand, will struggle to do so in the near future, leaving millions of people and numerous countries facing the stark reality of reduced food security.

Food security was coined in the 1960s by international development scholars (Osman 2002, cited in Le Page 2004). Food security, according to the World Food Summit (1996), occurs when all people have access to enough nutritious food to meet their dietary needs and food recommendations for an active and healthy lifestyle at all times. Schmidhuber and Tubiello (2007) expand on the idea of food security by suggesting that it is influenced by a variety of factors, including the ability to produce food on a self-sufficient basis, market access, and the ability to purchase food products. Anderson (1990) defines food security as an individual's ability to receive sufficient food daily.

It's worth noting that food availability is frequently used to quantify food security; thus, the terms are frequently used interchangeably. Thompson, Berrange, and Ford (2010) provide a clear distinction between the two by defining food availability as the presence of adequate quantities of food of acceptable quality. Food security, similarly, is defined by the Human Sciences Research Council (HSRC) in terms of three dimensions: food availability, food access, and food consumption. The council argues that a country's food supply must be sufficient consistently, both at the national and household level. On the other side, food access refers to a nation's and its households' ability to obtain sufficient food on a sustainable basis (Aliber 2010). According to Ludi (2009), access to food refers to a country's, community's, and individual's ability to purchase enough quantity and quality of food. Another aspect of food security is food utilisation, which Negin et al. (2009) say is contingent on how food is consumed, noting that while food availability and accessibility are required conditions for food utilisation, they are insufficient to eliminate malnutrition. Wlokas (2008), on the other hand, contends that climate change has a direct effect on food security through changes in agricultural output. Similarly, according to the Food and Agriculture Organization (FAO 2011), climate change affects the rate and pattern of production of many food commodities.

Smith, Pointing, and Maxwell (1993) define food security in terms of national food self-sufficiency, implying that a country should be capable of producing and distributing sufficient food to meet the needs of all its residents. On the other hand, Reddy and Moetsane (2009) contend that food security does not guarantee food security at the household level. According to the United Nations Development Programme (UNDP 2006), food security is inextricably tied to poverty, as the two ideas are inextricably intertwined and impact one another. Additionally, the data demonstrates a strong correlation between poverty and food insecurity, demonstrating that it begins with job loss, which results in a major decline in living standards.

Food security can be defined succinctly in terms of food accessibility, availability, stability, utilisation, and affordability. Ziervogel (2009) summarises this, stating that food security encompasses not just food availability (production, distribution, and exchange), but also access (affordability, allocation, and choice) and use (food safety, nutrition and social value). Additionally, the World Bank (2016) reported that climate change affects food utilisation capacity by altering the rate and pattern of production of various food items, which in turn affects the population's nutritional requirements.

2.2.1 Climate change and food security in Sub-Saharan Africa

Humanitarian crises exacerbated by environmental circumstances on the African continent, such as severe and prolonged droughts, highlight the vulnerability of rural developing economies' people and communities to acute physical strains. These shocks affect communities that are already vulnerable due to poverty and a lack of institutional assistance and can have a severe effect on people's food security and livelihoods. Food insecurity is the outcome of complex interactions between many stressors (socioeconomic and environmental) over extended periods and in response to abrupt shocks (Swift 1989; Misselhorn 2005; Devereux 2007; Akrofi et al., 2012). Chronic drivers such as poverty, environmental stressors, a lack of property rights, and limited market access all contribute to the creation of a vulnerable environment in which short-term drivers (e.g., food price hikes) put communities under stress (Misselhorn 2005). These interactions occur in a variety of sizes and might have unforeseen consequences for livelihoods (O'Brien et al., 2009).

Climate change is a new stressor that affects both long-term climatic norms and shorter-term frequency and intensity of extreme weather occurrences. Climate change is widely acknowledged to have a significant impact on food security and livelihoods (Thompson and Scoones 2009). Extreme droughts already impair people's capacity to cultivate food and raise cattle in Sub-Saharan Africa, and pastoralists and agro-pastoralists will need to adjust to changing water regimes to sustain food security and well-being (Kebede et al., 2011; Songok et al., 2011b). Climate change effects, vulnerability, and adaptation research (often referred to as IVA) have shed light on the implications of climate change for food security and livelihoods. Research in the realm of food security/insecurity and ideas from the field of sustainable rural livelihoods provide somewhat divergent viewpoints on this subject.

Sub-Saharan Africa is sensitive to climate change due to the interaction of several biophysical, political, and socioeconomic pressures that increase the region's susceptibility and hinder its adaptation potential (Davidson et al., 2003; Reid and Vogel 2006; IPCC 2007). Apart from temperature increases, climate change in Sub-Saharan Africa is expected to result in changes in rainfall intensity (Thomas et al., 2007; Songok et al., 2011a), an increase in the occurrence of extreme events such as droughts and floods (Niang et al., 2014; Tschakert et al., 2010). In many locations of Sub-Saharan Africa, expected implications include shortened or disturbed growing seasons, losses in arable land, and declines in agricultural productivity (Niang et al., 2014; Müller et al., 2011; Sarr 2012).

70% of Africans are expected to rely on rain-fed agriculture, which is characterised by small-scale, subsistence farming that is subject to a range of pressures, including those connected with climate change (Challinor et al., 2007; World Bank 2009). Climate change is projected to have a detrimental influence on food security in Africa due to its overwhelmingly negative consequences on agriculture and livelihoods (Niang et al., 2014; Challinor et al., 2007; Brown et al., 2009; Thornton et al., 2011). As evidenced by IPCC assessments, the majority of research on climate change impacts on food in Africa focuses on changes in agricultural yields and food production (Niang et al., 2014; Porter et al., 2014). According to the United Nations Development Report, one in every four households in Sub-Saharan Africa lacks appropriate food (United Nations 2012). According to the IPCC (2007), Southern Africa is more vulnerable to climate change and the repercussions might be catastrophic, wreaking havoc on the livelihoods of many people.

According to the IPCC (2007), agricultural productivity in Sub-Saharan Africa will fall from 21% to 9% by 2080 as a result of climate change. According to the analysis, rising temperatures in precipitation are anticipated to lower stable food output by up to 50%. Pedram, David, and Navin (2011), by 2050, a projected increase of 2 degrees Celsius will reduce the average output of maize, sorghum, and rice by 13%, 8.8%, and 7.6%, respectively. According to Knueppel, Demment, and Kaisser (2009), lower levels of education are closely related to Tanzania's high rate of food insecurity. Gutu, Bezabih, and Mengistu (2012), Ethiopian agriculture faces significant challenges as a result of climate change, with yearly output losses due to climate variability increasing drastically year after year. Similarly, the European Commission's (2009) research indicates that climate change in Africa will diminish crop yields, increasing food prices, forcing people to alter their production and consumption patterns. Vogel (2005) asserts that Sub-Saharan Africa is extremely prone to food insecurity, citing drought, flooding, and pest outbreaks as stressors. Schmidhuber and Tubiello (2007) predict that global warming will have a detrimental effect on food security, putting between 5 and 170 million people in danger of starvation by 2080. Hendriks (2005) believes that while South Africa is food secure on a national level, between 58 and 73% of families face food insecurity.

The literature on food security demonstrates that food security is contingent on not only food production but also on food access and usage (Misselhorn 2005). While food security is a necessary condition for human survival, other factors of people's lives, such as income, health, and assets, also influence their well-being (Bashir and Schilizzi 2013). The literature on sustainable livelihoods reveals that livelihoods are made up of a variety of assets (or capitals) that enable people to pursue a variety of livelihood outcomes (including improved or diminished food security) (Scoones 1998; Carney et al., 1999). Enhancing our understanding of the relationships between climate, food, and livelihoods is not only a scholarly imperative; it is also necessary for guiding practical initiatives, such as policies, programmes, and actions (including climate change adaptation), aimed at sustaining or improving the livelihoods and food security of people in Sub-Saharan Africa as the climate continues to change.

Initiatives that do not account for interdependence risk becoming ineffective. Perch (2011), for example, demonstrates how climate change adaptation programmes [such as climate change National Adaptation Plans of Action (NAPAs)] that are created without regard for vulnerable communities' livelihoods are unlikely to succeed. Similarly, Levine et al. (2004) demonstrate how food security strategies that ignore livelihoods fall short of meeting the needs of targeted groups. Climate change, from crop production to food distribution and consumption, clearly poses a significant threat to food security in Sub-Saharan countries. To reduce these concerns, an integrated policy approach is required to save arable land from the effects of global warming. Additionally, rural small-scale farmers require increased support for agricultural productivity improvement, particularly at the household level.

2.2.2 Status of food security in South Africa

Between 2004 and 2014, the South African government pledged to halve poverty levels. In his 2014 State of the Nation Address, President of the Republic of South Africa, Jacob Zuma, stated that food security has been re-prioritized as a key government priority. This is because climate change and its influence on food (security) are becoming a serious worry in various parts of the world, including South Africa. Household food security is a critical component of achieving that aim. In comparison to other African countries, South Africa is widely regarded as a food-secure nation, producing adequate staple foods and can import food to meet its population's basic nutritional requirements (FAO 2008). Hart and Aliber (2009) also contend that while South Africa appears to be food secure at the national level, the same cannot be true at the household level, particularly in rural areas where agriculture is the primary source of income for the majority of people. Landman (2004), on the other hand, discovered that food security remains a severe issue in South Africa.

Additionally, the right to enough food and water is enshrined in Sections 26 and 27 1(b) of the 1996 Constitution of the Republic of South Africa. This also aligned with South Africa's millennium development goals, which include halving poverty by 2015. While national food security indicators indicate that South Africa has been able to meet the food needs of its rising population over time, there are no reliable statistics on household food security (Statistics South Africa 2009). Hendriks (2005) discovered that a sizable proportion of rural households in South Africa are vulnerable to food insecurity. According to Knueppel et al. (2009) and De Cock (2012), South Africans living in rural homes are the most vulnerable to climate change. Worse yet, Earl (2011) noted that hunger and malnutrition continue to be widespread in South Africa, owing to inequalities in access to productive land.

According to Demetre, Yul, and Zandile (2009), about 14 million individuals, or around 35% of the South African population, are food insecure. According to the authors, a person is defined as food insecure if they receive less than 2261 kcal per day, which equates to R211 per person per month. Rudolph (2012) discovered a substantial correlation between work, income, and food insecurity in Johannesburg. According to his research, members of households with full-time work are more likely to be food secure than those with part-time occupations. According to Bonti-Ankomah (2001), South Africa's primary food security concern is access to food. This is because demand and purchasing power determine food access. Another factor worsening food insecurity in South Africa is excessive unemployment, which restricts the purchasing power of many households.

Countries vary in their susceptibility to and vulnerability to climate change. Thus, South Africa's ability to adapt and safeguard its food security will be contingent on its ability to comprehend hazards and the vulnerability of specific food commodities to climate change. More importantly, understanding how such spillover effects will affect households, particularly those in rural areas that rely heavily on agriculture, is critical given South Africa's current drought, which has resulted in a lack of rainfall, rivers drying up, livestock losses, and farmers' production declining significantly. As a result, the government must undertake policies to improve household food security. Additionally, it is critical to educate populations, particularly those in rural regions, on how to continue farming operations during periods of severe climate change.

2.3 Climate change crisis

Although 2020 will be remembered as the year of the coronavirus epidemic, the head of the United Nations World Food Programme has warned of another threat on the horizon. While the world is grappling with COVID-19, it is also on the verge of a pandemic of hunger. 700 million people went hungry in 2019, the United Nations said, and another 132 million will be added in 2020. COVID-19 has aggravated the problem, although hunger was already increasing before the pandemic due to poverty, population growth, disease, conflict, and climate change. By 2050, the climate catastrophe might result in an additional 183 million people becoming hungry (IPCC). As the earth continues to warm, it affects how food is grown and delivered. Since the early 1990s, the number of calamities such as excessive heat, drought, and flooding has doubled, harvests have shrunk, and crops have been ravaged by pests such as the gigantic locust swarms that devastated east Africa. Then there are plant diseases, which are getting more difficult to forecast as they adapt to changing climates and develop in previously undiscovered locations. Food becomes less nutritious as a result of climate change when crops such as wheat, rice, corn, and soy are subjected to CO_2 levels expected for 2050. Plants lose up to 10% of their zinc, 5% of their iron, and 8% of their protein content. Oceans are also impacted. As oceans warm, fish that prefer colder waters are forced to migrate, which means those relying on fish may need to find alternative sources of food in the future. Climate change means that places that were formerly favourable for growing specific crops are no longer viable. As it becomes more difficult to produce a crop on current farmland and as population and need for food increase, farming has extended into forests, such as Brazil's Amazon. As forests are removed to make way for cultivation, conditions get warmer and dryer, resulting in increasing droughts.

Agriculture consumes around 70% of the world's freshwater, which is becoming increasingly limited. The majority of the world's population has much too little knowledge about groundwater supplies and how to use them sustainably to irrigate crops and vegetation. Only 1% of farmed land in Sub-Saharan Africa is prepared for groundwater irrigation, compared to 14% in Asia, but in other nations, too much water can be a problem as well. For instance, in countries such as Bangladesh that are prone to flooding and cyclones. These weather extremes result in a decline in agricultural production and food supply, impacting both people with and without access to food. Food access will become more difficult as a result of catastrophic weather occurrences and the rising cost of good diets. Those most likely to suffer are poor communities and cities that lack the financial means to compete. It may also affect individuals who produce food, such as subsistence farmers who raise crops for their consumption and that of their families. Extreme weather and pests can wipe off entire crops, leaving farmers with nothing. Additionally, countries that rely significantly on food imports such as wheat and rice may suffer if global food resources become depleted and exporting countries retain more food for their people.

2.3.1 Reduction of crop yields

Most African countries heavily rely on rain-fed agriculture, With temperatures rising and rainfall seasons shortened, reductions in crop yields are common (FAO, 2009). Sorghum, rice and wheat; which are some of the most used staple crops in African countries are heavily affected by climate change (FAO, 2009). When temperatures rise without/or with very little rain plants wilt due to lack of sufficient moisture and minerals (FAO, 2009).

According to the FAO (2009), a 1^{o}C increase in average temperatures in drylands in African countries reduces the dryland's profit by at least 10% which is a major setback for poor people. Nelson et al. (2009) further stated that; people can withstand occasional hazards but continuous ones were a problem and were likely to hit them hard ultimately promoting food insecurity and poverty.

Sub-Saharan Africa is considered to be highly threatened by climate change worldwide. This is because Sub-Saharan Africa highly depends on rain-fed agriculture, has a poor agricultural infrastructure, low adaptive capacity and poor socio-economic situation. In the midst of climate change Sub-Saharan African cereal's production is predicted to decrease by net losses which are up to 12% (FAO, 2009). By 2020 due to the dependence on rain-fed agriculture some countries might have their yields reduced up to 50% (FAO, 2009).

