UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

MAINSTREAMING CLIMATE SMART TECHNOLOGY ADAPTATION IN MSINGA'S FARMERS' EVERYDAY AGRICULTURAL PRACTICES THROUGH UNIVERSITY, SMALLHOLDING FARMING COMMUNITY AND GOVERNMENT PARTNERSHIPS: THE PLACE AND SPACE FOR INDIGENOUS KNOWLEDGE SYSTEMS

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July 2020

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Thesis Submitted in fulfilment of the academic requirements for the degree of Doctor of Philosophy of Education in the Cluster of Science and Technology Education

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DECLARATION

I, Nwokocha Godson Chinenye declare that:

(i) The research reported in this thesis, except where otherwise indicated is my original work;

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

(iii) This thesis does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons;

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a) Their words have been re-written, but the general information attributed to them has been acknowledged;

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(v) The work described in this thesis was carried out in the School of Science and Technology Education, University of KwaZulu-Natal, from 2015-2019 under the supervision of Prof Busisiwe Precious Alant (Supervisor); and

(vi) The Ethical Clearance No. HSS/0659/016D was granted prior to undertaking the fieldwork.

Signed:________________ Date: 21 July 2020

As the candidate's supervisor, I, Professor Busisiwe Precious Alant, agree to the submission of this thesis.

Signed:________________ Date: 21 July 2020

ETHICAL CLEARANCE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

28 June 2016

Mr NG Chinenye 212558483
School of Education
Edgewood Campus

Dear Mr Chinenye

Protocol reference number: HSS/0659/016D
Project Title: Mainstreaming Climate-Smart Technology adaptation in Msinga's farmers' everyday agricultural practices through University, Small-holding farming community and government partnerships: The place and space for Indigenous Knowledge Systems

Full Approval – Expedited Application

In response to your application received 20 May 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

Dr Shenuka Singh (Chair)
Humanities & Social Sciences Research Ethics Committee

/pm

Cc Supervisor: Dr BP Alant & Dr T Ndarana
Cc Academic Leader Research: Dr SB Khoza
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DEDICATION

This study is dedicated to God, the author and finisher of our faith, and to the three most beautiful women in my life: my adorable wife Chinny, my daughter Chidinma and my lovely mother Comfort.

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ABSTRACT

This study adopted the Sustainable Livelihood Approaches (SLA) and the Quintuple Helix Innovation Model (QHIM) to explore the mainstreaming of climate smart technology adaptation in the everyday agricultural practices of smallholder farmers in Msinga, KwaZulu-Natal, through partnerships amongst university, government and smallholder farmers. Guided by an exploratory qualitative case study research design, involving questionnaires (open and closed-ended), document analysis and focus group interviews, the study was divided into two phases, namely, a preliminary and a main study. The preliminary study explored the knowledge and awareness of Msinga smallholder farmers about climate change and the accessibility as well as the suitability of support services available to them. In this regard, the current agricultural extension practitioners within Msinga were engaged to ascertain their level of competency to offer climate-related extension services to smallholder farmers within Msinga. Equally, the education and training programme of pre-service agricultural extension practitioners of one of the higher education institutions in KwaZulu-Natal was analysed to determine its suitability in training future extension practitioners.

The second phase of the study explored the existence or non-existence of partnerships between the stakeholders engaged in this study as well as the roles played by each stakeholder group in these partnerships. Furthermore, the type of Climate Smart Agriculture (CSA) as well as Indigenous Knowledge Systems (IKS) promoted in these partnerships were explored. The findings from the preliminary study revealed that Msinga smallholder farmers are indeed aware and knowledgeable about climate change. Their knowledge and awareness were classified into four categories, namely, evidence of climate change, causes of climate change, effects of climate change and solutions to climate change. Furthermore, the findings showed that a good number of the in-service agricultural extension practitioners are not adequately equipped to offer extension services related to climate change to farmers, when considered in terms of their level of qualification, exposure to content related to climate change during training and in-service training on climate change. This confirmed the view in the literature that most agricultural extension practitioners in smallholder farming contexts in South Africa lack the requisite knowledge and skills to facilitate adaptation to climate change. In tracing the root of this problem through research question three in the preliminary study, it was revealed that content related to climate change and climate change adaptation was not accommodated in the pre-service extension programme.

However, content related to climate change was implicitly included by academic staff members while teaching topics such as social sustainability, environmental sustainability and economic sustainability.

The findings from the main study showed that there are indeed different types of partnerships existing between academia, government and the smallholder farmers. In addition, the findings from the main study showed that the government and academia, as represented by Agricultural Extension and Rural Development lecturers are supporting the farmers through their roles in the direct and indirect partnerships they share. This was contrary to the assertion in some literature that there is a lack of interactions between stakeholders on climate change in developing countries and contexts. The roles played by academia and government stakeholder groups corresponded with the roles of academia and government, as conceived in QHIM, thereby paving way for the attainment of livelihood outcomes of food security, adaptation to climate etc. Again, these finding highlighted that not having the required qualification does not necessarily mean that the extension practitioners are incapable of offering extension services related to climate change adaptation. Surprising, the findings of the main study revealed that farmers were de-centred and hence played no roles in these partnerships, even though they proved to be aware and very knowledgeable about climate change during the preliminary study. This was contrary to the conceived roles of end-users under QHIM.

It was found that the partnership between academia and the government promoted one CSA practice, while the partnership between the government and farmers promoted one other CSA practice. Additionally, the findings revealed that the partnership between the government stakeholder group and the farmers promoted six CSA practices while the partnership between the farmers and government yielded two CSA practices. It was significant to note that the highest number of CSA practices were promoted in the partnership between the government and the farmers. This implies that the government stakeholder group are the main drivers of climate change adaptation and sustainable livelihood outcomes in rural Msinga. Interestingly, the CSA practices promoted in these partnerships uphold the three key pillars of climate smart agriculture, namely adaptation, mitigation and food security. Most significantly, is the finding that these partnerships, do indeed, promote the use of indigenous knowledge systems (IKS) in the form of indigenous agricultural practices in the everyday agricultural practices of Msinga smallholder farmers. This means that the place/space of IKS still largely resides with the end-users.

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LIST OF ABBREVIATIONS

CSA	**Climate Smart Agriculture**
CA	**Conservation Agriculture**
IK	**Indigenous Knowledge**
IKS	**Indigenous Knowledge System**
SLA	**Sustainable Livelihood Approaches**
QHIM	**Quintuple Helix Innovation Model**
C.C	**Climate Change**
EC	**Economic Capital**
HC	**Human Capital**
NC	**Natural Capital**
SC	**Social Capital**
PC	**Physical Capital**
MSF	**Msinga smallholder farmers**
GDP	**Gross Domestic Product (GDP)**
SDG	**Sustainable Development Goal**
OCED	**Organisation for Economic Co-operation and Development**
IPCC	**Intergovernmental Panel on Climate Change**
FOA	**Food and Agricultural Organisation**
NGO	**Non-Governmental Organisation**
R&D	**Research and Development**
UNDP	**World Bank and United Nations Development**
OXFAM	**Oxford Committee for Famine Relief**
DFID	**Department for International Development**
SKAV	**Skills, Knowledge, Values and Attitude**
SPSS	**Statistical Package for Social Sciences**

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CHAPTER 1

CONTEXT AND BACKGROUND TO THE STUDY

The name "Msinga" means a current in the sea where air movement causes ripples on top of the water surface and ends up influencing the nearby climatic conditions through its breeze (Msinga Local, 2014, p. 1 – http://www.msinga.org/index.php/about-us).

This study sought to explore the mainstreaming of climate smart technology adaptation in Msinga farmers' everyday agriculture through partnerships involving a university, government and smallholder farmers. The study was situated in Msinga Local Municipality which is the south-western part of KwaZulu-Natal, South Africa, and involved participants drawn from Msinga smallholder farmers, agricultural extension practitioners (advisors) at the Department of Agricultural and Rural Development and academic staff members from the Department of Agriculture and Rural Development of a higher education institution in Kwazulu-Natal South Africa.

Figure 1: Map of Umzinyathi District showing Msinga local Municipality (uMzinyathi District Municipality, 2012)

Msinga Local Municipality is an administrative area under the Umzinyathi District of KwaZulu-Natal in South Africa. Msinga has a population of about 160 000 people, in an area of 2 500 square kilometre with about 32,592 households (Msinga, 2014). It is composed of six Traditional Authority areas namely, Qamu, Mchunu, Bomvu, Ngome, Mabaso and Mthembu (Municipality, 2012). In terms of agriculture, farming contributes 18% of the income for the area (Msinga, 2014). Approximately 30% of the municipal area to the north comprises commercial farmland, while subsistence agriculture is practised in areas adjoining the Tugela River irrigation schemes.