2.3.2 Post-harvest losses

Due to increases in temperature levels rodents, pests and diseases are introduced to the environment. Such diseases negatively affect food storage methods after the food has been harvested (Ndwandwe, 2013). These diseases do not only make people who eat the crops sick but they also decrease the farmer's profits because they reduce the value and usability of the stored crop thus, they cannot be sold to consumers. According to our yield projections and the International Food Policy Research Institute's (IFPRI) economic projections, increased volatility in African agricultural systems, which are already characterised by wide variations in output and quality, could destabilise local markets (via supply shocks), restrain economic growth, and increase the risk for agricultural investors (McKinsey Global Institute, 2020).

Similarly, during heavy and frequent rainfalls it is hard to dry up cereals and legumes causing these foods to be easy targets of moulds and other aflatoxins which reduce the appearance of the crop making it unattractive to the consumer's (Udoh et al., 2000). Farmers and other value chain actors typically do not reap the full benefits of good years due to a limited ability to sell bumper harvests into shallow local markets, a lack of storage infrastructure to smooth supply over multiple years, and a lack of transportation infrastructure that makes exporting difficult. Simultaneously, a bad year might have long-lasting consequences for farmers. Farmers on a subsistence level, in particular, may be forced to acquire debt (McKinsey Global Institute, 2020). With their knowledge of IKS farmers build well-ventilated huts to store their food during rainy seasons to ensure that it does not grow mould and spoils and to prevent pests and rodents from breeding in the food.

2.3.3 Poor livestock

More frequent droughts and other natural disasters result in reduced crop and animal production. Due to climate change, animals and crops experience severe heat stress which will in turn negatively affect animals and crops by causing diseases to them (Udoh et al., 2000). Heat stress would also indirectly affect food production systems like crops and rangelands causing animals to be vulnerable to diseases (FAO, 2009). Additional droughts may impede the recovery of agriculture and animal systems, leading in a long-term degradation of grazing resources, diminishing herds, and unstable incomes for poor livestock keepers" (Ndwandwe,2013).

2.3.4 Water shortages

Our planet has gotten warmer during the previous century, particularly in the last 50 years. It is now widely accepted that human activities are substantially to blame for this warming. In particular, the burning of fossil fuels has created massive amounts of carbon dioxide and other greenhouse gases, which trap more heat in the lower atmosphere. Globally, this has resulted in glaciers melting, sea levels rising, and the expansion of desert areas. The African continent is particularly sensitive to the negative consequences of global warming; in South Africa, higher temperatures and greater evaporation rates mean that farmers demand more irrigation water, but also make rains more irregular. Water scarcity has thus become a concern to agriculture, which accounts for 8% of the South African economy. As a result, the African Union and the European Union have begun cooperating in three critical areas of research impacted by climate change: water, agriculture, and health.

Changes in rainfall patterns, intensity and frequency all affect agricultural production as many African countries heavily rely on rain-fed agriculture (Udoh et al., 2000). With temperatures rising and rainfall patterns changing, many African countries which are already arid and semi-arid will face severe food insecurity problems. Many rivers and other water systems are drying up because of climate change. In KwaZulu-Natal many cases have been reported whereby community members have been left without water to use even for necessities like bathing, cooking and cleaning (Udoh et al*.,* 2000).

When asked about what could be reasons for droughts and water shortages, many rural communities replied that people were evil and prayer to God was needed to ask him for rain because SHFs and their families were starving and struggling to produce food for themselves, their families and consumers (FAO,2009). To try and deal with water shortages, SHFs plough drought-resistant plants and intercrop their plants to make sure that they do not go without food and that food insecurity is minimised. Though changes in rainfall patterns have harmed and will continue to harm the majority of African countries, Nelson et al. (2009) argue that the literature demonstrates that not all countries will confront water scarcity, but that some will gain from climate change.

2.3.5 Land degradation (lack of suitable/fertile land)

Due to the fact that the majority of African countries already have arid and semi-arid areas as a result of climate change, many more hectares of productive land will be lost as temperatures rise, dehydrating the land and rendering it unsuitable for agricultural techniques (Ndwandwe, 2013). Due to shortages in water systems, many marginal croplands in dry land areas are being converted to rangeland since some crops and rangelands are already not suitable for food production (Ndwandwe, 2013). This affects the majority of SHFs who depend on agriculture to survive since about three-quarters of African countries are already in arid and semi-arid regions in which even a minor shift in rainfall patterns will cause unbearable living conditions for them (Ndwandwe,2013).

Because of such issues, SHFs and scientists should work together to combine both IKS and scientific knowledge to reduce food insecurity in rural areas (Boven & Mohorashi, 2000). The government has been deploying agricultural scientists to rural areas to educate farmers about scientific techniques that can be implemented to combat land degradation and soil infertility, thereby increasing and promoting food security. SHFs get taught about inter-cropping, diversification, planting drought-resistant plants and burying old food in the soil to enhance soil fertility. To curb land degradation scientific knowledge and IKS must be incorporated to come up with much more effective measures to deal with food insecurity.

2.4 Indigenous Knowledge Systems importance in agriculture

Climate change already has a negative impact on all people, particularly subsistence farmers who rely on agriculture for a livelihood. However, experience has aided in the development of a lesser-known resistance to this condition. Many subsistence farmers throughout Africa and South Africa employ ancestral wisdom, which has immense potential for assisting rural communities in adapting to climate change. There is no reason to reinvent the wheel, and the value of indigenous knowledge should not be overlooked. Local communities have often applied their indigenous knowledge systems in gathering, predicting, interpreting and decision-making in relation to climate variability and weather events. Thus, indigenous knowledge is the basis for local-level decision-making in many rural communities (Ofoegbu, 2017)

It is significant to the culture in which it develops. However, lessons learned from the experience of climate variability and extreme weather events in several developing countries suggest two things: (a) indigenous knowledge application can be insufficient and ineffective at times; and (b) while indigenous knowledge is indigenous, some households may lack access to and awareness of the available indigenous knowledge system. Thus, even within a community, indigenous knowledge systems are frequently accepted unevenly by households. While the indigenous knowledge system's effectiveness and efficiency in addressing climate change challenges are limited, it has demonstrated some success in providing households with low-cost means of coping with climate and extreme weather occurrences. Thus, it is necessary to comprehend the range of indigenous knowledge systems available within a community and to build mechanisms for enhancing them to increase community resilience.

In recent years, an increasing number of community members have begun to combine indigenous and scientific knowledge systems to cope with and adapt to climate change and catastrophic weather occurrences. Numerous case studies across Africa demonstrate farmers, livestock keepers, and fishers utilising a combination of traditional and scientific knowledge systems to enhance their livelihood activity's resistance to the effects of climate change. At the community level, the integrated use of indigenous and scientific knowledge systems to increase resilience to climate change is already occurring in the majority of developing nations.

2.4.1 Control of pests and diseases pre and post-harvesting.

According to the Oxford Dictionary (2000), a pest in agriculture is any destructive animal or insect that destroys food and livestock. If left unattended to pests destroyed cultivated, harvested and stored grain making it hard to sell and buy them.

Unlike commercial farmers, SHFs have no money to buy costly agricultural machines so they depend on IKS to protect their crops (Udoh et al., 2000). According to many researchers, IKS are more sustainable and ecologically friendly than the use of pesticides and chemicals (Udoh et al., 2000). Some of the IKS include intercropping, crop rotation, farm plot location, digging up grasshopper egg masses, traps, scarecrows, smoke, and timing of weeding and repellents states Ndwandwe (2013). In other cases, SHFs used grey water and soapy water to trap insects from eating their crops (Udoh et al., 2000). Besides the pest management practices mentioned above here, there are many other IKS measures used by SHFs to deal with pests and insects.

2.4.2 Food storage

Many farmers store their food in traditional granaries and buckets (Boven & Morohashi, 2000). They also use the traditional method of canning food to preserve it. The greatest threat to these methods though is climate change as these methods lack the sophistication to withstand the pressures of climate change (Udoh et al., 2000). Sacks, maize cribs and tanks are amongst other storage methods used by farmers (Udoh et al., 2000). With regard to sacks and maize cribs, most farmers complain that pests, rats and rodents eat their food, therefore reducing its appearance and its ability to be consumed and sold. Maize cribs are susceptible to environmental conditions which increase aflatoxins in maize (Udoh et al., 2000). One study by the FAO showed though that maize cribs can be efficient in maize storage if they have rat guards, corrugated iron sheet roofs and wire mesh adds Udoh et al. (2000).

2.4.3 Water conservation

According to Mulat (2013), about 200 million people in sub-Saharan Africa face serious water shortages around the world. The highest number of the world's poor which is about 70% live in rural areas without any real or sustainable water systems to rely on except rainfed agriculture Mulat (2013). However with the changes in climate change and the changes in the seasons less and less rainfall is experienced throughout Africa and this causes serious problems for most SHFs to struggle even more with safe food production (Trobes, 2002).

Also with the growing numbers of the population comes the problem of having to overproduce food. Such excessive ploughing and agricultural activity comes with a lot of land degradation and ploughing even on environmentally protected land such as wetlands (Ubisi, 2015). This reduces water conservation and enhances food insecurity. Most rural communities have little to no water systems, so to save water farmers use buckets, boreholes and tanks (Boven & Morohashi, 2000). Grey water is also used on crops too. Boven & Morohashi (2002) add that in other parts of Africa water is stored in clay pots/ wide-mouth clay pots for safe drinking later. According to Nelson et al. (2009), to help sustain water, measurements such as mixed cropping, strip cropping, mulching, contour farming and other methods can be used to enhance plant growth while conserving water. Boven & Morohashi (2002) say that baseline survey suggests that about 90% of poor communities in Kenya prefer storing their water in wide mouth clay pots because the pots have an evaporative cooling effect on the water.

2.4.4 Soil conservation (ecosystem and land management)

"Soil is the basis for crop production because about 99% of food is produced from the soil, thus food security depends directly on food productivity"(Blanco-Canqui & Lal, 2010).

Excess use of land either for construction, agricultural activity etc is the main cause for land degradation and eventually food insecurity (Blanco-Canqui & Lal, 2010). Unfortunately with the population increasing more than ever before the need for more construction and agricultural production is much higher too. This means that scientists, the government and the SHFs should be more united than ever to come up with solutions that will enhance the land's fertility and promote soil conservation to promote food security for all (Blanco-Canqui & Lal, 2010).

Soil and land degradation are said to be some of the things that limit food production in South Africa and many other developing countries. Indigenous knowledge systems used by farmers to conserve soil over the years include contour ploughing, crop rotation, fallowing, terracing, mixed cropping, agro forestry, fertilization, surface mulching and field boundaries (Mulat, 2013). For the IKS soil conservation methods to be much effect they need to be incorporated with the sciences too.

2.5. Use of indigenous knowledge to predict weather changes.

According to rural farmers in Zimbabwe, the change in weather patterns is noticed by certain changes in nature, for instance, the growth of new tree leaves in October which marks the beginning of the rainy season in October/November (Jiri et al., 2015). The onset of rains from a few days to a few weeks is indicated by an increase in night-time temperatures, shifts in direction of the prevailing winds, particular phases of the moon and the appearance of strong whirlwinds, changes in the smell of the environment, all highlighted as happening just before the rains (Jiri et al., 2015).

To predict changes in seasons and weather SHFs use animal behaviour, tree phenology, cloud cover, wind circulation and other social indicators to predict rains and season quality (Jiri et al., 2015: 161.).

Table 2.1: indicators of changes in season and weather (Jiri et al., 2015)

Indicators		
Onset of rains	**Season quality**	**Significance**
The appearance of birds like the stock and the *Quella.*		Farmers should be prepared and be ready for the occurrence of more than normal rains (Malawi).
Frogs crooking in swampy areas at night.		Indicator for the onset of rains (Swaziland).
Rock rabbit Termite appearance		Imminent rainfall if it squeaks in an unusual manner (Zimbabwe). The appearance of many termites indicates near rainfall onset (Bostwana).
Red ants, moist anthills, a fast increase in the size of anthills		Indication of good rains to come (South Africa).
First appearance of sparrows, a flock of swallows, preceding dark clouds		Rain is around the corner and farmers and farmers should be prepared for more than normal rains (Bostwana).
Cicadas, dragon flies and day-flying chafers.		The appearance of these animals indicates imminent rainfall.
Cry of phezukwemkhono bird		Signals the star of the wet season in august-November (Swaziland).

	The abundance of butterflies during the farming season and the presence of army worms.	Possible drought and famine in mid-season
Budding of the acacia species, the flowering of apricot and peach trees.		The start of a rainy season in Botswana.
	Mango tree, Nandi fame tree.	If the mangos flower in abundance this indicates the occurrence of a potential drought (Malawi).
	Dropping off of young avocado fruits.	Challenging farming season (Swaziland).
	Change of behaviour in certain plants: germination of new leaves on baobab trees and sprouting of *Aloe ferox*.	The abundance of wild fruits (Malawi, South Africa and Swaziland). An indication of good grains in (Bostwana). The reproduction of *scleroc aryacaffra* and *englerophytumnatalense* during December and February indicates the occurrence of a challenging farming season (Zimbabwe and Zambia).
Moon phases		Moon crescent facing upwards indicates upholding water and when facing downwards is realising water in the next three days (South Africa and Malawi).
Star constellation		Star pattern and movement from west to east at night under clear skies means rain will fall in 3 days (Malawi and Bostwana).
	The appearance of fog/haze in the morning	This indicates that no rain will occur (Malawi).
	Wind swirls	Sign of good rains if they occur frequently (Bostwana).
	Moon profuse halo	Erratic rainfall and more diseases if the moon is dispositioned (Malawi). Good rains (South Africa).
	Temperature	Near onset and a good rainy season are indicated by high temperatures in October and November. More rainfall in the coming season is indicated by heat in low areas in August (Bostwana and Malawi).
	Mist-covered mountains	Good rains (South Africa)

Other social indicators

Table 2.2: other social indicators of changes in season and weather (Jiri et al., 2015)

Indicators	**Significance**
Asthmatic attacks	Cold weather and humid conditions (Zimbabwe)
The body feels excessive heat during the night and day; body pains (flu, backaches and headaches)	Indicates the occurrence of rain in the next 1-3 days. (usually in Zimbabwe).

2.5.1. Weed management

Weed management means the use of different practices to deal with invading weeds that may try to outcompete the growth and adaptation of crops (Iyagba, 2010). Other weed management practices include cutting the grass as soon as it starts to grow. Pesticides, manures, heaping manures, early planting, crop rotation, placement of chemical fertilizers, tillage and intercropping (Mandumbu et al., 2011) are all examples of the different weed management practices used by farmers to reduce weed.

2.5.2. Weather services report from 1996-2003

As literature has proven, the weather has changed over the years, with precipitation levels going down and heat levels going up the roof. In the South, there are 10 provinces, and all are said to have experienced the severe changes of global warming and climate change in a negative way.

The following information shows the different weather stations that were used to provide this research with the meteorological statistics from South Africa. The reason for including such information in this research is to help us observe the differences/changes in weather patterns and how they have been affecting agricultural production over the years. These tables also tell us more about the importance of rainfall in rain-fed agriculture for SHFs.

The information provided in the following tables was obtained from 112 automatic weather stations, 24 weather offices, 48 first-order stations, 13 second- order stations, 56 third-order stations and 1622 rainfall stations (StatsSA, 2005):

- 112 automatic weather stations: report rainfall, sunshine, pressure, temperature and humidity every hour.

- 24 weather offices: hourly report, and all visible climate variables e.g. cloud, visibility and present and past weather.
- 48 first-order stations: reports all climate variables, observations are done at 08:00, 14:00 and 20:00.
- 13 second- order variables: maximum and minimum temperatures are reported at 08:00 and 14:00, rainfall at 08:00, observations are done at 08:00 and 14:00.
- 56 third-order stations: observations are done at 08:00 and only maximum and minimum temperatures and rainfall are recorded.
- 1622 rainfall stations: these stations record rainfall reports only once a day (08:00), these are stations that have rain- gauges.

Table 2.3: Annual rainfall (mm): historical table

			Province(s)		
Year	**Cape town**	**Durban**	**Johannesburg**	**Bloemfontein**	**Nelspruit**
1996	706,5	1442,0	900,4	743,8	1220,6
1997	422,8	1390,8	1003,9	407,5	699,0
1998	516,6	1046,3	716,8	740,2	283,01
1999	441,5	1161,7	561,2	481,7	821,0
2000	376,1	1149,7	1088,5	644,8	1301,4
2001	595,3	985,3	814,6	764,0	616,0
2002	523,4	980,4	666,2	548,6	407,6
2003	376,1	819,1	538,9	405,8	301,0

The table above shows the changes in annual rainfall per (mm) for Cape Town, Durban, Johannesburg, Mpumalanga and Bloemfontein. Looking at the table one can see that over the past 10 years (1996-2003)rainfall has decreased with the rainfall patterns severely decreasing across the South African provinces from 2001. This serves as clear evidence that over the years rainfall has decreased due to climate change. With such a great decrease in rainfall, SHFs are finding it even harder to plough as they depend on rain-fed agriculture for food, hence increasing the rate of food-insecure rural households.

Table 2.4: Average monthly rainfall (mm) and average minimum and maximum temperature (oC)- main weather stations, 1961-2003

Month	Temperature ^{O}C					Rainfall	
	Mean of		Extreme		The daily average number of hours of sunshine	Average total rainfall in mm	The average number of days with rain
	Daily maximum	Daily minimum	Maximum	Minimum			
	19	**20**	**21**	**22**	**23**	**24**	**25**
J	27.8	21.1	36.2	14.0	6.3	134.0	15
F	28.0	21.1	33.9	13.3	6.7	107.0	13
M	27.7	20.2	34.8	11.6	6.6	119.0	12
A	26.1	17.4	36.0	8.6	6.9	73.0	9
M	24.5	13.8	33.8	4,9	7.2	59.0	7
J	23.0	10.6	35.7	3,5	7.4	28.0	5
J	22.6	10.5	33.8	2,6	7.4	39.0	5
A	22.8	12.5	35.9	2.6	7.1	62.0	7
S	23.3	15.3	36.9	4.5	6.1	73.0	11
O	24.0	16.8	40.0	8.3	5.4	98.0	15
N	25.2	18.3	33.5	10.3	5.5	108.0	16
D	26.9	20.0	35.9	11.8	6.0	102.0	15

The table above shows the average monthly rainfall patterns per annum. On the table, the daily minimum (temperature) and average number of days with rain are enough, while the minimum (extreme temperature) and a daily average of hours of sunshine are both too low, especially from April- June. Even though these figures seem to be very low around April- June it could be argued that they are fine as around April- June winter begins hence the decrease in days with rain temperature levels. According to data collected from KZN, Kilmun around April- June farmers do not plough anything as they experience frost often. During this time SHFs rely on food they have stored during the harvesting season.

Temperature (mean: daily maximum and extreme: maximum) and rainfall (average rainfall in mm) patterns are very high. This is a bad thing as it negatively affects agricultural growth for

SHFs. One may argue that there is more than enough rainfall but the high temperatures are likely to excessively evaporate the soil, therefore, drying it up making it hard for SHFs to plough the land and making them food insecure.

Table 2.5: Average rainfall (mm) by year and province (KwaZulu-Natal)

Year	Year total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996	085,1	187,8	218.5	114.0	42.4	29.1	4.3	77.1	11.5	14.2	123.8	97.3	125.5
1997	1124.2	155.8	91,8	130,9	79,2	43,7	84,5	27,0	26,4	58,2	101.7	177.0	78.5
1998	910.4	127.6	148,7	94,1	39,9	19,3	1,1	7,0	21,5	34,1	76.5	134.1	154.5
1999	828.9	133.4	143,6	82,0	35,5	19,1	12,1	7,6	22,6	33,3	110.7	68.6	160.5
2000	1152.7	173.5	154,6	173,4	77,5	81,8	8,8	5,2	4,7	73,5	84.4	166.8	149.2
2001	886.2	105.8	96,2	82,5	68,3	20,4	6,0	14,8	15,9	89,9	102.3	155.6	128.4
2002	812.4	128.3	73,5	56,1	48,9	21,1	26,9	107,6	76,9	60,3	41.5	62.3	109.2
2003	635.5	86.3	86,3	71,1	49,1	28,3	33,4	6,9	15,9	53,5	25.8	108.2	70.7

From the year 1996- 2003 by carefully looking at the figures on the table above it is noticeable that annual rainfall patterns have decreased over the years. In the field, during a focus group discussion, SHFs were asked to tell if they have noticed any changes in annual rainfall patterns over the years. Many agreed that there has not only been a decrease in annual rainfall seasons as they feel that with climate change nature (eg seasonal changes) has changed making it hard for them to know when to plough, therefore perpetuating food insecurity and poverty.

2.6. Disaster Management

Many researchers including the World Bank have realised the importance of IKS in the reduction of disasters. According to Maferetlhane et al. (2012) rural communities have long been using different indigenous strategies to cope with different environmental, physical and economic factors. Such strategies include for example knowing the colour of clouds that may carry hailstorms so that people can seek cover early. Also knowing that after long periods of droughts storms, lightning and thunder will occur allows people to prepare in advance for the disaster, while changes in bird cries indicate changes in seasons. According to Maferetlhane et al. (2012) in Swaziland IKS as a disaster management tool is used can be used to predict floods by simply looking at the height of the bird's nests near rivers, by moth numbers which predict drought, and by the position of the sun/cry of a specific bird on trees near rivers may indicate the start of a rainy season for farming.

2.7 Summary

This chapter tells us more about the different factors that promote climate change, economically, socially and environmentally. It tells us more about the different challenges SHFs go through daily to try and survive. Literature shows us that SHFs throughout the world have similar struggles, having to deal with post-harvest losses, poor livestock, water shortages and land degradation because of climate change.

Many of these SHFs rely on their indigenous knowledge systems to deal with climate change. They observe nature to know when and when not to plough, but that too is becoming harder to rely on as climate change is negatively impacting seasonal changes which SHFs rely on for ploughing times.

The chapter also tells us more about the different disaster management tools that are generally used by SHFs around the world and their effectiveness in adapting to climate change.

In this chapter annual rainfall and sunshine tables are included to show us more about the changes in the rainfall patterns over the years and how these changes affect agricultural production.

CHAPTER 3
METHODOLOGY

3.1. Introduction

This chapter discusses the technique used to investigate the various indigenous knowledge systems utilised by smallholder farmers (SHFs) in Kilmun, KwaZulu-Natal, to adapt to climate change and increase agricultural production to secure food security. To begin, the research area is defined, followed by the research design, and sampling strategy that will be used. Additionally, the data collection procedures, tools, and methodological approaches used in the study are discussed, as well as the justification for their inclusion. Data analysis, validity, and ethical considerations conclude this chapter.

The study explored three sub-problems as subsets of the overall research question. The sub-problems that were explored are as follows:

- To determine what SHFs think are the risks associated with climate change
- To determine the impacts of climate change and variability on agriculture.
- To explore the importance of indigenous knowledge systems in agriculture to climate change adaptation.

3.2. Description of the study area

Kilmun, an agricultural village in southern KwaZulu-Natal, was the location of the study. Kilmun is a municipality in the Ingwe district of KwaZulu-Natal. Kilmun is the most populated district in the Ingwe local municipality, covering an area of 1976 square kilometres and having a population of 10177 residents (IDP of Ingwe Local Municipality, 2015). In this demographic, females outweigh males; females account for 55.3% of the population. This is due to increased male migration in search of a job, which has resulted in women leading 56.5% of homes. Women account for the majority of people who have low to no education. (Ingwe Local Municipality, 2015). According to Statistics South Africa (2011), the Ingwe municipality's population is primarily young With 71% of the population under the age of 30, 36% in the working-age group (24-34 years), and 5% above the age of 60.

Economically, Ingwe's populace works at a rate of less than 10%. Around 5% of the population is unemployed, while another 4% are unsuccessful job seekers (Ingwe Annual Report 2016). Women are blatantly marginalised. The majority of children, who represent the population's youth, are socially inactive. Perhaps the most telling indicator of poverty is income inequality. When the economically jobless are combined with the employable, 58% of the overall population is defined as having no income. Following that is the wage level that pays up to R20 000 per year — individuals earning more than that earn statistically insignificant amounts.

Sanitation and water Boreholes, wells, and rivers/streams provide the majority of the water that Ingwe people have access to. A public water system serves about 4% of the community. Eskom supplies electricity to Ingwe Local Municipality (ILM). Ingwe utilises a variety of energy sources for lighting, cooking, and heating. The majority of households heat with wood, light with electricity, and cook with wood. It cannot be concluded that the use of wood as a substitute energy source is solely motivated by a lack of or insufficient access to electricity. It's worth noting that this could result in energy savings.

ILM is divided into two bioclimatic areas in terms of climate change. There are the bioclimatic zones of highland and wet upland. The region can be separated into three distinct temperature zones. Western (higher) Ingwe is usually cooler than eastern (lower) Ingwe. Winter temperatures in the colder western regions often dip below 0°C, although they seldom fall below 5°C in the warmer eastern regions. Summer temperatures in the west vary from the low thirties to the mid-thirties, while in the east they reach the high thirties. The average annual rainfall in the region is between 700mm and 1200mm, with the eastern areas being generally wetter than the western areas.

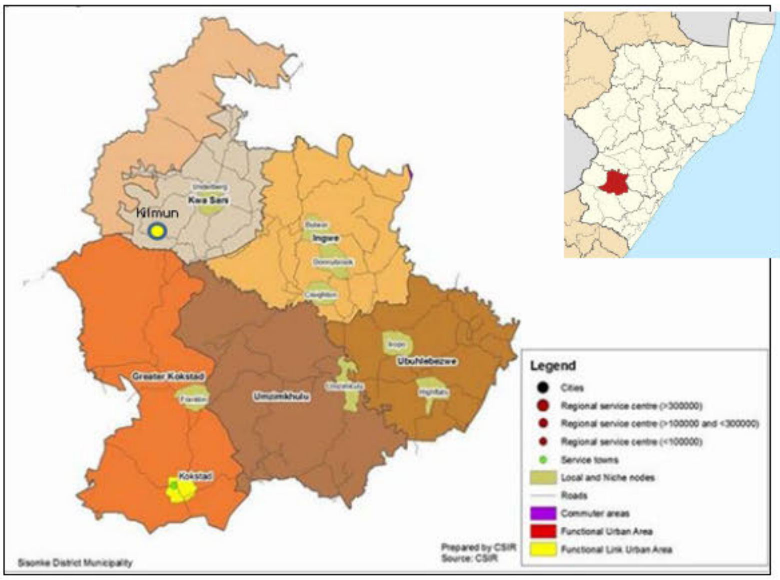

Figure 3.1: Map of the Harry Gwala District showing the study area indicated by the yellow dot.

3.3 Research design

This study used the case study design. It is used to explore a phenomenon in context, using one or more data collection methods and also describing in-depth a case or cases. Usually the "how, why, and what questions are answered to understand the current research study, which is to examine the indigenous knowledge systems used by SHFs in adaptation to climate change to increase agricultural output and food security. This design is a qualitative method, which is used to gain a deeper understanding of the perceptions of people regarding a particular phenomenon. In addition, this study will also use a quantitative method. Integrating these two approaches are key to answering the research question as well as collecting the data to answer the research needed for the study.

The research used an integrated approach. The terms integrating, integration, quantitative and qualitative approaches are both used to refer to mixed methods research (Creswell, 2014). The integrated research method is a relatively recent technique that was developed as a result of the work of individuals in diverse fields such as assessment, education, administration, sociology, and health science. It has evolved, beginning with the formative stage, intellectual controversies, procedural advancements, and most recently, expansion into various fields and countries worldwide (Creswell, 2014).

According to Bryman (2006), the approach combines qualitative and quantitative approaches to increase the accuracy of study results and provide more detailed findings. It triangulates qualitative and quantitative approaches to extract the best characteristics from both. The use of Triangulation has dominated attempts to combine fieldwork and survey approaches. The comprehensive method's advantages over a single approach method include improved relevance and credibility of observations and assumptions, the ability to gather a variety of divergent views, and the ability to simultaneously answer a variety of confirmatory and exploratory questions using both qualitative and quantitative methods (Teddie & Tashakkori, 2009). Additionally, Creswell (2014) emphasised the importance of using an applied approach across three stages of analysis. At a high level, the streamlined technique combines the best aspects of qualitative and quantitative research and minimises the drawbacks of each solution. On a realistic basis, it presents researchers with a refined and intricate methodology that is enticing to those at the cutting edge of modern testing procedures. Finally, it is a helpful method for gaining a more holistic interpretation of the analysis issues or concerns at the procedural stage. Additionally, both qualitative and quantitative data were gathered within a single phase of the study. Creswell (2014) coined the term "convergent parallel technique" to refer to this approach to mixed-methods analysis.

A mixed approach study entails rigorous data processing and time-consuming data interpretation, and it necessitates that the researcher is familiar with both qualitative and quantitative testing methods (Creswell 2014). To resolve these issues, the researcher enlisted the assistance of two post-graduate students familiar with the research process. Data processing and analysis took place over two months, with validity tests completed during the analysis stage.