Against the above background, this section offers further insight into the research context by foregrounding the stories told by the farmers on my initial visit to Msinga on the 29th – 30th October 2016 to gain entry into the study.

1.1 UNDERSTANDING THE CONTEXT THROUGH STORY TELLING

The stories below were informally but enthusiastically shared by the farmers during my first visit in October 2016. After giving the participants a breakdown of the study and its links with indigenous agricultural practices, the farmers excitedly shared the following stories:

> *"I want to talk about my experience, about my childhood days. My great grandfathers, they use to know when summer, spring and autumn is. Our fathers and grandfathers knew when it was summer, spring and autumn. They knew that a particular month was for planting sorghum and they knew that you can only plant sorghum in that month and nothing else. Even the prediction that we are talking about, the device, they used to dictate the rain, they knew that, eh. They knew that after the first rain, they have to plant. And when they have harvested, there will be another rain that will fall and that rain that will come after harvesting, it will mean that it will come to soften the soil. And it is now going to produce compost from that". "They knew that the first seed to go into the soil should be on the 15th and the second planting will take place on the 22nd of November. They knew the planting will fall under the parameters of November".*

> *"….there was a bird our grandfather and fathers knew, when that bird starts singing, then they know what it meant and it is still in existence even today. So they listened to this bird's tone. Tone of its singing, of the voice. So when the sorghum time is over, the tone will change and then they will know that now is millets time". This bird could also tell you that beyond this point never go on planting because you are wasting your seeds". "The bird changes three times, when it sings for the first time, it says go out, take your hole, take your seeds go to the fields, go and plough and the second voice says, you are slow, you will regret it for the rest of your life. I told you to go and plough and you didn't go and when people go to plough and you don't have millets, then you won't blame anyone, you are going to blame yourself. So you are going to regret it. And the third voice will say, you just wasted your seeds, wasted your seeds hahahahahah (everyone laughs). "They also use the trees, they look at the trees and when the tree started blossoming, then they will know which season that we are in and the birds as well, they use to know which trees to perch (settle) on. When somebody happens to go pass the tree, he will tell the others that he has seen that tree. That it has blossom and then they will know that they can start planting. But the sad part now is that people have destroyed nature. They just cut down all those valuable trees that had history behind them (Informal discussion with farmers in October, 2016).*

According to Iseke (2013), storytelling is a popular practice in indigenous cultures that sustains communities and validates their experiences and epistemologies. In educational research, story- telling or narrative inquiry is a qualitative research method that seeks ways to understand and present the experiences of individuals through the stories they live and tell (Lapan, Quartaroli, & Riemer, 2011). Lapan et al. (2011) reason that storytelling presents and analyses the socio-cultural context of human experience through their stories.

The stories shared by the farmers centred on the farming practices prevalent in their area in the past. Of particular significance about the stories told was the decentring of the present to foreground the farming methods/practices of their parents (older generations). In the context of the present study, it would seem that the farmers needed to talk about the past in order to understand the present impacts of climate change in their lives. This means that the ecosystem was much better and or safer in the past, when their fathers interacted harmoniously with their environment. They took care of their environment and the environment reciprocated naturally. The community of Msinga has always been affected by climate change. The area is very susceptible to drought and other components of climate change (Ngcoya, 2017; Mthembu & Zwane, 2017). However, the Msinga community has always coped with these conditions using their Indigenous knowledge. It is these coping strategies embedded in these three stories that are of significance to this this study.

1.2 CONTEXT AND BACKGROUND TO THE STUDY

Smallholder agriculture remains key to poverty alleviation and food security within rural household (Baiyegunhi, Majokweni, & Ferrer, 2019). According to Modi (2019) as well as Lipper, Thornton, Campbell, Baedeker, Braimoh, Bwalya, Caron, Cattaneo, Garrity and Henry (2014), smallholder agriculture is the main source of food production and livelihood of sub-Saharan Africa and South Asia. Rain-fed farming covers 97% of agricultural production in sub-Saharan African (Calzadilla, Zhu, Rehdanz, Tol, & Ringler, 2013). Similarly, research by many scholars shows that agriculture offers between 70% and 80% of employment in Africa and contributes an average of 34% of Gross Domestic Product (GDP) and at least 40% of exports in the region (Commision for Africa, 2005; African Water Development Report, 2006; Turpie & Visser, 2013). In a similar vein, the study by Mbatha and Masuku (2018) revealed that 78.5% of rural households in South Africa engage in agricultural activities for food and income generation. The improvement ofrural economies and livelihoods of rural communities is tied to smallholder agriculture (Mbatha & Masuku, 2018).

In KwaZulu-Natal province, Mthembu and Zwane (2017) revealed that smallholder agriculture is the dominant source of rural livelihood and socio-economic activities. Narrowing it down to Msinga Local Municipality where this study is located, research by Rukema (2010), as well as by Mthembu and Zwane (2017), reveals that smallholder agriculture that is rain-fed is practised by almost every household in the Msinga community. By implication, smallholder agriculture is central to the survival and sustenance of rural communities in sub-Saharan Africa. However, uncertainties associated with rainfall as a result of climate change have become a major threat to agricultural production and the livelihoods of rural communities across sub-Saharan Africa (Bryan, Deressa, Gbetibouo, & Ringler, 2009; Mbatha & Masuku, 2018). According to Mthembu and Zwane (2017) as well as Mbatha and Masuku (2018), smallholder agriculture in South Africa has become more susceptible to climate change due to its dependence on rainfall. This has made it more difficult to attain food security (Sustainable Development Goal 2) within the country (Mugambiwa & Tirivangasi, 2017).

In rural contexts, such as the Msinga Local Municipality, research by Mthembu and Zwane (2017) assert that climatic phenomena such as drought is a threat to predominant smallholder agriculture. This was earlier noted Rukema (2010) whose study found that smallholder farmers lost about 70% of their crops between 2004 and 2007 as result of drought conditions. Again, sharp increases in temperature and drought conditions experienced in 2010 and between 2013-2014 in Msinga resulted in low agricultural productivity, thereby crippling socio-economic activities in the area (Mthembu & Zwane, 2017). This situation is further exacerbated by factors such as low adaptation capacity in the face of high vulnerability, lack of access to livelihood capital/assets, delay in and lack of access to information related to climate change and climate change adaptation, poor interactions/relationships between smallholder farmers and institutions (governmental, research/academic, NGOs, etc.) to mention but a few (Hassan & Nhemachena, 2008; Sullivan et al, 2012; Mthembu & Zwane, 2017). This has jeopardized the chances of attaining the all-important Sustainable Development Goal (SDGs) 2, which aims to "end hunger, achieve food security and improved nutrition, and promote sustainable agriculture" (Organisation for Economic

Co-operation and Development, OCED 2009; Almassy, 2014; Houlden, Tsarouchi, & Walmsley, 2015).

Nonetheless, smallholder farmers in the Msinga area (Shisanya, 2015) and other smallholding farming communities across sub-Saharan Africa (Hassan & Nhemachena, 2008; Ajani, Mgbenka, & Okeke, 2013; Chanza, 2015) have continued to survive and adapt to climate change using their indigenous knowledge systems. To a large extent, these indigenous adaptation strategies or practices are not accorded a space in public/government policies and programme on climate change within South Africa (Makhubele, Shokane, & Mabasa, 2016; Ngcoya & Mvuselelo, 2017). As a result, Speranza (2010) concludes that climate change adaptation policies and programmes can only be successfully implemented in rural communities, such as Msinga, when local knowledge (input) is combined with other knowledge systems in the formulation and implementation of such policies and programmes. In the light of the foregoing, this study was concerned with two key research issues, namely:

(a) the challenges faced by smallholder farmers in South Africa and Africa in general, in adapting to the negative impacts of climate change (Turpie & Visser, 2013; Food and Agriculture Organisation, 2015, p. 7).
(b) the neglect of IKS in various contemporary adaptation arrangements (policies and programmes) in the African context even though IK adaptation technique is perhaps the most widely used technique in rural African contexts (Nyong, Adesina, & Elasha, 2007; Ngcoya, 2017).

Based on the above concerns, this study explores the mainstreaming of climate smart technology adaptation in Msinga's farmers' everyday agricultural practices through university, smallholding farming community and government partnerships. In doing this, the study interrogated the place and space accorded to IKS in existing partnerships amongst these three stakeholder groups.