3.4. Population and Sampling selection

This section discusses the general population, target population and study sample. The general population will focus on SHFs. According to the DAFF report, SHFs in South Africa are defined as "small-scale or smallholder" is often equated with a backward, non-productive, non-commercial, subsistence agriculture that is found in parts of the former homeland areas. It is generally associated with black farmers as if black farmers cannot become large-scale commercial farmers (Kirsten and van Zyl 1998). The targeted population was SHFs in Kilmun, Ingwe Municipality, KwaZulu-Natal. The targeted population was chosen since the study area was closer to the researcher and had actively participating SHFs. The study sample, therefore, were SHFs in Kilmun as the area had more women farmers since most men migrated outside the areas in seek of work in other parts of KwaZulu-Natal and other provinces.

A purposive sampling (a.k.a. judgement, selective, or subjective sampling) is a sampling procedure in which the researcher makes selections from the sample to engage in the analysis based on his or her judgement. Purposive sampling is a non-probability sampling technique in which "elements chosen for the sample are selected based on the researcher's judgement." Researchers also assume that by using good judgement, they can achieve a representative sample, thus saving time and money" (Creswell 2014). The advantages of purposive sampling are cost-effective and time-effective sampling methods available; appropriate method available if there are only a limited number of primary data sources who can contribute to the study; effective in exploring anthropological situations where the discovery of meaning can benefit from an intuitive approach. The disadvantages are Vulnerability to errors in judgment by the researcher; low level of reliability and high levels of bias; inability to generalize research findings. Purposive sampling was the most appropriate method for this research since it focuses exclusively on women SHFs. From a population of 2108, 100 women SHFs were purposively chosen to participate in the study.

According to Guarte & Barrios (2006), purposive sampling is a “random selection of sampling units within the segment of the population with the most information on the characteristic of interest”. SHFs were chosen based on their known characteristics which would relate to this study.

3.5. Data collection tools

This section identifies and describes the type of data that was collected as well as specific instruments and sources used to collect data. These included questionnaires, focus group discussions and transect walks.

3.5.1. Qualitative tools:

Qualitative data is data that is precise and reliable. Qualitative data is non-numerical but can be observed and recorded. It seeks to understand the meaning people assign to problems (Creswell, 2014).

For this study, qualitative tools that were used included focus group discussions and a transect walk. Qualitative data was collected from the general SHFs as well as from traditional authorities in Kilmun, however traditional authorities had a separate focus group discussion conducted with them. This was done to show respect to the authorities and to also find in-depth information as the authorities are usually easy with the provision of the needed knowledge, unlike general SHFs who are sometimes secretive about some information out of fear of being reported to their authorities.

a) Focus Group discussions:

Focus group discussions (FGDs) consist of a variety of specific and set questions from the researcher to get a clear view of the research topic from the targeted sample population rather than a statistically representative sample. It is used to gain an in-depth knowledge of social issues (Nyumba et al., 2017). FGDs were conducted to understand the beliefs, opinions/ ideas and perceptions attitudes of the indigenous knowledge systems (IKS) SHFs in Kilmun. FGDs for more information from SHFs. The FGDs were conducted in the local language, isiZulu, to encourage the participation of the members. To conduct FGDs, respondents were divided into groups of eight to twelve. This allows for better management, and for all respondent to articulate their view on the subject. The researcher aimed for a 90% saturation rate (e.g. 4–5 focus groups). Additionally, it is critical to maintain a realistic perspective on the degree of saturation desired (e.g., 80% or 90%).

As with every research tool, this one has several advantages and disadvantages. Using this tool has several downsides, including the requirement to reward participants for their time and participation. Additionally, it is biased since one person typically ends up leading and dominating the discussion while the rest of the participants listen silently, resulting in the researcher receiving information based solely on one person's point of view. A lack of honesty from participants is another issue that usually arises from such group discussions(Nyumba et al., 2017).

Advantages of this tool include it being time-saving as it allows many people to be all interviewed at once while providing a diverse set of responses based on the interviewee profiles. It also yields a rich amount of data as it allows proper brainstorming by the participants.

b) Transect Walk:

A transect walk is a walk taken by a researcher through a community of study. This walk shows the improvement of the community, its social, environmental as well as economic resources (Creswell,2014). A transect walk was conducted in this research so that the researcher could be able to see areas of importance based on the study such as the soils found and used for ploughing in Kilmun and the different water systems used for irrigation and their efficiency in promoting food security in Kilmun.

Transect walks were conducted with a maximum of five farmers. Throughout these walks, farmers were the leaders, with the farmers who have been ploughing the land the longest leading the walks. During transect walks farmers clearly showed the different resources and mechanisms they used to survive climate change. Resources such as water and fertile land were shown. Transect walks were also used to show areas in Kilmun that were most susceptible to climate change. Most of these areas were eroded and can no longer be used for ploughing. These walks were used to interview farmers about their adaptation methods and practices towards climate change.

The downfall of this tool is that it only shows the area from the researcher's point of view as the transect diagram is drawn using only the path/route the researcher took while at Kilmun and neglects the rest of the area. The advantage of conducting a transect walk is that it clearly showed the researcher the main resources of the area with the help of the SHFs, so it provided the researcher with tangible and valid proof.

3.5.2. Quantitative tools

Quantitative data is data that focuses more on the aspects of the number of the research. Each data set has a unique numerical value associated with it and these are analysed using statistical procedures (Creswell, 2014). Questionnaires were utilised in this study to assist the researcher in sampling an average number of the Kilmun population to provide a snapshot of the entire community.

Questionnaire:

A questionnaire is a data collection method that comprises a list of questions that are used for quantitative analysis in research. Furthermore, a data collection instrument nearly typically entails asking a subject to respond to a series of oral or written questions.

Table 3.1: The pros and cons of this tool (questionnaire) are as follows:

Advantages	**Disadvantages**
a) For this study, the identities of the interviewees are protected and the questionnaires are usually anonymous, allowing the respondents to share information honestly without fear of being traced back. Open-ended questions allowed participants to provide in-depth information on their feelings, experiences and perceptions on the indigenous knowledge systems of SHFs in Kilmun, KwaZulu-Natal, utilising to adapt to climate change and increase agricultural output to ensure food security. b) The use of questionnaires for the study was beneficial is the questionnaire survey is cheap and do not require as much effort	a) The cost of obtaining the data is often a major expense in studies. It is also hard to ensure that the data collected is of a high standard and reliable as the interviewees are usually anonymous and so the information collected can be hard to be traced back (Creswell, 2014). b) Questionnaires are not always the best way to gather information. For example, if there is little previous information on a problem, a questionnaire may only provide limited additional insight. c) On one hand, the investigators may not have asked the right questions which allow new insight into the research topic. On the other hand, questions often only allow a limited choice of responses. If the

from the researcher as verbal or telephone surveys. Answers are standardised, making it simple to compile data (Creswell (2014). c) A standard questionnaire provides quantifiable answers for a research topic. These answers are relatively easy to analyse.	right response is not among the choice of answers, the investigators will obtain little or no valid information. d) Another setback of questionnaires is the varying responses to questions. Respondents sometimes misunderstand or misinterpret questions. If this is the case, it will be very hard to correct these mistakes and collect missing data in a second round.

3.6. Data Analysis

Descriptive statistical analysis was used for quantitative responses. This meant the usage of the Statistical Package for the Social Sciences (SPSS). SPSS is used by various kinds of researchers for complex statistical data analysis, and processing and analyzing survey data. Also, SPSS allowed for the creation of tables and graphs which helped the researcher analyse responses from the research participants and be able to quantify those answers. For qualitative responses data was analysed by analysing the focus group discussions and questionnaires using content and theme analysis. This allowed the researcher to obtain information about different issues from different views of SHFs.

3.7. Validity and reliability

The term "reliability" refers to the consistency with which an instrument measures the concept under examination, whereas "validity" refers to the amount to which the instrument accurately reflects the abstract construct under examination (Burns & Grove 1993:778,783). Validity refers to the extent to which the content area under examination is covered. Validity is especially critical when conducting knowledge assessments (Polit & Hungler 1999:418).

The questionnaire, focus group discussion, and transect walks were evaluated for their content validity and construct validity, as well as their logic and coverage of the research's scope. The study's validity and reliability were increased through the inclusion and involvement of all smallholder female farmers in the study area. The researcher's willingness to answer questions, the assistance provided to illiterate participants via structured interviews, and the researcher's presence during questionnaire completion all contributed to the study's consistency and validity.

3.8. Ethical consideration

Ethical consideration is about keeping the privacy and confidentiality of participants used during a research Fouka & Mantzorou (2011). This means that whatever answers are recorded down by the researcher they will be recorded in full confidentiality of participants. Because the information provided by participants may be sensitive, which may be dangerous if the participants' names were disclosed, ethical consideration is critical to protecting the participants' identities.

Additionally, ethical considerations include ensuring that individuals participate in the study voluntarily and not as a result of coercion or threat (Fouka & Mantzorou, 2011). Due to the participants' free will, the researcher can be confident that the information provided by SHFs will be valuable and credible, as it was contributed voluntarily. Taking ethical factors into account in research also requires researchers to be candid with participants and avoid making empty promises to coerce them into participating even when they are not interested. The University of KwaZulu Natal's Ethical Committee granted permission for this investigation under the protocol reference number HSS/1657/016M.

Summary

Chapter 3 described the research design and technique used to accomplish the research objectives. The research was guided by an integrated research strategy. A case study research design was used for this objective. A questionnaire, focus group discussions, transect walks, observational field notes and document analysis were used to collect data. To analyse data, descriptive statistics, themes, and content were primarily used. Ethical principles were followed, and concerns about validity and reliability were addressed.

CHAPTER 4
RESULTS AND DISCUSSION

4.1. Introduction

This chapter describes the results of the data followed by a discussion of the research findings. The findings relate to the research questions that guided the study. The data was analysed to determine the various indigenous knowledge systems that smallholder female farmers in Kilmun employ to adapt to climate change and to improve agricultural production while maintaining food security. The data was collected using self-administered questionnaires completed by 100 SHFs (n=100), yielding a response rate of 100%.

4.2. Results and Discussion

The following section clearly explains the demographics of the Kilmun community. It clearly shows their different perception's towards climate change.

Literature demonstrated that women make up a greater proportion of SHFs (Hadgu et al., 2013). The explanation for this is that many males are offered the opportunity to seek work to be able to support their families, while women are forced to stay at home to provide for their children and farm operations. This is why women are more concerned about climate change than men, despite the fact that they do not own the land they plough. This was also confirmed by the fact that even during data collecting, the majority of participants were women, while men were stated to be working in other cities to support their families. Additionally, studies have shown that women and children are more vulnerable to poverty and hunger (Hadgu et al., 2013). This is because they are left at home with little or no means of subsistence and because women lack education and rely on their husband's earnings.

4.3. Demographics of smallholder farmers in Kilmun

This section analyses the various demographic characteristics of the respondents. Supporting tables and figures are provided. Age, level of education, farming experience and accessibility to information influenced the likelihood of farmers to correctly perceive climate variability.

Table 4.1: Education level of the sample population in Kilmun

Female		
Education Level	**Frequency**	**Per cent (%)**
No formal schooling	14	14.0
Primary school	30	30.0
Secondary school	27	27.0
Tertiary	0	0.0
Male		
No formal schooling	6	6.0
Primary school	11	11.0
Secondary school	12	12.0
Tertiary	0	0.0
Total	**100**	**100.0**

4.3.1 Education level of respondents and their knowledge of climate change

Smallholder farmers (SHFs) are one of the most vulnerable communities to climate change but attempt to help farmer adaptation are hampered by a lack of data on their experiences and responses to climate change. Additional research is required to understand how different types of SHFs perceive and react to climate change, as well as how to adjust adaptation systems to the unique circumstances of smallholder women farmers. Education is central to understanding, mitigating and adapting to climate change. Results indicate that out of the sampled population 30 females and 11 males have minimal education level (primary education). According to the Ingwe IDP (2015/2016), generally, education levels are low in the Ingwe Municipality where only 13.8% (no schooling) 17.7% (have a matric) and 4.0% (higher education).

The findings from this study support the current status quo in the study area. As a result, the low levels of education could have an adverse effect in terms of climate change mitigation and adaptation in the study area. Furthermore, the study sample constitutes a larger samples size for female farmers, who are responsible for agricultural production and food security. Also, they have a lower level of education as opposed to their male counterparts thus leaving them more vulnerable to climate change as a result of their low level of education and their ability to mitigate and adapt against climate change. Additionally, while SHFs are aware of indigenous knowledge systems (IKS) to survive, they have limited awareness about climate change and its causes due to a lack of proper formal education, resulting in poor adaptation and mitigation strategies against climate change. According to Thornton & Jones (2003), educated people have a better understanding of climate change and its causes, and are thus more capable of adopting lifestyles that aid in adaptation and mitigation efforts in the face of climate change

Since women are left behind to plough the land, studies have shown that they are very knowledgeable about the indigenous knowledge systems used in agriculture to deal with climate change. Studies have also shown that rural women SHFs contribute a lot towards food security and the alleviation of poverty, hence the government should focus more on equipping these farmers with the necessary skills and equipment to continue farming as they hold the key to food security. Looking at the sample size one can notice that there is a large number of women left behind to plough the land while men are away at school and work. The Sustainable Development Goal 2 calls for the eradication of hunger, as indicated by the phrase 'Zero Hunger.' In keeping with these objectives, women play a critical role in agriculture not only in South Africa but throughout the world; they are the backbone of agriculture, performing between 50% and 80% of field labour.

According to Denton (2002), women make up 80% of the agricultural workforce; yet, according to Grantham (1996), Nepalese males are responsible for land preparation, ploughing, and harvesting. Men are assigned these tasks, while Nepalese women are assigned fodder gathering, livestock feeding, kitchen gardening, organic fertiliser and manure collection, and crop fertilising. Nepalese women also work on farms, preparing seedbeds, sowing, planting, and weeding, as well as seed selection, threshing, food processing, and water gathering. Olatokun and Ayanbode (2008) suggest in their research that rural women are critical to development in African countries because they play a variety of roles in development. They contribute to family and wage activities, engage in marketing and distribution of food products, and secure the family's and society's survival as wives and mothers.

4.3.2 Ages of the study participants

The graph below depicts the age distribution of the sampled population. The results indicate that a sizable proportion of participants are youths. This may demonstrate that agriculture and food security have a future in Kilmun, as it is well known that the youth are rarely interested in agriculture. From the data in Table 4.1, it is clear that the majority of these respondents are female. This further demonstrates that women are agriculture's driving force. The high level of engagement among females of the ages depicted in Figure 4.1 below is due to the high employment rate and local norms that assume women are only responsible for household responsibilities and agriculture, while men can continue their education and seek work to support their families. Women also have limited decision-making positions in a patriarchal culture, are at risk of losing traditional rights, and have little time for other activities due to the time spent bringing water and firewood (Sithole 2019).

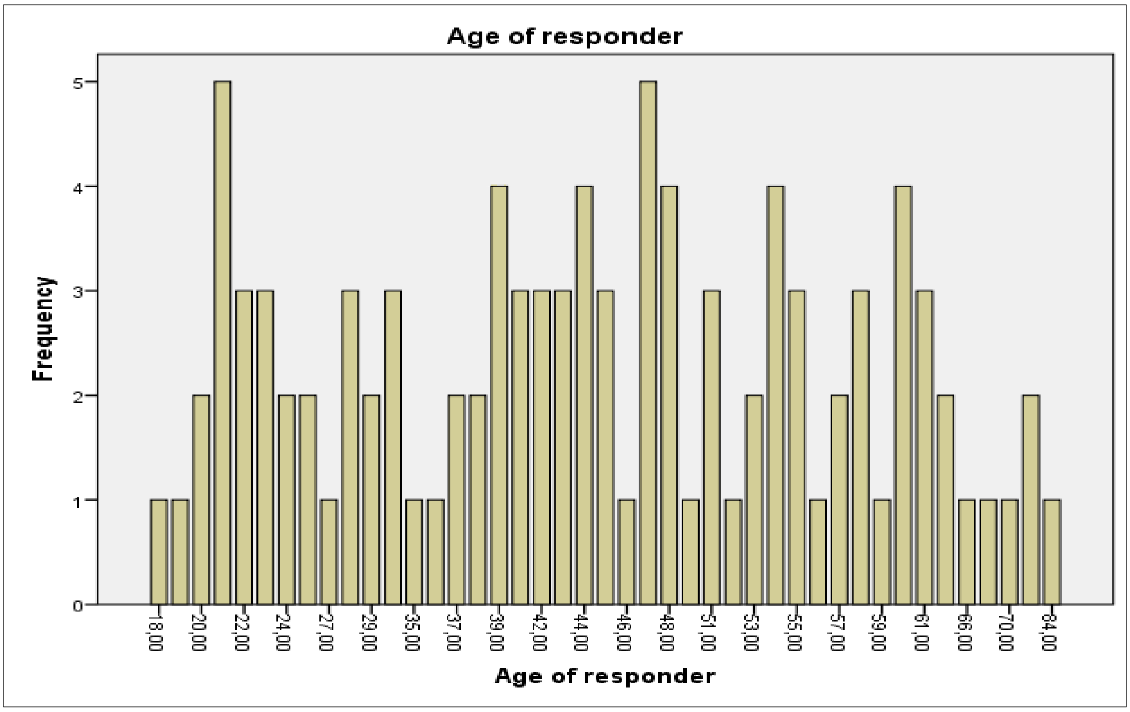

Figure 4.1: Ages of the participants

Table 4.2: Employment status of smallholder farmers sampled from Kilmun

Employment status	Frequency	Percent (%)
Full-time	3	3.0
Part-time	34	34.0
Unemployed	47	47.0
Pensioner	16	16.0
Total	**100**	**100.0**

4.3.3 Employment status

Low income and reliance on natural resources exacerbate climate change vulnerability (Rout & Pragyan, 2013). 3% of SHFs participants work full-time, 34% work part-time, 47% are unemployed, and 16% are pensioners (see Table 4.2). Cultural norms such as the requirement for girls to marry young and assume household responsibilities, as well as a lack of employment opportunities in the region, were cited as contributing to the SHF's high rate of unemployment. Women account for the highest proportion of socially inactive residents in the municipality, according to Ingwe LM (2015). Furthermore, the 2015/5016 Ingwe annual reports state that fewer than 10% of people are employed in Ingwe. Around 5% are unemployed and around a further 4% are discouraged work-seekers. The high level of economic inactivity among women in the Municipality can be due to women's household roles, obligations, and cultural norms, which consume their time and prevent them from seeking jobs. Additionally, women are responsible for household food security, which requires them to be actively engaged in agriculture, which is the primary source of income for certain households.

Table 4.3: Marital Status of the sampled populations

Marital status	Frequency	Percent (%)
Married	42	42.0
Divorced	2	2.0
Widowed	10	10.0
Single	46	46.0
Total	**100**	**100.0**

4.3.4 Marital status

Individuals' vulnerabilities and reactions to climatic and non-climatic threats vary depending on how societal expectations, rules, and policies interact with various aspects of their identity. One must abandon traditional approaches that rely exclusively on male and female binary categories and instead address intersectional variables, such as how marital status, age, ethnic origin, and class, among other factors, communicate with gender to influence vulnerability and response strategies to climate change. The way households handle risks is influenced by factors such as income, marital status, and age. One observes these various identities manifesting differently in various contexts, impacting an individual's adaptive capacity to respond to climate-related risks.

Surprisingly enough and contrary to what literature shows, most SHF who participated in the study are single (46%). Reasons for this are unclear since in many rural areas people marry at a young age, increasing the number of married people. When SHFs were questioned about this, some said they were not ready for marriage or already had life partners with whom they live but are not married. Women are at the frontline of climate change regardless of their marital status. The findings in this study indicate that young single women are still actively involved in climate change mitigation and adaptation using IKS. They often do not have to wait for spouses who are often the decision-makers to instruct those who are married what should be done though women are responsible for all the farm operations while the spouse is working away from home.

Table 4.4: Household income

Household income	Frequency	Percent (%)
Below R800	22	22.0
R801-R1500	45	45.0
R1501-R3500	29	29.0
Above R3500	4	4.0
Total	**100**	**100.0**

4.3.5 Household income

In the table above one can see that most households in Kilmun have an income between R801-R1500, R1501-R3500 and below R800 this means that most SHFs from Kilmun have little money to buy the necessary equipment to help them deal with climate change. This also implies that they rely significantly on rain-fed agriculture, as they lack the financial means to purchase food from stores monthly. Given that the majority of SHFs are married/have partners, it is also true that some of these stay-at-home wives receive monthly remittances from their husbands/partners to purchase food and care for the family while the husband is at work.

Farmers argued that now that the seasons have changed, they are unsure where and when to sow their crops. Untimely winds, heavy hailstorms, flooding, and other natural hazards have been occurring at an alarming pace, wreaking havoc on crops and livestock. According to one farmer, the majority of their livestock die of starvation during the winter. Farmers assert that they rely on melting snow to keep the soil fertile to allow vegetation to grow so that their livestock can graze on it, but when this does not occur, they lose their livestock and food ploughed during the winter as they have little income and in severe cases rely solely on agriculture for income generation. Female family members perform the majority of work on male-owned farms, but earn little cash from crop sales and have little choice over how that income is spent. For example, a study of sugar farming contracts in Africa discovered that while women controlled less than half (43%) of the contracts, they contributed the majority of labour on 60–70% of contracted plots (Porter and Philips-Howard 1997). Not only did a review of the literature reveals that this pattern is pervasive in African contract farming systems, but it also revealed that men frequently spend their contract farming revenue on personal rather than family requirements (Schinder and Gugerty 2010).

This section of the study will examine **subproblem 1**: determining the risks associated with climate change as seen by SHFs.

4.4.1 Farmers' understanding of what climate change is and its causes

Agriculture is a climate change vulnerability and a producer of greenhouse emissions (GHGs). Farmers are under pressure to alter their agricultural operations to cope with increasingly unpredictable weather (adaptation) and to minimize GHG output (mitigation). This section will discuss farmers knowledge about climate change and its causes.

Table 4.5: Importance of climate change to you personally (farmers responses)

Question	Participant comment
(a) What is climate change?	Climate change is caused by severe drought and other natural disasters that promote food insecurity. These include hail storms, extreme rainfall and heavy winds.
(b) How important is climate change to you?	Climate change is important to me as it affects my crop production
	Climate changes seasons, therefore making it hard for me to know when to plant as I usually use seasonal changes to know when to start ploughing.
	Climate change is not so important to me as it does not affect me when I plough. I also do not heavily rely on agriculture so climate change does not affect me that much.
	Climate change is important to me as it is costly for me to adapt to it since I need to rely on selective cropping and drought-resistant crops which is costly.
(c) What do you think are the causes of climate change?	Burning of waste irresponsibly
	Neglect of traditions/ ancestors and the government taking over people's cultures, replacing them with the constitution.
	People have stopped praying to God and instead have raised their standard on sinfulness.
	Development included cutting down trees to build roads.

Most farmers believe that climate change is when there is severe drought and other natural disasters that result in little to no food production. The causes were said to be the burning of trash which causes the atmosphere to be dirty. Some responses were that climate change is caused by people who disrespect nature and God, therefore concluding that God is angry and is now punishing humankind for its sins. Elders of the Kilmun community added, "*We don't know what's happening to God? It used to be when there was enough rain, life was smooth. God was with us even when it was very hot, there is still rain. When there is rain, our herd can graze peacefully and grow food. The grass is our milk for our life. Today the rain is not coming as soon as usual, and when it does rain, it rains once and then we might go two to three weeks without rain until the plantings die.*"

According to the chief and his committee, the depletion of traditional leadership has resulted in a chaotic society. Because traditional leaders were custodians of cultures, this chaos contributes to climate change because people are no longer connected to nature and heritage and thus lack the fundamental adaptation and mitigation skills that were once used for generations against natural disasters. Additionally, traditional leaders lamented that the government now owns and controls everything, including people's customs and traditions, upsetting the systems of various societies and that people have forgotten to appease their ancestors to continue caring and protecting them from food insecurity and economic loss.

The chief proposed that the government collaborate with traditional leaders to ensure that communities operate and develop sustainably to improve food security. Additional responses from SHFs regarding their views on climate change factors included the construction of highways and the removal of trees. They argued that the constant development of towns and road construction contributes to global warming and climate change, destroying their waterways and fertile land.

Table 4.6: How important is the issue of climate change to you personally?

Importance of climate change	Frequency	Percent (%)
Very important	86	86.0
Not at all important	14	14.0
Total	**100**	**100.0**

In the questionnaire's SHFs were asked about the importance of climate change to them. A large percentage of 86% said that climate change is very important to them as it affects their agricultural growth and production. Hence concluding that it is important that the government equips them with different mitigation and adaptation measures against climate change.

Looking at (Table 4.6) it is clear that the numbers differ strongly between farmers who see the importance of climate change and farmers who don't. Reasons for this could be that many SHFs did not attend high school and higher educational institutions (see table 4.2 above) therefore lack knowledge about climate change and its impacts on agricultural production and food security. There is widespread agreement that understanding of climatic variability is dependent on the availability and accessibility of information (Scoones, 2004; Recha et al., 2008). According to survey data, indigenous knowledge and media were the primary sources of information on climatic conditions in the research area. The number of farmers who sought information from the media indicated that they were still grappling with the concept of "climate variability." This insight may be viewed as a catalyst for developing an indigenous strategy for climate variability mitigation and management (Bello et al., 2013).

4.4.2. Farmers' perceptions and knowledge regarding the link between climate change and food prices

SHFs believed there was a link between climate change and rising food costs as a result of little rain or excessive rain that hampered and harmed ploughing. When this occurs, SHFs are unable to self-sufficiency and are compelled to purchase food from stores. Commercial farmers become aware of this and subsequently increase food costs, knowing that people are having difficulty growing their food as a result of climate change adds (Badzej et al., 2014).

Additionally, SHFs have expressed concern about the risks connected with climate change, including financial insecurity as a result of being unable to sell crops due to unpredictable weather changes that disrupt ploughing seasons adds (Badzej et al., 2014). This impacts not only their household income but also their food security, as they must now rely on food grown on infertile ground, which may exacerbate their health problems and add to their financial hardship.

According to Gerald et al, (2009) higher temperatures reduce yields of desirable crops therefore encourage weed and pest proliferation. The developing and underdeveloped nations suffer economically from this as they are already vulnerable and food insecure. In 2005 about 2.5 billion in developing countries relied and survived on agriculture for livelihood, today about 75% of that population is considered poor because of the increase of food prices as a result of climate change (Gerald et al., 2009).

4.4.3 Farmers perceptions of Government interventions towards climate change

The inability of over one-third of the farmers to correctly perceive climate variability is attributed to the limited presence of extension workers in the area. The latter, this study argues, represents an important arm of government responsible for the oversight of agricultural activities, especially in rural communities. Failure by extension workers to monitor the activities of SHFs (perceptions, coping and adaptation strategies) compromises opportunities for timely interventions, where incorrect mitigative strategies have been adopted. The current practice is therefore detrimental to the drive for food security in South Africa. To guarantee the sustainability of the sector, intervention by the government and other key stakeholders to address underlying factors responsible for observed discrepancies is recommended.

Climate change adaptation is a priority for many scientific researchers to enhance agriculture, particularly in third world countries that rely significantly on rainfed agriculture to survive. As the literature has demonstrated, climate change may increase the frequency of extreme weather events such as flooding, thunderstorms, and heatwaves, requiring to modify our living conditions (Nelson et al., 2009). This is precisely why the government should make a greater effort to send out individuals who can educate SHFs about climate change and the many adaptation and mitigation techniques available. The limited presence of extension officers in the area may have provided the additional impetus. Inaccessibility to information may be partly responsible for poor government interventions by the smallholder women farmers.

This section of the chapter will present and discuss the findings from **subproblem 2**: determining the agricultural implications of climate change and variability.

4.5. Determining the impacts of climate change variability on agriculture amongst smallholder women farmers.

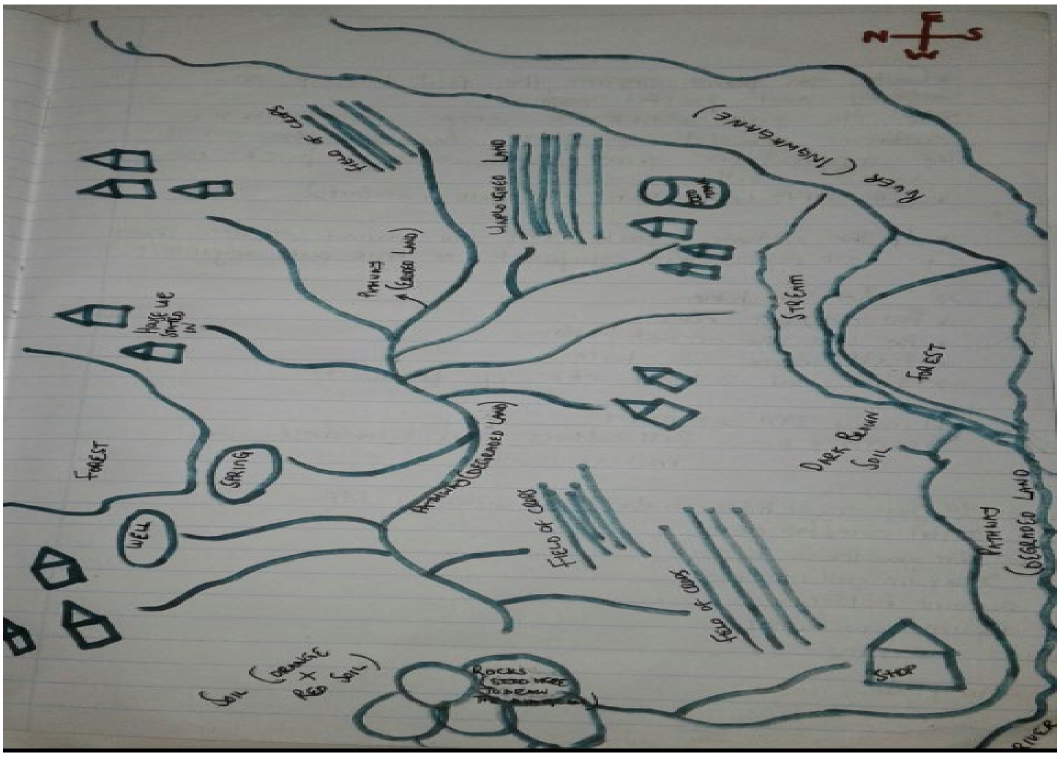

Figure 4.2: Rough sketch of a transect walk conducted by the researcher

The transect walk above provides an overview of Kilmun. The researcher stood on the rocks to obtain a clear view of the region. Kilmun's soil is red and orange, which is rich in iron and promotes plant development, while black dirt would be much liked for its nutritional value and ploughing ability. Another major issue confronting Kilmun SHFs is a lack of appropriate ploughing equipment, as well as climate change, which has altered the seasons, affecting the soil's characteristics and fertility, making it difficult to plough according to seasonal variations. Kilmun's SHFs lack adequate infrastructure, including forests for wood and a river (Ingwagane), wells, and springs for irrigation.