1.3 CLIMATE SMART TECHNOLOGY ADAPTATION MAINSTREAMING

Conceptually, the term 'mainstreaming' means ensuring that a particular issue or issues are considered, taken into account, reflected in and integrated into broader decision making processes and activities, essentially with the result that this issue becomes broadly accepted and is viewed as a normal aspect impacting on processes and activities (Jordan, van Asselt, Berkhout, Huitema, &

Rayner, 2012). This implies that mainstreaming does not only occur at policy level, rather it occurs at both policy and practice level. Mainstreaming in the context of climate change implies that awareness of climate impacts and associated measures to address these impacts are integrated into the existing and future policies and plans of countries, as well as multilateral institutions, donor agencies and NGOs (Tanner & Mitchell, 2008). At the national level, mainstreaming shifts responsibility for climate change adaptation from single departments or agencies to all sectors of government, civil society and the private sector (Tanner & Mitchell, 2008). However, to achieve this requires a coordinating mechanism such as a multi-stakeholder arrangement/committee to ensure policies are informed by practical knowledge and experience from the bottom to the top (Ibid.).

As indicated in the penultimate paragraph, smallholder farmers in Msinga, like their counterparts across sub-Saharan Africa, are grappling with problems of climate change and hence are in dire need of solutions. To address this problem, scholars such as Sullivan, Mwamakamba, Mumba, Hachigonta, and Majele Sibanda (2012, p. 1), as well as Partey, Zougmoré, Ouédraogo, and Campbell (2018) make a case for the adoption of climate smart agricultural practices in smallholder farming contexts.. According to Sullivan, Mwamakamba, Mumba, Hachigonta, and Majele -Sibanda (2012, p. 1), climate smart agriculture (CSA) holds the answer to weather and climate issues and perhaps is the future of African agriculture.

From a definitional point of view, CSA or Climate-Smart Agricultural Technologies (CSAT) (Lipper et al., 2014) represents sustainable agricultural practices that increase productivity and reduces the emission of greenhouse gases (Sullivan, Mwamakamba, Mumba, Hachigonta, & Majele -Sibanda, 2012, p. 1). Similarly, Nwajiuba, Emmanuel, and Bangali Solomon (2015), reason that CSA includes innovative farming approaches that sustainably increases agricultural productivity and the living conditions of the rural populace, while at the same time contributing to the mitigation of the impact of climate change. Additionally, Sullivan et al. (2012, p. 1) suggest that climate smart agriculture can impact positively on smallholders' farmers as it increases the efficiency of valuable inputs such as seeds and fertilizer, increases food security and improves the prospects for income generation. In keeping with the foregoing perspectives, Lipper and Zilberman (2018, p. 4) support "calls for integration of the need for adaptation and the possibility of mitigation in agricultural growth strategies to support food security".

Drawing from the above perspectives on CSA, three key definitional components can be identified as embedded in CSA:

(a) adaptation to climate change
(b) mitigation (reduce emission of greenhouse gases)
(c) achieving food security.

Therefore, it can be concluded that CSA has the capacity to increase agricultural productivity, while reducing the emission of greenhouse gases. Examples of CSA practices include integrated crop, livestock and agroforestry systems, and improved pest, water and nutrient regulation (Lipper et al., 2014). Furthermore, Lipper et al. (2014) explain that CSA includes practices such as reduced tillage and use of diverse varieties and breeds; integrating trees into agricultural systems, improving the efficiency of water and nitrogen fertilizer use and manure management etc. (Lipper et al., 2014). For effective implementation of CSA, Lipper et al. (2014) explain that all stakeholders at all levels (from global to local levels, from research to policies and investments, and across private, public and civil society sectors) have key roles to play in reducing information costs and barriers and increasing the capacity of extension systems to disseminate context-specific information through avenues such as radio programmes and information and communication technologies (ICT). According to Chambers and Conway (1992), though households and groups may aspire to adapt to climate change, however, their adaptive capacity is either enhanced or restrained by access or lack thereof of five key livelihood capitals, namely: human, physical, natural social and economic. Similarly, Mirzabaev (2018) explains that adoption of climate smart agricultural technologies depends on the capacity of individuals, resources, institutional policies and extension services.

1.3.1 Barriers to climate change adaptation and adoption of CSA

According to Ekstrom and Moser (2014) adaptation barriers are obstacles that make climate change adaptation inefficient or less efficient. Moser and Ekstrom (2010) reason that adaptation barriers are obstacles that can be overcome with concerted effort, creative management, change of attitude and thinking, education, prioritisation and related shifts in resources, land uses and institutions /institutional linkages. As indicated above, some of the barriers to climate change adaptation and the adoption of climate smart agriculture or technologies include lack of access to livelihood capitals, lack of access to extension services, lack of education and knowledge about climate change, etc. (Chambers & Conway, 1992; Obayelu, Adepoju & Idowu, 2014; Mirzabaev, 2018). Some of these barriers will be discussed below.

1. 3.1.1 Institutional weakness

A study by Pasquini, Cowling, and Ziervogel (2013) identified three broad constraints or barriers to mainstreaming of climate change adaptation within local government/municipalities in South Africa. These are cognitive/individual barriers, regulatory and institutional barriers and socio-cultural barriers. The study, which investigated barriers to action on climate change adaptation in eight municipalities in the Western Cape Province of South Africa, found that only two out of the eight municipalities had climate change in their strategic plan in some form (either specifically or grouped as part of other environmental issues). According to Pasquini et al. (2013), none of the eight municipalities had completed either a climate change or adaptation plan/policy at the time of the study.

Similarly, Taylor (2016), in Cape Town, revealed that, though significant progress has been made in developing a citywide climate adaptation plan, implementation is constrained by poor monitoring and feedback within and between departments. Furthermore, Grist (2014) suggests that there is lack of long term institutional plans on climate change in South Africa. Rather, most government-led adoption approaches are targeted at short-term results like agricultural production, instead of redressing the long term institutional, economic and political challenges that prevent holistic and long-term climate adaptation (Ibid.). Therefore, the failure of government to take timeous action on climate change is a barrier to adaptation.

1.3.1.2 Poor extension services and lack of access to economic/agricultural capital

Researchers such as Schlenker and Lobell (2010) as well as Fosu-Mensah, Vlek, and MacCarthy (2012) suggest that many farmers in sub-Saharan Africa face cash constraints and find it difficult to adapt to new technologies, as evidenced by the fact that a high proportion of growers currently use production technologies that are suboptimal and insufficient, such as too little fertilizer. Similarly, a study by Schlenker and Lobell (2010) found that lack of access to credit, markets and technology in rural sub-Saharan African contexts makes it difficult for farmers to adapt to climate change and this impacts negatively on agricultural productivity in the region. Again, Mbatha and Masuku (2018) found that smallholder farmers have become more vulnerable to the effects of climate change due to insufficient support from the government.

With respect to extension services, Ngcoya (2017) asserts that the agro-ecological approach, which combines both indigenous knowledge and technical expertise to address climate change issues, is prioritised in the eThekwini Municipality, Kwazulu-Natal, South Africa. However, the municipality lacks the quantity and quality of agricultural extension advisors who are knowledgeable in both scientific and indigenous knowledge (Ibid.). In the same vein, a study conducted by Fosu-Mensah et al. (2012) revealed that access to agricultural extension services, among other factors, has a significant impact on adaptation to climate change. The study established that farmers with little or no access to extension services struggle to access climate information and they are less likely to take up adaptation strategies in their farming activities. Furthermore, Zikhali (2016) found that poor delivery of extension services is a major barrier in local municipalities in Limpopo province of South Africa.

1.3.1.3 Lack of education and poor training

The level of education acquired by extension practitioners as well as individuals (farmers) influences both the dissemination and adoption of climate change adaptation technologies (Gbetibuuo, 2009; Obayelu, Adepoju & Idowu, 2014; Zikhali, 2016). According to studies done by Gbetibouo (2009b) as well as by Obayelu, Adepoju, and Idowu (2014), the level of education attained by individuals influences their adaptation decision and capabilities. The study highlights that farmers with no formal education have less knowledge of climate change and its causes and struggle most to adapt, when compared to those that have secondary and tertiary education (Obayelu et al., 2014).

Similarly, Zikhali (2016) revealed that a high proportion of agriculture extension advisors engaged in her study had not received formal climate training in their curricula at the tertiary education level and hence struggled to meet the extension needs of smallholder farmers in their workstations. In keeping with the foregoing perspective, Williams, Mayson, de Satgé, Epstein, and Semwayo (2008) contend that some agricultural extension advisors do not have the capacities to facilitate rural development adequately, as they were not exposed to content related to climate change during their training. The above perspective is confirmed by Chakeredza et al. (2008), as well as Mberego and Sanga-Ngoie (2014), who argue that most agricultural extension practitioners in smallholder farming context across sub-Saharan Africa lack the ability to deliver extension services related to climate change as a result of their lack of content knowledge of climate change.

1.3.1.4 Exclusion of smallholder farmers and their indigenous knowledge systems

According to Parkinson (2010, p. 102), there is a lack of organised effort to collect and utilize indigenous knowledge regarding climate change to address the challenges of climate change. Equally, Nyong et al. (2007) argue that little or no effort has been made to incorporate indigenous knowledge and coping strategies into formal climate mitigation and adaptation strategies. In addition, the study by Ngcoya (2017) found that local farmers' experiences and practices of climate change are not taken into account by climate change policymakers and practitioners. Still, Makhubele et al. (2016) report that little has been done to incorporate indigenous knowledge into formal climate change adaptation strategies. Earlier, Gerrard (2008) found that there has been little space afforded to dialogue and collaboration with indigenous peoples about their responses to climate change.

1.4 RATIONALE AND SIGNIFICANCE OF THE STUDY

My interest in this topic evolved from the challenges faced by smallholder farmers across sub-Saharan Africa in adapting to the current day variable weather and climate. Most countries and places in Africa are struggling to adapt to the present severely daunting weather and climate (Sanogo et al., 2017). Most rural communities that depend on rain-fed agriculture for the production of staple foods are under the threat of food insecurity, as a result of uncertainties in rainfall and their inability to adapt to weather and climate challenges (Mbatha & Masuku, 2018). This will imply that attaining one of the global Sustainable Development Goals (SDG), of food security for all in 2030, is a mirage.

Furthermore, the lack of access to and/or poor extension services, lack of cooperation/partnerships between different agricultural stakeholders, lack of access to financial capital, etc., have made it difficult for smallholder farmers to adapt to climate change, thereby making them food insecure (Luseno, Mckpeak, Barrett, Little & Gebru, 2003; Pasquini, et al. 2013; Wilke & Morton, 2015; Zikhali, 2016; Ngcoya, 2017). Hence, there is a need for cooperation between smallholder farmers and other relevant stakeholders in the agricultural sector, in order to develop and exchange knowledge and resources that could facilitate adaptation to climate change. This is in agreement with Hassan and Nhemachena (2008), who argue that education and information dissemination is a key policy measure for stimulating local participation in various developmental initiative across Africa.

In addition, Sullivan et al. (2012) argue that the problem of climate change cannot be addressed by any single sector, hence there is a need for partnerships amongst different stakeholders in the agricultural sector. These types of partnerships might aid in identifying and addressing the most important interactions, synergies and trade-offs between climate change and agriculture (Ibid.). In concurring with the above view, Stephens, Hernandez, Román, Graham, and Scholz (2008) suggest that the urgency to tackle climate change challenges offers a great opportunity for different societal stakeholders and institutions to engage in new ways. However, scholars such as Pinkse and Kolk (2012) assert that there is a lack of partnerships for climate change and sustainable development in developing countries and contexts. This means that there is a lot of work to be done in assisting smallholder farmers to adapt to the challenges of climate change. This motivated me to explore how partnership arrangement between a university, government and smallholding communities can facilitate the mainstreaming of climate smart technology adaptation in everyday agricultural practices in rural Msinga, Furthermore, the place and space accorded to indigenous knowledge systems in climate change discussions between universities, government and smallholder farming communities will be explored.

Thus, the outcome of this study will significantly benefit agricultural extension education, smallholder agricultural practices and government policies on climate change adaptation. The outcome of this study will be beneficial to smallholder farmers in South Africa, as it reveals climate smart adaptation technologies for everyday agricultural practices and food security. It will be beneficial to higher education institutions in South Africa and beyond, with respect to programme design (content) in Agricultural Extension and Rural Development in response to climate change. With respect to policy, it stands to inform the climate change adaptation policies that are guiding government climate change efforts in South Africa and globally. Furthermore, it will contribute to existing literature on the impact of climate conditions on agricultural practices and food security in sub-Saharan Africa.

1.5 PURPOSE OF THE STUDY

The purpose of this study, at a broader level, is to explore the mainstreaming of climate smart technology adaptation in everyday agricultural practices of rural farmers in Msinga through partnerships amongst a university, government and smallholding farming community.

Theoretically, the study also aims to explore the place and space accorded to IKS in these partnerships. Therefore, the study describes the various roles of stakeholders, with the aim of strengthening and developing a new model of partnership for mainstreaming climate smart technology adaptation in rural farming contexts like Msinga. To achieve this aim, the study is guided by the following objectives:

1.5.1 Objectives of the preliminary study:

(i) To explore the awareness and knowledge of Msinga smallholder farmers on climate change

(ii) To explore if in-service agricultural extension practitioners in rural contexts are adequately trained to offer extension services related to climate change adaptation to smallholder farmers:

(a) To identify the level of education and training of extension practitioners

(b) To explore if their education and training exposes these extension practitioners to knowledge of climate change.

(c) To explore if the extension practitioners have received in-service training on climate change

(d) To understand how the extension practitioners rate their competency level in disseminating climate change information

(iii) To explore if climate change and climate change adaptation being accommodated in the Agricultural Extension and Rural Development Programme:

(a) If yes, to understand the extent to which it is accommodated

(b) If not, to unearth what areas are foregrounded in the programme

(c) To understand why those areas are foregrounded.

1.5.2 Objectives of the main study

(i) To understand if a partnership exists between university, government and small holding communities with respect to changing weather and climate patterns and their impact on agriculture.

(a) If a partnership exists, to identity the type of partnership that exists between the stakeholders with respect to changing weather and climate and its impact on agriculture.

(b) If not, to unearth what does exist.

(ii) To understand the roles of each of the actors in this partnership and why they play such roles.

(iii) To explore if this partnership promotes climate smart adaptation practices technologies in everyday agricultural practices

(iv) To explore if these partnerships promote the use of indigenous knowledge systems in climate smart adaptation technologies applied to everyday agricultural practices.

In order to achieve the set objectives, the following broad research questions guided the study:

1.5.3 Research questions for the preliminary study

(i) What is the awareness and knowledge of Msinga smallholder farmers on climate change?
   (a) If yes, what is their awareness and knowledge of climate change?

(ii) Are in-service agricultural extension practitioners in rural contexts adequately trained to offer extension services related to climate change adaptation to smallholder farmers?
   (a) What is the level of education and training of extension practitioners?
   (b) Does their education and training expose these extension practitioners to knowledge of climate change?
   (c) Have extension practitioners received in-service training on climate change?
   (d) How does the extension practitioners rate their competency level in disseminating climate change information?

(iii) Is climate change and climate change adaptation being accommodated in the Agricultural Extension and Rural Development Programme?
   (a) If yes, to what extent?
   (b) If not, what areas are foregrounded?
   (c) Why are those areas foregrounded?

1.5.4 Research questions for the main study

(i) Do partnerships exist amongst universities, government and smallholding communities with respect to climate change?
   (a) If so, what type of partnership exists amongst these actors with respect to changing weather and climate patterns and its impact on agriculture in South Africa?

(b) If not, what exists? What is its nature?

(ii) What are the roles of each of these actors in these partnerships, and why?

(iii) Do these partnerships promote climate smart adaptation practices in everyday agricultural practices?

(a) If so, what CSA practices are being promoted?

(iv) Do these partnerships promote the use of indigenous knowledge systems in everyday agricultural practices?

(b) If so, what IKS practice is promoted?

1.6 RESEARCH METHODOLOGY

To address the critical research questions asked in this study, the qualitative research method was adopted. According to Creswell (2012), qualitative method is a research method used to explore the meanings that individuals and groups attach to their daily experiences of the social world and how they make sense of their world. For the purpose of this study, the exploratory qualitative case study design was adopted. The exploratory case study design offers the researcher the tools to engage in an in-depth and detailed exploration of a particular issue (Creswell, 2019). In concurring with the above view, Cohen, Manion, and Morrison (2011) reason that the exploratory qualitative case study approach addresses the crucial 'what', 'how' or 'why' of the phenomenon under investigation and also provides a detailed explanation of the phenomenon being explored by focusing on specific instances within a bounded system.