4.5.1. Seasonal calendar from Kilmun smallholder farmers

Seasonal calendars are also used by SHFs to predict weather changes and be able to know when and what to plough during a certain seasonal change. The seasonal calendar below forms part of the IKS and was created using the information provided to the researcher by the SHFs during data collection on the field. The seasonal calendar shows some of the crops that are ploughed by SHFs in Kilmun throughout the year.

Table 4.7: Seasonal calendar of Kilmun smallholder farmers

CROPS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Beans	✓	✓	✓	✓	X	X	X	X	✓	✓	✓	✓
Butternut	✓	✓	✓	✓	X	X	X	X	X	X	✓	✓
Cabbages	✓	✓	✓	✓	✓	X	X	X	X	✓	✓	✓
Spinach	✓	✓	✓	✓	✓	X	X	X	X	✓	✓	✓
Tomatoes	✓	✓	✓	✓	X	X	X	X	X	✓	✓	✓
Carrots	✓	✓	✓	✓	X	X	X	X	X	X	✓	✓
Mealies	✓	✓	✓	✓	X	X	X	X	✓	✓	✓	✓

"A seasonal calendar helps farmers understand how seasonal changes in agriculture and livelihood tasks, cash flow, labour requirement, as well as the health environment, affect farmers access to food, health and care" (USAID 2018:20).

Seasonal calendars allow farmers to easily recognise seasonal changes, harsh weather conditions and other big events. This allow farmers to know when to plough and what to plough adds the USAID (2018).

The seasonal calendar above does not show all the crops, but those that the farmers in Kilmun claimed to largely plough. According to SHFs from Kilmun the first four months, October, November and December are the easier months for planting as they are usually accompanied by sufficient rainfall and sunshine which are both needed for the crops to grow healthily, adds the SAWS (2021).

According to the SAWS (2021) May, June, July and August are dry months that usually have no rains, making it hard for farmers to plough as the soil is usually dry and infertile in these months. In June and July, there is usually hail and frost, which discourages SHFs from ploughing during these months. This information was articulated by the SHFs during focus group discussions.

Farmers also added that in August they usually do not plough that much as the soil is still recovering from the harsh winter conditions of the previous months, so to survive they eat food that they had stored in the traditional granaries, and if they choose to plough any crops they choose them carefully as the weather conditions are harsh for ploughing around this time, (USAID, 2018).

Table 4.8: Soil quality changes

Have you observed any soil quality change in your farm or land over the last 5 to 30 years?		
Observation of soil quality	**Frequency**	**Percent (%)**
Yes	85	85.0
No	15	15.0
Total	**100**	**100.0**

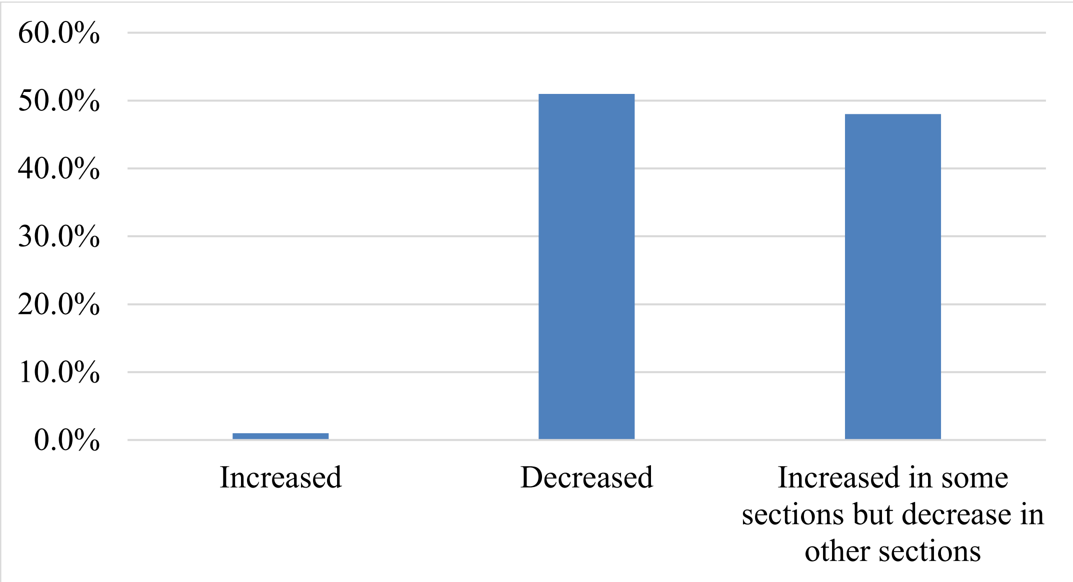

Figure 4.3: Soil quality changes

Both (Table 4.8 and Figure 4.3) above demonstrate a distinct lack of equipment to assist farmers in reducing agricultural losses due to climate change. According to table 4.8 above, soil quality has deteriorated severely for 85 % of the tested population, with a roughly 55 % in soil fertility. Including changes in soil quality and fertility affect ploughing and contribute to food insecurity, hence increasing the hazards connected with climate change, such as food insecurity and health problems caused by a deficiency of minerals and nutrients in the human body.

The government should act promptly to assist SHFs, as they are the major producers of food in South Africa and other third-world countries worldwide, and are critical to rural poverty alleviation. Additionally, the literature demonstrates that SHFs are the primary players in agriculture throughout the world, particularly in third world nations, and are critical to achieving food security (UNDP, 2015). The figure above illustrates how farmers have observed and documented changes in the quality of their soil over time. Many of these farmers reported that the soil's quality had deteriorated by more than 50%, making it nearly impossible for SHFs to grow enough food for consumption and sale, hence reducing food insecurity. Farmers also stated that a lack of financial resources to purchase manure further impairs their ability to make their soil productive. Many have complained that manure prices are prohibitively high and that they are unable to afford it. Due to the decline in soil fertility, SHFs face food insecurity, affecting both the quality and quantity of their food.

4.5.2 Farmers perceptions of the impacts of climate change and variability on agriculture.

Table 4.9: Change in agricultural productivity over the last 5 to 30 years

Do you think the length of the growing season has changed?		
	Frequecy	**Percent (%)**
Yes	67	67.0
No	33	33.0
Total		
% within the farming major source of income		
Yes	90	90.0
No	10	10.0
Total		

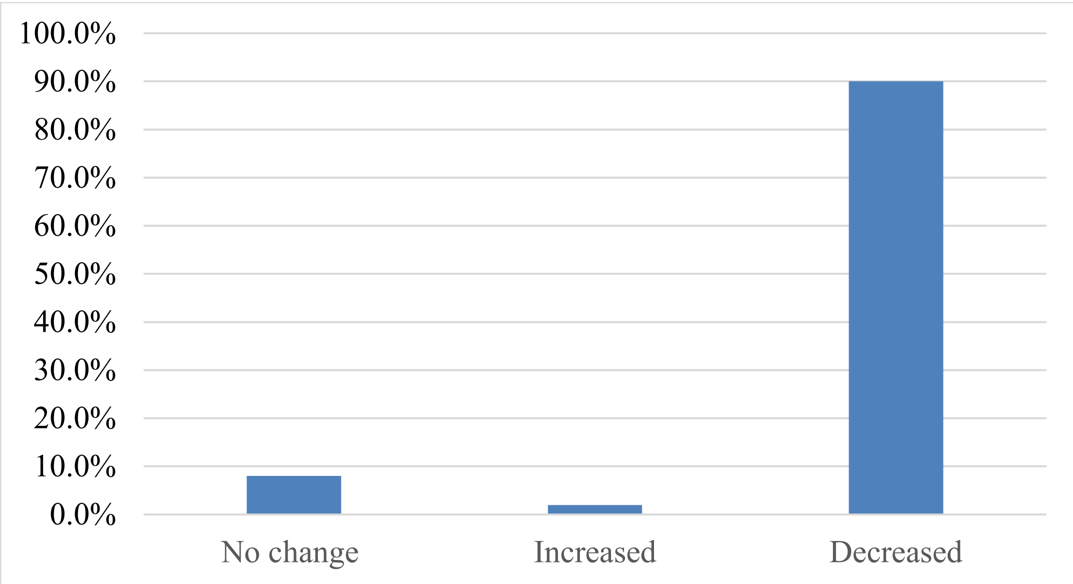

Figure 4.4: How has the agricultural productivity of your land changed?

A greater proportion (67 %) of SHFs reported that the length of the growing season has increased, whereas just 33% disagreed and reported no change. When questioned about changes in the agricultural productivity of their land over time, 90% stated that it had dropped, slightly more than 3% stated that it had increased, and 9% stated that there had been no change.

The SHFs were then questioned about the possible causes of such changes in agricultural productivity; the majority of them stated that decreased agricultural productivity on their land was due to people's sins, trash burning, and a few (14%) stated that climate change/global warming was the primary cause. Most farmers who positively (86%) perceived variability in climate were in the age group, 41-50 (40%) and 51-60 years (35%), compared to farmers below the age of 30 years (15%) or above the age of 60 years (10%). The reason is that farmers younger than 30 years do not have extensive farming experience while those above 60 are not as focused as they used to be. While eliciting responses on possible reasons for land infertility, it was clear that many SHFs continue to lack an understanding of climate change, its associated hazards, and causes. Amadou et al. (2015) asserted that age and experience have a favourable correlation with an accurate impression of climate variability. Most results have indicated that a sizeable portion of participants are youth.

Table 4.10: Have you observed any losses from your agricultural produce as a result of the climate changes?

Losses from your agricultural produce as a result of the climate change		
Observed losses in agricultures	**Frequency**	**Percent (%)**
Yes	85	85.0
No	15	15.0
Total	**100**	**100.0**

As illustrated in the table above, climate change and a lack of adequate equipment have resulted in significant agricultural losses for a large number of SHFs. This contributes to increased food insecurity and economic difficulties, as SHFs rely primarily on agriculture for food and money. One farmer stated:

" Ever since the weather started constantly changing there has been a lot of disease on our livestock. For example, our hens might be very weak, after a day or two she'll die. We can't do anything about it." Another farmer said, *" there was always rain, but that's no longer the case. Now it is even still colder. Normally in September and October, there are good rains that can get into the earth. But not anymore."*

4.5.3. Measures used for irrigation in Kilmun among smallholder farmers

Table 4.11: Irrigation measures found in Kilmun

Water for irrigation	Frequency	Percent (%)
Tap	10	10.0
River (stream)	38	38.0
Dam	2	2.0
Borehole	4	4.0
Spring	34	34.0
Well	3	3.0
Other	9	9.0
Total	**100**	**100.0**

Table 4.11 above demonstrates that SHFs in Kilmun have inadequate irrigation water access. Limited access to water is one of the issues SHFs experience, contributing to their crop losses. While climate change and global warming are accelerating, water for irrigation is becoming more scarce as South Africa experiences less rainfall for agricultural uses. In Africa, the majority of the agricultural industry is reliant on rainfed irrigation, but with climate change, this is becoming increasingly difficult to achieve. While commercial farms can afford irrigation equipment, SHFs are obliged to remain hesitant and wait for rain before ploughing, exacerbating South Africa's food insecurity and poverty. A farmer stated that "*There is even less food produced*."

Figure 4.5: Ingwegane river- water source used for irrigation in the study site

4.5.6 Water conservation and management measures

From the irrigation measures stated above, it is evident that farmers require additional measures to save water resources, as the majority of their irrigation measures fail to function during dry periods. Farmers use wells, twenty-litre buckets, drums, and twenty-litre water bottles to conserve and manage water. The majority of wells are drilled into the ground, and some are surrounded by stones to protect them from pollution. Springs were also mentioned as another source of water in the Kilmun area, as the area is quite watery, according to farmers and some local agricultural extension officers who confirmed that water shortages occurred between 2015 and 2016, but the impact was minimal due to the area's high hydrological table. Boreholes and dams were also reported by researchers in the area, as well as by SHFs. Boreholes have also been discovered in and near Kilmun.

Figure 4.6: Borehole used by the community

This section of the conclusion and discussion chapter will examine **subproblem 3**: the role of indigenous knowledge systems in agriculture for climate change adaptation.

4.7 Analysing the significance of IKS in climate change adaptation in agriculture

Indigenous knowledge systems are characterised as institutionalised indigenous place-based knowledge that is anchored in indigenous cultures and has been built upon and frequently passed down through oral history (Osunade 1994; Orlove et al., 2010). IKS is informed by the observations and experimentation of earlier generations and gives an innate connection to one's surroundings and environment (Nyong et al., 2007). Following several years of observations

(Ziervogel and Opere 2010), IKS weather forecasting is embedded and established in several African cultures and communities, with diverse indicators used by various tribes and cultures to anticipate future weather conditions. Farmers, pastoralists, and indigenous experts in East Africa monitor local weather phenomena and the behaviour of living organisms (appearances and behaviour of specific insects, animals, and plants), wind direction, and cloud types to forecast local weather conditions—the onset, cessation, intensity, and distribution of rainfall, as well as the occurrence and magnitude of drought and flood events.