This exploratory qualitative case study design was employed in the preliminary and the main study. The preliminary study was carried out in three phases, representing the three research questions addressed, namely, phase one and phase two and phase three. In the same vein, the main study consists of four phases, in line with the four research questions addressed in the main study. A combination of document analysis, focus group interviews and questionnaires (structured, semi-structured and unstructured) were used to generate data for analysis.

1.7 FRAMEWORKS

The study is guided by three frameworks, namely, Jansen and Reddy's (1994) document analytical tool, Sustainable Livelihood Approaches (SLA) and the Quintuple Helix Innovation Model (QHIM). The Jansen and Reddy's (1994) document analytical tool (framework) is applied in the 2nd phase of preliminary study in attempting to understand the extent to which Agricultural

Extension and Rural Development Programmes equip pre-service extension practitioners to facilitate adaptation to climate change in smallholder farming contexts such as Msinga. The Sustainable Livelihood Approaches (SLA) is employed as both an analytical framework and as a theoretical lens. The framework will be applied throughout the preliminary study and in the last two phases of the main study. The SLA explores the livelihood challenges faced by individuals and groups in contexts like Msinga and how they follow different livelihood pathways to overcome these challenges (Scoones, 1998). The theory highlights that the living conditions of people can be enhanced if they are able to access livelihood capitals such as human capital, economic capital, social capitals, natural and physical capital (Scoones, 1998). The last framework employed in this study is the Quintuple Helix Innovation Model (QHIM). It was employed as an analytical tool in the preliminary and main study. According to Carayannis, Barth, and Campbell (2012), the QHIM is an innovative collaborative model between five helices, namely, the education system/academia, the end-users or media-based public, the economic system, the political system and the natural environment.

1.8 OUTLINE OF THE STUDY

Chapter 1: This chapter, which is the introductory chapter, outlines the background of the study, context/location of the study, the purpose and significance of the study and the rationale behind the study. Also, this chapter presents the objectives of this study, the critical research questions and clarification of terms used in the study.

Chapter 2: In this chapter, I present the literature review of the study. It explores literature dealing with climate change impacts on agriculture in South Africa and beyond. Furthermore, this chapter discusses climate smart agriculture (CSA). In addition, the chapter provides a brief review of literature on partnerships and on the mainstreaming of climate change adaptation. Lastly, the chapter explores the place and space for indigenous knowledge systems in climate change adaptation in everyday agriculture.

Chapter 3: This chapter presents the theoretical underpinning of this research study, namely, the Sustainable Livelihood Approach (SLA) and Quintuple Helix Innovation Model (QHIM). The chapter provides the historical background of both theories and their application to this study.

Chapter 4: This chapter presents the research methodology guiding this research. It consists of the method of data collection, sampling procedure and sample size, location of the study, validity of the research data analysis, ethical issues and limitations of the study.

Chapter 5: This chapter presents the analysis of the preliminary research question, which explores the knowledge and awareness of Msinga smallholder farmers on climate change.

Chapter 6: This chapter presents the analysis of research question two of the preliminary study, which explores the level of preparedness of agricultural extension practitioners in Msinga to offer extension services related to climate change to smallholder farmers.

Chapter 7: This chapter presents the analysis of research question three in the preliminary study. The chapter explores the inclusion of climate change and climate change adaptation in pre-service agricultural extension curriculum and training.

Chapter 8: This chapter presents the analysis of research question one in the main study, which explores partnerships in existence amongst the stakeholders engaged in this study and the nature of the partnerships in existence.

Chapter 9: This chapter presents the analysis of main research question two in the main study. This question explores the roles of each stakeholder group in their respective partnerships.

Chapter 10: This chapter presents the analysis of main research questions three and four in the main study, which explores the promotion of climate smart agricultural practices and indigenous knowledge systems in the respective partnerships between the stakeholders engaged in this study.

Chapter 11: This chapter presents the summary of finding of the preliminary and main study. Furthermore, the chapter provides the discussion of findings arising from the analysis of data generated in the study.

Chapter 12: This chapter offers the conclusion of the study, implications of the findings and its contribution to knowledge.

1.9 CLARIFICATION OF TERMS AS THEY ARE USED IN THE STUDY

Climate Change: Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (Climate Change [IPCC], 2012).

Vulnerability: The degree to which a system or subsystem is likely to experience harm due to exposure to a hazard (Turner et al., 2003)

Adaptation to climate change: Adaptation to climate change represents practical steps and efforts to protect people and places from actual or potential disruption and damage that will result from effects of climate change (United Nations Convention on Climate Change glossary as cited in Levina & Tirpak, 2006).

Climate smart agriculture (CSA): According to Sullivan, Mwamakamba, Mumba, Hachigonta, and Majele -Sibanda (2012, p. 1), climate smart agriculture consists of sustainable agricultural practices that increase agricultural productivity and reduce the emission of greenhouse gases. Climate smart agriculture helps to ensure that climate change adaptation and mitigation are directly incorporated into agricultural development planning and investment strategies (Sullivan, Mwamakamba, Mumba, Hachigonta, & Majele Sibanda, 2012, p. 1)

Food security: When all people, at all times, have physical and economic access to sufficient, safe and nutritious food (FOA, 2006).

Stakeholders: Stakeholders are individuals or groups concerned about the development and welfare of an establishment and thus see their interests linked with the community's state of being (Forh, 2011). In the context of this study, a stakeholder refers to any individual(s), institutions or establishment whose contribution can yield a positive impact on the mainstreaming of climate smart agriculture in the Msinga community**.**

Partnerships: A collaborative arrangement in which stakeholders from different spheres of the society (state, market and civil society) are involved in a non-hierarchical process, and through which these actors strive for a sustainable goal (Van Huijstee, Francken, & Leroy, 2007).

Mainstreaming adaptation: Integration of information, policies and measures to address climate change into ongoing development planning and decision making (Klein, Schipper, & Dessai, 2005; Ayers & Huq, 2009).

Indigenous knowledge systems (IKS): According to Maluleka, Wilkinson, and Gumbo (2006), IKS can be considered as the use of technological knowledge, skills and resources developed and transmitted by indigenous people to their young ones in their cultural settings, to enable them to manipulate the environment in order to meet their everyday needs and wants.

Livelihood: Livelihood is the means of gaining a living or a combination of the resources used and the activities undertaken in order to live (Chambers, 1995).

SLA: The Sustainable Livelihoods Approach (SLA) is a framework for analysing and changing the living conditions of people experiencing poverty (Chambers, 1995). As a theory, it highlights that all people have abilities and assets that can be developed to help them improve their lives (Scoones, 1998).

Sustainable development: 'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987). It is, further, development that is conducted without the depletion of natural resources.

QHIM: The Quintuple Helix Innovation Model (QHIM) is an innovative institutional configuration comprising of five helices, namely, the education system, the economic system, the natural environment, the media- and culture-based public and the political system (Carayannis et al., 2012).

CHAPTER TWO
REVIEW OF RELATED LITERATURE

INTRODUCTION

According to Hlahla, Nel, and Hill (2019, p. 1089), climate change is recognised as the "chief ecological challenge" in South Africa in the 21st century. On a global scale, research by the Intergovernmental Panel on Climate Change (IPCC) (2014), Food and Agriculture Organization (FAO) (2015), Aggarwal et al. (2018) as well as Campbell, Hansen, Rioux, Stirling, and Twomlow (2018) suggest that climate change impacts negatively on agricultural productivity, thereby impeding the attainment of Sustainable Development Goal two which aims to "end hunger, achieve food security and improved nutrition, and promote sustainable agriculture" (FOA, 2015). Though a global phenomenon, countries in sub-Saharan Africa and South Asia have been found to be most disproportionately affected by the impact of climate change (Lipper et al., 2014). Even so, the impacts are more severe at local or community levels, due to the vulnerability of rural communities across sub-Saharan Africa and South Asia (Senyolo, Long, Blok & Omta, 2018; Hlahla et al., 2019).

In searching for solutions to the negative impacts of climate change, scholars such as Broto (2017) argue that collaboration, cooperation and coordination between the private sector, public sector, civil societies and local communities have become imperative, especially at the local government level, given that the impacts of climate change are felt more at local level, and the government and people at this level alone do not have the capacity to address these challenges. This concurs with the views of Sullivan, Mwamakamba, Mumba, Hachigonta, and Majele Sibanda (2012), who reason that the challenges associated with climate change, agriculture and food security cannot be addressed by any single institution. Therefore, Stephens et al. (2008) suggest that the challenges of climate change and the urgency to tackle them demands that stakeholders must engage and work together in new ways. However, there seems be a lack of discussion and action within developing countries on partnerships and collaborations toward addressing climate change (Pinkse & Kolk, 2012).

In sub-Saharan Africa, though some research has revealed the existence of partnerships on climate change, such partnerships have been found to be weak on many fronts. For instance, a recent study conducted in Cameroon by Ngum, Alemagi, Minang, Kehbila & Tchoundjeu, (2019) reported that, though there is multi-stakeholder interaction between Government, NGOs and Universities on climate change, however, these arrangements are poor and inadequately financed. Other challenges identified in the study include inadequate coordination, insufficient sensitization and capacity building, ineffective implementation, inadequate compliance, lack of proper transparency and inadequate public participation (Ngum et al., 2019). In South Africa, Ziervogel, New, Archer van Garderen, Midgley, Taylor, Hamann, Stuart-Hill, Myers and Warbuton (2014, p. 613) found that the relationships that exist between different stakeholder groups in South Africa (government, civil society, researchers, practitioners, private sector) is weak, even though these relationships are critical in driving adaptation in the country. In this regard, Ngum et al. (2019) suggest that networks and partnerships must be created and knowledge must be shared between stakeholders and experienced countries in the design and implementation of integrated strategies for managing climate change.

Drawing from the foregoing studies, this chapter attempts to provide a review of literature that identifies relevant issues on mainstreaming climate smart adaptation technologies through partnerships, as well as the place and space for IKS in climate change adaptation. The discussion in this chapter is divided into four broad sections. Section 2.1 presents a review of literature on the impacts on climate in South Africa, with specific reference to agriculture. Section 2.2 engages literature on climate smart agricultural practices as solutions to climate change. Section 2.3 discusses the mainstreaming of climate change adaptation through partnerships. Lastly, section 2.4 focuses on the place and space of indigenous knowledge systems in climate change adaptation efforts.

2.1 THE IMPACTS OF CLIMATE CHANGE ON RURAL AGRICULTURAL PRACTICES IN SOUTH AFRICA

According to the Global Climate Risk Index (2016), recent climatic events such as drought, flooding, wildfire, etc pose a major threat to smallholder agricultural practices and livelihood across the globe. Affirming the above view, research by Lipper et al. (2014) reveals that climate change has reduced global output of staple crops such as maize and wheat by 3.8% and 5.8% respectively and it is predicted that the decrease in crop yield may worsen in the near future. In sub-Saharan Africa, climate change is one of the biggest challenges faced by smallholder farmers

(Sanogo et al., 2017; Turpie & Visser, 2013). Early, a report by the United Nations (2009) shows that 21 countries out of the 36 countries worldwide that are currently facing food insecurity are in Africa. In addition, Lipper et al. (2014) state that 75% of world's underdeveloped and poor population depends on smallholder agriculture for survival, however, climate change has dampened agricultural output across the world's "global South". The foregoing shows that climate change is a major threat to agricultural practices and food security in Africa.

Within South Africa, the impact of climate change on agricultural and livelihood is widely recognized. For example, a study by Turpie and Visser (2013), which used secondary data generated from about 7301 households by Statistics South Africa (StatsSA, 2007) and the 2008 National Income Dynamics Study, revealed that climate change has led to higher temperatures, sporadic rainfall patterns, frequent droughts, economic downturn and untimely deaths across the country. In addition, the study by Turpie and Visser (2013, p. 115) reported that the decrease in rainfall and an increase in temperature will have adverse effects on both crops and livestock in South Africa, with an estimated decrease of net revenue of about 144% by the year 2080 for crop farmers and decrease of about 127.7% by 2080 for livestock farmers. Similarly, a report by IPCC (2007) predicts that, by 2050, yields for maize and other staple crops in South Africa could decrease by more than 30%. Again, Madzwamuse (2010), found that increases in temperature and reduction in rainfall will collectively impact on the agricultural systems in South Africa by reducing the amount of land suitable for arable and pastoral agriculture.

Thus, the Food and Agricultural Organization (FAO) (2008) reports that climate change will affect all four components of food security in South Africa – food availability, food accessibility, food utilisation and food systems stability. Almost a decade after, Mugambiwa and Tirivangasi (2017) affirms that food availability and utilization in South Africa would be highly compromised as a result of a decrease in crop yield caused by climate change. Perhaps agriculture is particularly vulnerable to climate change because it is highly dependent on climate variables, and also because of the country's semi-arid nature (Turpie & Visser, 2013; Mugambiwa & Tirivangasi, 2017). Moreover, the impact of climate change in South Africa is more evident in the rural areas/communities, where 40% of the underprivileged population resides (Turpie & Visser, 2013). According to De Cock (2012) and Hosken (2013), South African rural dwellers are most strongly affected by climate change. Correspondingly, Landman (2004), as well as Aliber and Hart

(2009), argue that food security remains a challenge in South Africa, especially in rural households that depends on rain-fed agriculture for their food needs. Again, Hendriks (2005) emphasises that South Africa is nationally food insecure, given that 58% to 73% of households experience food insecurity. In this regard, Aliber and Hart (2009) as well as Mugambiwa and Tirivangasi (2017) suggest that, though South Africa may appear secure at national level in terms of food, at individual or household level, the story is different. Hence, looking at the above studies, one can argue that the chances of achieving food security by 2030 in South Africa are very slim.

Additionally, climate change could exacerbate rural poverty in South Africa (Statistics South Africa, 2007). Equally, Turpie and Visser (2013) reason that the impacts of climate change on agricultural output can be expected to have not only direct impacts on rural communities (in the form of reduced income and employment), but also knock-on effects for rural economies as a whole. This will put considerable strain on rural local governments/municipalities, which provide services and promote development at local level (Ibid.). Turpie and Visser (2013) emphasise that the burden on municipalities will increase because of the anticipated increases in natural disasters, water scarcity and disease, and reduced agricultural production and food security. Evidently, climate change has serious consequences on other economic sectors that are directly or indirectly associated with the agricultural sector. Therefore, the fluctuations in the agricultural sector will definitely cause other sectors to become extremely unstable and vice versa (Mugambiwa & Tirivangasi, 2017).

2.1.1 The impacts of climate change in Msinga

In a rural context such as Msinga, where this study is situated, research conducted earlier by Rukeme (2010) found that many households have suffered loss of agricultural inputs, such as crops, livestock and seasonal employment, because of drought. The study, which used a random sampling method to engage 120 heads of household in Msinga, revealed that almost every household in the area has lost two or more of their livestock to drought. The participants in the study stated that the loss of cattle is the greatest loss and is central in perpetuating the poverty of the household (Rukema, 2010). Similarly, research by Joseph and Hamilton (2013) reveals that drought is a major socio-economic problem in Msinga. The study found that between 1999-2004, and between 2006-2007, droughts of different magnitudes were experienced in Msinga and the effect of each one was worse than the previous.

Still on the impacts of climate change in Msinga, the South African Weather Services Indicator (2008) report shows that Msinga is highly susceptible to dry weather conditions. This poses a big challenge for the prevalent rain-fed and commercial agricultural practices in the area. The Department of Water Affaires and Forestry (2004) reports that the 2003-2004 droughts in uMzinyathi district municipality, which includes Msinga as one of its local municipalities, affected about 160,000 people in one way or the other. In the same vein, the result of the study conducted by Rukema (2010) highlights that smallholder farmers in Msinga lost 70% of their crop production between 2004 and 2007 and had to rely on small donations from friends, churches and from relatives for survival. The study further shows that crop failure as a result drought caused severe starvation and mass migration of men to urban areas in search of employment/livelihood**.**

Again, Mthembu and Zwane (2017), whose study investigated the adaptive capacity to climate variability impacts by Ncunjane farming community in Msinga, found that drought affected the farming community in 2010 and again in 2014–2015. The study revealed that many households in the area experienced high livestock mortality rates and crop failure in both cases (Ibid.). The study further shows that the community was vulnerable to climate change and became highly dependent on government support/interventions, which often were futile, given the large number of households affected (Ibid.). Correspondingly, a study by Rukema and Umubyeyi (2019), which adopted a qualitative approach to engage 16 participants from Msinga villages, suggests that the fluctuating nature of rainfall in most areas of Msinga makes it risky to invest in the production of crops such as maize, vegetables and sorghum, which are the main sources of food in these areas. The study further shows that drought conditions in Msinga are aggravated by the prevailing economic and social situation in the area. It is evident that drought is a major problem in Msinga Local Municipality, where rain-fed agriculture is the main source of livelihood. This has increased the level of hunger, unemployment, and poverty in the area. The situation is further exacerbated by the fact that the capacity to adapt to climate change is very low in the area. Therefore, rain-fed farming within Msinga remains vulnerable to the impacts of climate change.