4.7.1 Significance of seasonal changes according to smallholder farmers

With over 500 million smallholder farms globally, this is a long-standing practice in agriculture. Although SHFs cultivate crops on scarce land and resources, they account for between 70% and 80% of global farmland and provide the majority of the world's food. However, smallholders are frequently trapped in a vicious cycle, resulting in much lower output than their large-scale competitors. As a result, seasonal changes contribute significantly to our understanding of climate change when indigenous knowledge systems are used. As a result, the majority of farmers and pastoralists rely on IKS, which employ local indicators and experiences to monitor and forecast weather conditions. While IKS-based forecasting is embedded and established in a wide number of communities throughout Africa, comprehensive research and documentation of IKS for weather forecasting, including its accuracy and dependability, are mostly lacking (Radeny et al., 2019).

Table 4.12: Indigenous knowledge systems indicators of seasonal changes in Kilmun

Season	Significance
Spring	• Heavy rains • Trees and flowers start becoming green • animal start gaining weight, especially horses • Phezukomkhono bird sings (farmers must begin to plough the land).
Summer	• Trees are green and flowers flower • Animals, especially sheep, cows, horses and mutton lose excess hair they might have grown in winter to keep themselves warm • Clear skies, harvesting season for farmers
Autumn	Traditional leaders collect food (first harvest) from the community and send it to the king for Shawarma to honour him • Fresh mealies are harvested
Winter	• Animals grow thick hair to help them survive the cold, windy and frosty winter which follows after the end of April • Water systems dry up and if there is available water it is ice cold

Observation of environmental changes plays a significant role in SHF's life; through observing these changes, they learn what to plough during specific seasons. This knowledge enables them to determine when and when not to plough. It enables them to monitor rainfall trends. When asked where the majority of SHFs obtained their knowledge, many respond that their parents and great grandparents taught them. This means that agriculture is threatened for many rural households, as literature has demonstrated that older people are more interested in agriculture than younger ones.

Since older people are the custodians of indigenous knowledge and have been handing it down from generation to generation, it is safe to conclude that food insecurity will prevail in rural regions in the years ahead when the majority of older people have died. The purpose of the research was not only to collect data from the community for the thesis, but also to raise awareness about climate change, the transmission of generational agricultural knowledge from one generation to the next, and to teach SHFs that they can receive government incentives and assistance to improve their livelihoods in agriculture and food security.

4.7.2 Indigenous knowledge systems indicators of weather changes in Kilmun

Planting times are very important because they help SHFs know when to plant. To do this, farmers use their indigenous knowledge to adapt to rainfall changes. Due to climate change, many farmers have complained about experiencing little to no rainfall which is unfortunate as they rely heavily on rainfall to plough. To deal with this farmers address the changing climate by changing planting dates, planting drought-resistant crops short-season crops (Ubisi,2015). To predict weather changes SHFs observe the changes in clouds, the appearance of certain animals, changes in moon phases and many other environmental factors.

Table 4.13: Indigenous knowledge systems used to observe weather changes

Indicator	Significance
Singing of certain birds	Phezukomkhono bird, farmers should start ploughing. Crocking of frogs indicates rain and wetland.
Moon phases	A full moon indicates calm weather Crescent moon-faced downwards indicates heavy rains
The appearance of certain animals	The appearance of ***hornbill*** (ingududu) feathers, heavy rainfalls are coming.
Cloud colour	Clear skies indicate no rain, dark skies indicate heavy rainfall in the next few days

In addition to the data reported in (Table 4.13), farmers indicated that they have faced severe drought and a scarcity of agricultural products over the last five years. They claim that this is because, when they were younger, they lived lifestyles that were pleasing to God, which is why he blessed them with food and rain, but now people are filled with sin and disobey God. In the past, elderly women would travel to **Fulwani Mountain** to pray for rain, which would occur; they would even offer sacrifices such as money and cattle, which God would accept. That no longer occurs as a result of God's wrath towards humanity.

Several farmers did comment, however, during the focus group discussions, that they are gradually losing interest in agriculture simply because the indigenous knowledge they once used to represent changes in the weather is eroding. Many argue that climate change has altered the seasons and that changes in the environment now do not always imply what they did in the past. Many of these farmers indicate that they have learnt to rely less on IKS and more on the information they receive from the government since they now send agricultural professionals to teach them more about climate change adaptation methods. In line with the above, Dube and Munsaka(2018) put forward the following challenges that are faced by rural women, this type of knowledge (indigenous knowledge) is not wholly trusted by many in the community and it lacks documentation. When government trainers come they teach SHFs more about climate change, agriculture and they provide them with manure and seeds. This means that researchers and SHFs now understand that a brighter future for food security means that IKS and scientific knowledge must be incorporated together to come up with solutions that are more resilient to climate change.

4.7.3 IKS used in crop selection and planting practices

In many rural areas, rain-fed agriculture is a livelihood**,** but with climate change and global warming affecting this, SHFs must find new soil conservation practices to survive. Soil conservation practices used by SHFs in Kilmun include the use of chemical fertilizer, improved seeds, organic fertilizer, legume inter-cropping and anti-erosion measures (organic fertilizer). Going through literature one can see that in many rural areas many SHFs have adopted soil conservation practices to help them enjoy higher crop income and better food security status compared to the non-adopters (FAO,2015). A farmer reports that, *"Over the years we have noticed that our plants do not grow the same way as they used to before. The yields have decreased and the soil has become infertile. We lack proper irrigation measures and therefore rely heavily on rain-fed agriculture. It is unfortunate that rains have decreased because of climate change forcing us to find new measures for planting practices and crop selection. To better conserve our soil and adapt to climate change we often use improved seeds and inter- crop our plants, these are just a few examples amongst many other measures we use for soil conservation and crop selection".*

Several studies have been conducted around the world based on adaptation measures used by SHFs against climate change. According to Ubisi, (2015) there are over 104 adaptation strategies used by SHFs, and these include diversification of on and off-farm activities; farm financial management; government interventions in infrastructure; health and risk reduction; and knowledge management, networks and governance (Gbetibou et al., 2010). The choice though to adopt a certain adaptation measure solely depends on them.

According to Gbetibou et al. (2010) amongst the adaptation measures mentioned above, others include mixed cropping, crop diversification, water conservation practices and switching from farming to non-farming activities. Some farmers added that they plant drought resistant crops, even though they are costly and require large amounts of irrigation. Farmers can only adopt a certain strategy depending on their financial status, this means that farmers who are well off can adopt a majority of these strategies while the one's that aren't cannot afford to adopt expensive strategies.

" We do not have enough money to buy enough manure as we are not well off, so in order to make our soil fertile we usually bury rotten food in the ground. This helps to re-moisturize the soil therefore making it fertile and rich with nutrients for us to plough and sell food in order to have an income". We also inter-crop our and diversify our plants so that even though other plants get damaged but some survive the harsh conditions of climate change".

In all honesty, it is fair to see that SHFs will find it difficult to rely on these adaptation measures as they are expensive. The government therefore must intervene and implement affordable development strategies that promote sustainable agriculture for SHFs too.

4.7.4 IKS used for food storage & preservation used by smallholder farmers in Kilmun

According to SHFs sampled in Kilmun, traditional granaries are the best storage items, even though many of them complain that a pest called Imbovane and climate change pose threats to storage. Canning is also another storage method farmers used to preserve their food.

To preserve potatoes after harvest the SHF usually dig a hole in the earth in which the collected potatoes would be put. Enough grass is first put in this to protect the potatoes from being eaten by termites and destroyed by water, then the potatoes are neatly arranged on top of the grass, following the potatoes, another pile of grass is put on top of the potatoes and the hole is closed. This was the most convenient method of storing and preserving potatoes, according to the majority of SHFs. Potatoes can remain unspoiled in this dug hole for up to three months.

4.8 General adaptation measures

To save on maize meal costs the women usually plant sorghum and use it for both porridge and home-brewed beer. To adapt to food insecurity women usually play stokvels to save up money to buy food. During seasons of soil fertility and good rain, women plough food and save on grocery costs

For water storage during periods of droughts women said that they store water in buckets and that limitations on water use are usually put in place by the chief. For animal health, SHFs added that they inject and dip their cattle to remove ticks and the sickness called ***Mbendeni.***

SHFs stated that during droughts, they vary their crops by growing a range of crops on the same field to ensure the success of drought-tolerant plants. Plough times are also adjusted to create more favourable circumstances for plant growth.

4.9 Summary

Chapter 4 outlined and summarised the study's descriptive findings. Women are the primary household heads in Kilmun, according to socioeconomic data. This is because they are responsible for their families when their husbands are at work. Kilmun has a very low employment rate, which is a result of patriarchy's long-standing marginalisation of women through generations. It is obvious from the results that women from Kilmun can support their families by relying on agriculture for food to sell and eat and hence rely on IKS to adapt to climate change due to a lack of scientific understanding. The findings indicate that SHF is aware of climate change, even though they lack the specialised information necessary to comprehend it and its causes precisely due to their lack of education. The sinful nature of humans was cited as one of the causes of climate change and global warming, among other factors.

SHF included a variety of techniques for irrigation, soil management, and food preservation. This demonstrates how SHF rely on IKS and have benefited from it over the years. Even though SHF relies on IKS to thrive, the critical necessity for government intervention to educate SHF about climate change and adaptation was emphasised. The subsequent chapter discusses the research's conclusions and recommendations.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

A critical analysis of the issue of rural smallholder women farmers, Indigenous Knowledge Systems (IKS) and agricultural research for sustainable livelihood in South Africa is needed. Climate change and variability are unavoidable, and people have developed strategies to ensure their existence. As previously stated, societies have created survival techniques known as IKS. IKS are systems of knowledge that are passed down orally from generation to generation. This traditional wisdom varies according to the community. Women are the primary producers of the staple foods on which communities rely, accounting for more than three-quarters of the agricultural labour as they labour in the fields to guarantee their families are fed and nourished. Those that rely on rain-fed agriculture bear the brunt of climate change's effects, which adversely influence their harvests. To adapt to climate change, women rely on IKS. Regrettably, they face challenges in their quest for survival.

The findings showed that for years rural farmers have relied on generational knowledge for survival including agricultural sustainability. For them, amongst other things, the changes in seasons and the environment have allowed them to know when to plough and when not to plough the land. Unfortunately with the rise in global warming, the use of IKS is almost ineffective resulting in food insecurity at the household level for SHFs. The results show that farmers use a combination of biological, and IKS indicators to forecast seasonal weather conditions and make important crop and livestock production decisions. IKS plays a key role in supporting local efforts to forecast and make sense of seasonal climate variability, especially in the absence of downscaled location-specific forecasts. Among the difficulties encountered by IKS weather forecasting include a deficient knowledge transfer mechanism, insufficient documentation, the death of forecast experts, and the effect of religion and modern education.

5.2. Limiting factors towards climate change adaptation to reduce food insecurity

- SHFs have little knowledge about climate change and its causes.
- Loss of IKS use over generations.
- Lack of skills and equipment.
- Little government incentives for SHFs.
- Expensive prices for drought/flood resilient seeds and manure.

5.3. Recommendations

- New research should try to bridge the gap between science and IKS to come up with solutions that are reliable for both smallholder and commercial farmers.
- Government should put more money into teaching SHFs about sustainable agricultural practices to improve food security at the household level.
- Policymakers and community leaders should increase women's involvement in decision making as they are the ones that are tasked with ensuring the survival of the community.
- Necessary skills, equipment, machinery should be provided by the government to SHFs.
- More time should be put into educating the youth about the importance of agriculture, therefore, making them appreciate it and want to participate more in it as the youth are the future of the country.
- Advocate for a more bottom-up approach in climate change and agricultural government responses, which in turn will allow the views and concerns of the SHFs to be heard and attend to more clearly on a local level.
- Women played a significant part in agriculture by utilising their IKS. These variables are frequently overlooked in agricultural studies. They have a restricted number of agricultural resources and limited control over them. As a result, researchers, policymakers, and other stakeholders should take a critical approach to IKS and gender in agricultural research. These elements all affect the interpretation and application of IKS in agriculture.

5.4 Future research studies

The research undertaken here examined the effects of climate change on agricultural productivity and the IKS measures used by Kilmun's SHFs to adapt to and mitigate climate change. Additional in-depth research is required to fully understand how IKS indicators are used for forecasting and the context in which they are employed, including an examination of the indicators' accuracy, reliability, and validity for weather and climate forecasting. Further research showed that SHF has little knowledge about climate change and therefore lack the scientific background making them more susceptible to household food insecurity.

It is prudent and logical to inform the government of the SHF's inadequacies moving ahead. Future research should place a greater emphasis on government officials supporting agriculture from the ground up to properly address SHF's concerns. Governmental agricultural officials should conduct demonstrations of scientific techniques to educate and raise awareness among SHF about the critical role of multidisciplinary approaches in addressing climate change and enhancing household food security.

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APPENDICES

Appendix A: Questionnaire

University of KwaZulu-Natal

Research questionnaire

NB: Please Mark the relevant block with an X. Where there are no blocks, please fill in the blank spaces in handwriting.

Section A: Demographics

1. Gender

1=Female □ 2=Male □

2. Please indicate your Age

□□

3. What is your highest education Level

No formal schooling □ Primary □ Secondary □Tertiary□

4. Marital Status

1=Married 2=Divorced 3=Widowed 4=Single

5. Are you the household head?

1=Yes 2=No

6. Total size of household__________

7. Employment status

1=Employed full time	**2=Employed part time**	**3=Unemployed**	**4=Pensioner**

8. Household income per month (including off-farm income)?

1= Below 800	**2= R801-1500**	**3= R1501-3500**	**4= Above R3500**

9. Is farming your major source of income

1=Yes **2=No**

10. If No, what other source of income you depend on?

____

____

____

11. What do you farm or produce?

I. **beans**
II. **butternut**
III. **cabbages**
IV. **spinach**
V. **tomatoes**
VI. **other**

12. When do you farm?

1= Jan	**2= Feb**	**3= March**	**4= April**	**5= May**	**6= June**	**7= July**	**8= Aug**	**9= Sept**	**10= Oct**	**11= Nov**	**12= Dec**

13. How do you cope with changing weather patterns?

____

____

____

14. Where do you get the water for irrigation?

1= Tap	**2=River (stream)**	**3= Dam**	**4=Borehole system**	**5= other (specify)**

Section B: To determine the impacts of climate change and variability on agriculture.

15. Have you heard of 'climate change'? Yes□ No□

If Yes, What you know about it and what do you think causes climate change.

____

____

____

16. Do you think the length of the growing season has changed?

1=Yes 2=No

17. If yes, how has it changed?

1= Increased 2= Decreased

18. How has that increase or decrease, in the length of growing season, affected your agricultural productivity?

1=positively (improved my productivity) 2=negatively (reduced my productivity)

19. Do you think the agricultural productivity of your land has changed over the last 5 to 30 years?

1= Yes 2= No

20. If yes, how has the agricultural productivity of your land changed?

1= Increased 2= Decreased

21. Have you observed any losses from your agricultural produce as a result of the climate changes that you have observed?