2.1.2 Linking climate change impacts to vulnerability and poverty

Vulnerability may be defined as the exposure of people and places to a future harm or threat (Wolf et al., 2013). In the context of climate change, vulnerability is the degree to which a system or subsystem is likely to experience harm due to exposure to a hazard (Turner et al., 2003). The level of vulnerability differs from one individual, group or sector to another (Ionescu, Klein, Hinkel, Kumar, & Klein, 2009; Costa & Kropp, 2013). This means that the level of vulnerability one is exposed to depends on his or her context (social, economic, etc). According to Agrawal, Mearns, Perrin, and Kononen (2011), the disproportionate burden of adverse impacts of climate change will be felt by poor, natural resource-dependent households. Agreeing to the above perspective, Adger (1999) suggests that poverty is a key aspect of vulnerability, due to its direct link to lack of access to resources, which affects both baseline vulnerability and coping from the impacts of extreme events. This underlines the fact that vulnerability to climate change is not just a function of biophysical consequences related to variations and changes in temperature, precipitation, topography and soils, but also of socio-political and institutional factors that can vary significantly amongst people (Adger, Arnell, & Tompkins, 2005). In line with the abovementioned, Beg, Morlot, Davidson, Afrane-Okesse, Tyani, Denton and Parikh (2002) argue that developing nations face greater vulnerability because of their reliance on rain-fed agriculture, their lower tolerance to coastal and water resource changes, and lower financial, technical, and institutional capacity to adapt. The authors maintain that, while sustainable development might reduce this vulnerability, uncertainties about the rate of climate change and pattern of economic development in poorer countries raise questions about whether development could occur fast enough to make a difference (Beg et al., 2002).

Furthermore, Beg et al. (2002) suggest that most countries in Africa are vulnerable to climate change due to their predisposition to drought and desertification, dependence on subsistence agriculture and vulnerability to poor rainfall. At household or individual level, Blaikie, Cannon, Davis, and Wisner (2004) reason that access to resources varies amongst households, thus the reason for the variation in vulnerability. Using their Access Model (AM), Blaikie, Cannon, Davis and Wisner (2004) argue that access to basic infrastructure and resources determines the ability of an individual, family, group, class, community or ethnicity group to recover or adjust to external shocks. Blaikie et al. (2004) emphasise that the lack of access to resources creates a situation where people are exposed to hazards and threats, while at the same time reducing the capacity to adapt and recover from such hazards. Similarly, Wisner and Luce (1993) argues that lack of access and resources can become a significant factor and a root cause of vulnerability degenerating to risks.

According to Wisner and Luce (1993), as well as Rukema (2010), there is a relationship between exposures to hazard, ability to respond, lack of access, lack of resources and vulnerability. In the same vein, Nwajiuba et al. (2015) reason that the vulnerability of African farmers stems from poor socio-economic circumstances, harsh biophysical environments, low technology, poor infrastructure and lack of access to agricultural credits as well as markets. Within the South Africa context, scholars such as De Cock (2012); Hosken (2013); Mugambiwa and Tirivangasi (2017) acknowledge that South Africa's poor and rural dwellers are those mostly affected by the adverse effect of climate change, owing to their inability to access the necessary facilities needed to mitigate and adapt to climate change. Thus, Tanner and Mitchell (2008) suggest that reducing household and community vulnerability to climate change is closely linked to poverty reduction. The authors emphasise that poverty is both a condition and a determinant of vulnerability. It can therefore be concluded that poverty, lack of access and lack of resources place individuals and groups in a vulnerable position with respect to the impacts of climate change. This exemplifies the situation in rural South Africa communities such as Msinga, KwaZulu-Natal, where unemployment has increased and lack of access and resources is prevalent, thereby putting people in a vulnerable situation.

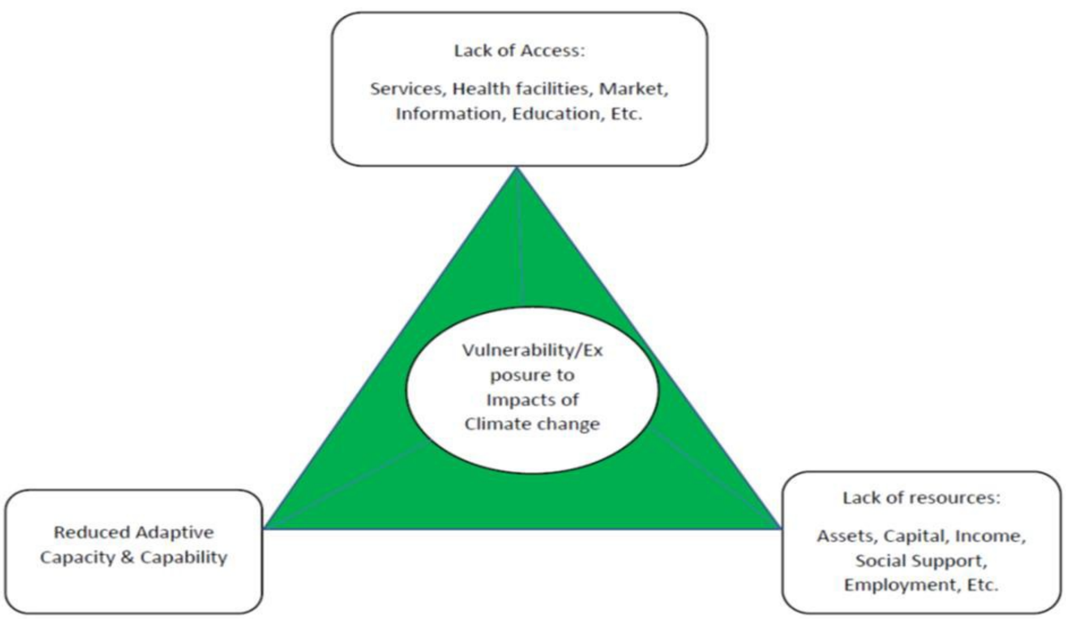

Figure 2: Relationship between, lack of resources, lack of access to livelihood capitals, reduced adaptive capacity and vulnerability to impacts of climate change (Adapted from Rukema, 2010).

2.2 FINDING SOLUTIONS TO CLIMATE CHANGE: MAKING A CASE FOR CLIMATE SMART AGRICULTURE (CSA) IN MSINGA

According to a policy brief by Sullivan, Mwamakamba, Mumba, Hachigonta, and Majele Sibanda (2012, p. 1), under the auspices of the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), climate smart agriculture holds the answer to weather and climate issues and perhaps is the future of African agriculture. The policy brief, which explores the role of engagement, partnerships and gender issues in climate smart agriculture within the African context, highlights that climate smart agriculture represents sustainable agricultural practices that increase productivity and reduce the emission of greenhouse gases. The authors' reason that CSA helps to ensure that climate change adaptation and mitigation are directly incorporated into agricultural development planning and investment strategies. In concurring with the above perspectives, Nwajiuba et al. (2015) in their study confirm that CSA is an innovative way of sustainably increasing productivity of farm and forestry production systems and improving the living conditions of the rural populace, while at the same time contributing to the mitigation of the impact of climate change. Using a combination of desktop studies, interviews and survey to investigate the state of CSA in Nigeria, Cameroon and Democratic Republic of Congo, the study found that smallholder farmers in these countries are already using climate smart approaches in their farming practices without even realising it. The study, however, reveals that there is a lack of policy/polices on climate smart agriculture at national, sub-regional, and regional levels in these countries.

In the same vein, a theoretical paper by Lipper et al. (2014) explains that CSA represents agricultural systems that use ecosystem services to support productivity, climate adaptation and mitigation. Examples of CSA practices include integrated crop, livestock and agroforestry systems; improved pest, water and nutrient regulation; practices such as reduced tillage and use of diverse varieties and breeds; integrating trees into agricultural systems; and improving the efficiency of water and nitrogen fertilizer use and manure management etc (Lipper et al., 2014). Similarly, Sanogo et al. (2017) adopted a Participatory Communication for Development (PCD) approach to engage 76 agro-pastoralist from the Kaffrine Region of Senegal in a participatory process of diagnosis and development of climate change adaptive capacity. Given the impact of climate events such as drought, flooding and strong winds in the area, the authors recommend that climate smart adaptation technologies and practices, such as the use of drought tolerant crop varieties and planting of improved plant varieties, should be adopted by the farmers.