1= Yes 2= No

22. Have you observed any soil quality changes in your farm or land over the last 5 to 30 years?

1= Yes 2= No

23. If yes, how has the soil quality in your farm or land changed?

1= Increased 2= Decreased 3= increased in some sections but decrease in other sections

<u>Section C: To establish climate change risks based on people's perceptions.</u>

24. How important is the issue of climate change to you personally?

Very important □ **Quite important** □

Not very important □ **No at all important** □

25. Based on the answer above, please explain

____

____

____

26. What challenges have you experienced, if any, as a result of climate change?

____

____

____

27. What impact do the challenges have on performance of the farm

____

____

____

28. What have you experienced regarding the following as a result of climate change?

Have you experienced with the following types of climate change and variability indicators?	Response		How often? (in the past 5 years)		
	yes	no	Very little	normal	Very much
Drought					
Floods					
Off-seasonal rainfall					
Too much rain					
Too little rainfall					
Higher temperature					

Frost (coolness)		
Others (specify		

29. According to what you have observed, how do these changes in climate affect agriculture?

____

____

____

<u>Section D: To analyze the significance of indigenous knowledge systems in climate change adaptation in agriculture.</u>

30. Do you understand what Indigenous Knowledge Systems are? If yes, please elaborate if whether you think there is any link between IKS and science.

____

____

____

31. What are the different Indigenous knowledge methods do you use to deal with climate change?

____

____

____

32. What IKS methods do you use to predict seasonal changes, rainfall patterns etc?

____

____

____

33. Where did you get this knowledge?

____

____

34. What results have you been getting from such actions and how are they helping

35. Do you think anything can be done to tackle climate change?

Yes □ **No** □ **Don't Know** □

36. If yes, what do you think can be done to tackle climate change?

37. How do you respond to pests and diseases on your crops as a result of climate change?

38. What practices/approaches do you adopt to control the outbreaks of weeds on your crops?

39. How do you store water whilst making sure that it is safe for use later?

IsiZulu version

InyuvesiyakwaZulu-Natali

Imibuzoyocwaningo

Okubalilekile: ngicelaufake u-X kulokhookuqondenenawe. Imibuzoengenawoamabhokisiadinga u-X uyigcwalisengokubhalaimpenduloyakho.

Isigaba A

1. **Emininingwaneniyabantu**

1=Owesifazane □ 2=Owesilisa□

2. **Celaufakeiminyakayakho**

□□

3. **Ufundewagcinakuliphiibanga**

Awuyangaesikoleni □ Amabangaaphansi □ Amabangaaphezulu □ Imfundoyasekolishi□

4. **Iminingwaneyomshado**

1=Ushadile	**2=Wehlukanisile**	**3=Ushonelwe**	**4=Awushadiile**

5. **Ngabeuyinhlokoyekhayalakwakho?**

1=Yebo **2=Chabo**

6. **Nibangakiendliniekhaya?__________**

7. **Imininingwaneyokuqashwa**

1=Uqashiwengokuphelele 2=Uqashiwekodwahhayingokuphelele 3=Awuqashiwe

8. **Imalietholwaumndeningenyanga (neyokulimanayoibaliwe)?**

1= Below 800 2= R801-1500 3= R1501-3500 4= Above R3500

9. **Ngabeukulimaikhonakodwaokungenisaimaliekhayana?**

1=Yebo 2=Cha

10. **Uma uthenachabo, iyiphienyeimaliengenayofuthiuyenza/nomauyitholakuphileyomali?**

____

____

____

11. **Ulimaziphiizitshalo?**

I. **Iklabishi**
II. **Ubhontshisi**
III. **Isipinashi**
IV. **Ithanga**
V. **Utamatisi**
VI. **other**

12. **Ulimangaziphiizinyangazonyaka ?**

1= Jan	2= Feb	3= Mar	4= April	5= May	6= June	7= July	8= Aug	9= Sept	10= Oct	11= Nov	12= Dec

13. Umelelanakanjaninezimozezulueziguquguqukayo?
____
____
____

14. Amanziokuchelelaizitshalouwatholaphi?

1= Empompini	2= umfula (emhosheni/emseleni)	3= Edamini	4= uwambaemgodini	5= okunye (isho)

<u>Isiqephu B: Ukubhekaimithelelayokuguquguqukakwezulukwezokulima.</u>

15. Uke wezwangokuguquguqukakwesimosezulu? Yebo□ Chabo□

16. Uma uthenayebongaphezulu, chazakabanzikuthiyinioyaziyonokuthiucabangaukuthilokhukubangwayini
____
____
____

17. Ucabangaukuthiisikhathisokukhulakwezitshalosesilulekile??

1=Yebo 2=Chabo

18. Uma uphendulewathiyebongaphezulu, shonoukuthisishintshekanjani.

1= Sinyukile 2= Sehlile

19. Ukwehlanokunyukakwesikhathisokukhulakwezitshalokukuphazamisekanjaniukuvuna?

1=kahle (ukuvunakukhulile) 2=kabi (ukuvunakwehlile)

20. Uchabangaukuthiukuvundanokuthelakomhlabathi/komhlabawakhokushintshieyinieminyakeniemihlanukuyakwengamashumiamathathuadlule?

1= Yebo 2= Chabo

21. Uma uthenayeboemubuzeniongaphezulu, shonoukuthiukuvundakomhlabawakhokushintshekanjani.

1= Kunyukile 2= Kwehlile

22. Zikhonaizivunoosukewazilahlekelwangenxayokuguquguqukakwesimosezulu?

1= Yebo 2= Chabo

23. Lukhonaushintshookewalubonaekuvundenikomhlabathiwakhoeminyakeniemihlanukuyakwengamashumiamathathuedlule?

1= Yebo 2= Chabo

24. Uma uthenayebongaphezulu, ushintshekanjaniumhlabathiwakho?

1= Uvundekakhulu	**2= Kwehlileukuvundakwawo**	**3= kwenzinyeizinxenyeuvundilekakhulukodwakwezinyeizinxenyeukuvundakwawokwehlile**

<u>IsigabaC: Ukwazikabanzingezinkingaabalimiababhekananazongenxayokuguquguqukakwesimosezulu.</u>

25. Kuwenaibalulekekangakanani indaba yokuguquguqukakwesimosezulu?

Kubalulekekakhulu □ **Kubalulekilenje** □
Akubalulekilekakhulu □ **Akubalulekanganhlobo** □

26. Kunganilokhukubalulekilekuwe?

____

____

____

27. Iziphiizinkingaosukewabhekananazongenxayokuguquguqukakwesimosezulu? Zibhalelapha.

____

28. Iziphiizinsalelaezibakhonaemasiminingenxayokuguquguqkakwesimosezulu?

____

____

____

29. Ikuphiosokuewabhekananakhokulokhuokulandelayomayelananokuguquguquka kwesimosezulu?

Khethaosukewabhekananakholapha?	**Impendulo**		**Sekwenzekekangakananilokhueminyakeniemihlanuedlule?**		
	yebo	**chabo**	**1.Kancane**	**2.Kahle**	**3.Kakhulu**
Isomiso					
Izikhukhula					
Ukunethakungasisoisikhathi					
Ukunethangokudlulele					
Ukunethakancanekakhulu					
Amazingaokushisaaphezulu ngokudlulele					
Isithwathwa					
Okunye (chazakabanzi)					

30. Ngokubukakwakho, ucabangaukuthilokhuokusemubuzweniongaphezulukukuphazamisakanjaniukuthsala? Chaza.

____

____

____

Isiqephu D: ukutholakabanzingezindlelazesintuabalimiabazisebenzisayoukulwisananokuguquguqukakwesimosezulu:

31. Uyaqondayiniukuthiizindlelazokulimazesintuziyini? Uma uthiyebo, ucabangaukuthimhlampelezizindlelazinobudlelwaneyininesayensi, ngobani?

32. Iziphiizindlelazesintuenizisebenzisaukubonaukuthiimvulaizonakanjaniezinyangeniezizay ukuthisekuzoshintshaisizininjalonjalo?

33. Iziphiizindlelazesintuozsebenzisayoukuzeulwisanenokuguquguqukakwesimosezulu?

34. Ulitholephilolulwazi?

35. Iyiphiimiphumelaobuyithola/oyitholilengokusebenzisaizindlelaozishongaphezulu ukuzeulwenokuguquguqkakwesimosezulu?

36. Ucabangaukuthikukhonaokungenziwaukulwisananokuguquguqukakwesimosezulu?

Yebo □ **Chabo** □ **Angazi** □

37. Uma uthenayeboemubuzweniongaphezulu, shonoukuthiucabangaukuthiyinileyoengenziwaukulwisananokuguquguqukakwe simosezulu.

---

38. Ulwisanakanjaninezinambuzaneezibangwaukuguquguqukakwesimosezuluezitsh alwenizakho?

---

39. Yinioyenzayokuzeumelelanenokhulaezitshalwenizakho?

---

40. Uwagcinakanjaniamaziakhoehlanzekileukuzeasebenzengesikhathiesizayo?

Appendix B: Focus Group Discussion guidelines

Consent Process

Consent forms for focus group participants are completed in advance by all those seeking to participate. Below is a summary of the information in the consent form that focus group organizers and facilitators should use to ensure participants understand the information in the consent form.

Thank you for agreeing to participate. We are very interested in hearing your valuable opinion on the role of Indigenous Knowledge Systems in adaptation to climate change and variability in the agricultural sector in a rural district in KwaZulu-Natal. The information provided by you is entirely confidential, and we will not associate your name with anything you say in the focus group.

- we would like to record the focus group discussions to ensure that we correctly capture the group's thoughts, opinions, and ideas. No names of participants will be attached to the focus groups, and the recordings will be destroyed as soon as they are transcribed.
- You can choose not to answer any question and withdraw from the study at any time.
- We understand the importance of keeping the information provided by the participants private and confidential. Therefore we will ask participants to respect each other's confidentiality.

Introduction:

1. Welcome

Introduce yourself and the note-taker, and send the Sign-In Sheet with a few quick demographic questions (age, gender) around to the group while you are introducing the focus group.

Review the following:

- Who we are and what we're trying to do
- How this information will be utilized
- Why we asked you to participate

2. Explanation of the process

Ask the group if anyone has experienced in a focus group before. Explain that focus groups are being used more and more often in research.

About focus groups:

- We learn from you (positive and negative)
- Not trying to achieve consensus, we're gathering information
- In this project, we are doing questionnaires, focus group discussions, and key informant interviews. Using these tools is that we can get more in-depth information from a smaller group of people in focus groups. This provides us with an understanding of the context behind the answers given in the written survey and helps us discover topics in more detail than we can do in a written survey.

Logistics

- Focus group will last about one hour
- Feel free to move around
- Where is the bathroom? Exit?

3. Ground Rules

Ask the group to suggest some ground rules. After they brainstorm some, make sure the following are on the list.

- Everyone should participate.
- Information provided in the focus group must be kept confidential
- Stay with the group and please do not have side conversations
- Turn off cell phones if possible
- Have fun

4. Turn on Tape Recorder
5. Ask the group if there are any questions before we get started and address those questions.
6. Introductions

- Go around the table: where you were born etc.
- The discussion begins, making sure to give people time to think before answering the questions and not moving too quickly. Use the probes to ensure that all issues are addressed, but move on when you feel you are starting to hear repetitive information.

Questions

1. Do you understand what climate change is? Explain (shared)
2. Do you think there is any relationship between climate change and agricultural production? Elaborate
3. Do you think that climate has changed over the past 10 years? If yes, how? (shared)
4. What do you think causes climate change?
5. Do you have any various institutions/organisations that advise/teach you about climate change?

   *Mention them

   * How reliable are they? (Rate them on a scale of 1-6).
6. What support systems have you been using to cope with climatic and non-climatic shocks?
7. Please name all the climatic shocks you have faced and explain how you dealt with each one of them.
8. Does the government provide you with any tools to help you cope with climate change?

9. Do you think that the government is doing enough to support small-holder farmers? Yes or no, please explain on both cases.
10. How do you think it should go about in trying to support small-holder farmers?

Indigenous Knowledge Systems:

- Do you know what IKS is? Please explain according to your own understanding.
- How do you use it to predict seasonal changes and rainfall levels?
- What is the significance of the appearance/ occurrence of the following?:

	Significance	
Occurence	**Season quality**	**Rainfall**
The appearance of ants, fast growth in anthills.		
Frogs crooking in swampy areas at night.		
Changes in wind circulation.		
Changes in moon phases.		
Misty hills.		

- How do you use IKS as an early warning indicator for disasters and changes in seasons?
- How do you get rid of pests from your crops? Why do use those strategies?
- What strategies do you use to keep your land fertile?
- What IKS methods do you use for food preservation and preparation?
- What IKS methods do you use for water collect, purification and conservation?
- How do you deal with water shortages?
- What IKS livestock do you use to keep livestock healthy?
- How do you heal livestock from diseases?

Transect walk (produce a transect diagram)

- Which areas are most affected by climate change?
- Community resources (eg. Water, farmlands).
- How are farmlands managed? (go to the site).
- Water sources: is there enough water to use and what is the quality? How is the water used and how is it collected?
- Water purification: how do different people obtain this water and how is it purified?
- How do you deal with shocks (learning about local practices and technologies)?
- What methods do you use to predict changes in weather patterns?

Take note of the following (with IKS in mind):

- Soil type
- Water resources
- Vegetation
- Socio-economic indicators
- livestock
- problems
- food storage cribs

***Observations will also be made during the transect walk.**

Appendix C: Ethical clearance

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

16 November 2016

Ms Qophelo Sinenhlanhla Dludla 211544157
School of Agricultural, Earth and Environmental Sciences
Pietermaritzburg Campus

Dear Ms Dludla

Protocol reference number: HSS/1657/016M
Project title: Assessing the role of Indigenous Knowledge Systems in adaptation to climate change and variability in the agricultural sector in a rural districk in KwaZulu-Natal: A case on the use of IKS by smallholder farmers in mitigating climate change (Bulwer)

Full Approval – Expedited Application

In response to your application received 4 October 2016, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

[redacted]

....

Dr Shenuka Singh (Chair)
Humanitities & Social Scinces Research Ethics Committee

/pm

cc Supervisor: Dr Mayashree Chinsamy
cc. Academic Leader Research: Professor Onisimo Mutanga
cc. School Administrator: Ms Marsha Manjoo

Humanities & Social Sciences Research Ethics Committee
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Appendix D: Picture during data collection

Figure 1: Map of Kilmun

Figure 2: Smallholder farmers garden

Figure 3: Smallholder harvesting cabbage

Figure 4: Cattle drawer

Figure 5: Manure preparation

Figure 6: Crop drawer


Figure 7: Eroded soil


Figure 8: Well for consumption

Figure 9: Women farmer preparing the field

Figure 10: Data collection with smallholder farmers

Figure 11: Spring water

Figure 12: Landscape of the study site

Figure 13: Inwegane river

Figure 14: Borehole