A related study was conducted by Zougmore, Partey, Ouedraogo, Omitoyin, Thomas, Ayantunde, Ericksen, Said and Jalloh (2016) with the aim of providing up-to-date information on climate change impacts, adaptation strategies, policies and institutional mechanisms that each agriculture subsector had put in place in dealing with climate change and its related issues, in the West African region. The study, which generated data from a range of published scholarly literature and policy documents noted that farmers and their products (especially crops, livestock, etc.) in the West African region remains vulnerable to sporadic climate events such as drought, flood and bush fire, with resultant loss of lives and livelihoods. In addressing these challenges, the livestock farmers in the region adopted climate smart adaptation practices such as livestock mobility to semiarid/sub humid zones, migration (local and regional), integration of crop and livestock etc. (Zougmoré et al., 2016). Similarly, crop farmers adopted and promoted climate smart agricultural practices such as water management – irrigation for commercial farmers and water harvesting for smallholder farmers (Ibid.). Practices such as the development and adopting of crops varieties that withstand higher temperature and drought; agroforestry, which entails the integration of trees with crops in the same farmland; and use of seasonal weather and climate forecasting, which entails accessing climate information and services from ICT companies and metrological institutions in contexts where such services are available (Ibid.). The authors conclude that the promotion of climate-smart agricultural (CSA) practices is one mainstream opportunity to mitigate climate change while sustaining the productivity of agricultural systems in the West African region. Therefore, developing or reinforcing adaptive mechanisms such as embedded in CSA to deal with the negative effects of climate change must be a high priority in the Africa region (Ibid.).

In South Africa, Elum, Modise, and Marr (2017) piloted a large study whose objectives were to understand the trend in climate parameters, examine farmers' perceptions of climate change and identify the responsive strategies that farmers have adopted to cope with the effects of a changing climate. Using a combination of random and purposive sampling, with the aid of questionnaires, the study drew 150 potato and cabbage (vegetable) farmers from Gauteng, Limpopo and Mpumalanga provinces of South Africa. The study revealed that a very high percentage (77.3%) of potato farmers engaged in the study experienced extreme high temperatures across the three provinces, leading to a large shortfall of (83.3%) in yield. Equally, the study showed that 66.7% of cabbage farmers suffered extreme high temperatures and this resulted in a shortage of about 74.7% in the yields of cabbage. Nonetheless, the study reported that the farmers adopted climate smart adaptation strategies to cope with the effects of climate change. While cabbage farmers adopted climate smart practices such as the planting of drought tolerant or resistant varieties, potato farmers opted for integrated pest management and the planting of different crops (Ibid.). Other climate smart adaptation practices reported in the study included changing of planting time and increased access to extension agents for cabbage farmers, while diversified and relocated crops as well as planting drought tolerant varieties were adopted by potato farmers (Elum et al., 2017). Evidently, the climate smart adaptation strategies adopted by the two set of farmers are similar, as planting of drought tolerant or resilient crops were adopted by both potato and cabbage farmers. The study recommended that climate smart adaptation strategies, such as access to improved seeds which are tolerant to drought, access to formal market and extension services as well as the use of efficient micro-irrigation systems should be enhanced in the three provinces and across the country (Ibid.). Drawing from these empirical studies, it is evident that climate smart agricultural technologies or practices such as discussed above are being promoted in response to the effects of climate change in many farming contexts across sub-Saharan Africa, and many studies such as above has alluded to this regard.

2.2.1 How and why should CSA be mainstreamed?

Although CSA practices are currently being promoted in some farming contexts within sub-Saharan Africa, there is still a challenge with respect to how CSA can be successfully introduced, mainstreamed and disseminated in all farming communities across the continent. In responding to the above challenge/question, Lipper et al. (2014) explain that all stakeholders at all levels (from global to local levels, from research to policies and investments, and across private, public and civil society sectors) have key roles to play in developing and disseminating knowledge related to CSA. The authors reason that all stakeholders should get involved in reducing information costs and barriers and increasing the capacity of extension systems to disseminate context-specific information through avenues such as radio programmes and information and communication technologies (ICT). In keeping with the above view, Speranza (2010) suggests that research needs to develop and modify climate smart technologies that are specific to smallholder contexts and needs. It also needs to examine and show how adopting a low carbon path can still maintain and increase agricultural production in Africa (Ibid.). In other words, research institutions/bodies are important stakeholders in CSA knowledge generation and dissemination.

Likewise, Nwajiuba et al. (2015) suggest that the anticipated increase in production arising from CSA should be hinged on a combination of technologies, policies, financing mechanisms, risk management schemes and institutional development. Furthermore, Nwajiuba et al. (2015) espouse that CSA should be embedded into identified development pathways and practices adapted to communities to bring "triple wins" that enhance opportunities to increase agricultural productivity, improve resilience to climate change, and contribute to long-term reductions in dangerous carbon emission. In this regard, the authors suggest that there is the need to ensure effective flow of CSA information through highly skilled extension staff to farmers with targeted information packages. However, the authors recommended that extension services (public and non-public) need foundation training to acquire core proficiencies in CSA from management levels, through specialists, to local field personnel to enable them to succeed in disseminating CSA information. This implies that the position of agricultural extension officers in the implementation of CSA is very important. Additionally, Nwajiuba et al. (2015) emphasise that CSA needs to be integrated into mainstream local, national and international agricultural development policies and planning processes to facilitate a more holistic and system-wide approach to engaging with agricultural sector challenges and responses.

2.3 MAINSTREAMING CLIMATE CHANGE ADAPTATIONS THROUGH PARTNERSHIPS

The need to mainstream climate change adaptation strategies and decisions has been emphasised over time (Adger et al., 2005). From a definitional point of view, the term mainstreaming is derived from the word mainstream – which means conventional, established, accepted or recognized (Compact Oxford Thesaurus for Students, 2007). In climate change discussions, mainstreaming has been given various conceptualisations, meanings and explanations, but there is no universally held definition as yet. According to Brouwer, Rayner, and Huitema (2013), this is even though there is widespread discussion and agreement on the importance of climate policy mainstreaming, with high-level declarations of commitment and guidance documents on the subject. This, however, has not translated into a common terminology or shared understanding of what precisely it entails to (Brouwer et al., 2013). Nonetheless, scholars such as Levina and Tirpak (2006) suggest that mainstreaming adaptation, simply put, is the integration of adaptation objectives, ideas, policies, measures or operations to the point that they become part of the national and regional development policies, processes and budgets at all levels and stages.

Ayers and Huq (2009) explain that mainstreaming adaptation involves the integration of information, policies and measures to address climate change into ongoing development planning and decision making. Mainstreaming adaptation implies making sustainable, effective and efficient use of resources rather than designing and managing separate policies from existing ones (Klein et al., 2005; Ayers & Huq, 2009). In addition, Wright et al. (2014) contend that climate change mainstreaming entails incorporation of climate change considerations into public policy and practice, at all planning levels, across all sectors and involving public, private and civil society actors. Climate change mainstreaming appears at different levels or in different categories. These categories include but not are limited to building adaptive capacity through institutions and technological approaches in sectors that are directly affected or sensitive to climate change. Second, it includes managing climate risk and confronting climate change through the integration of climate change in national, sectorial and local planning strategies, climate proofing, disaster response planning activities and technological approaches (Olhoff & Schaer, 2010). The next category involves confronting climate change by way of addressing climate change impact, exclusively. For example, the relocation of communities in response to sea-level rise and glacial melting, radical policies and technological approaches that address unprecedented levels of climate risk (Olhoff & Schaer, 2010). In other words, the term mainstreaming in the context of climate change means the integration of climate concerns, polices, programmes and adaptation responses into relevant government and non-government policies and programmes. It could also be interpreted as decisions or actions taken in order to prevent or respond to a climate event, like relocation of people in the event of a disaster.

However, Agrawal et al. (2011) reason that mainstreaming climate change adaptation with development policy remains a key challenge, in the sense that mainstreaming climate adaptation requires development and strengthening of institutional and organizational frameworks and synergies at all levels of government (Agrawal et al., 2011). Similarly, Olhoff and Schaer (2010) argue that there is no clear cut approaches, tools and processes on how to mainstream climate change adaptation in practice, given that the level of climate change impacts and needs differ from one context to another. In supporting this view, Brouwer et al. (2013) argue that there is scarcity of conceptual work and empirical research of how mainstreaming works in practice. At the level of local government, Anguelovski, Chu, and Carmin (2014) confirm that there is a lack of understanding around how climate adaptation programmes are eventually mainstreamed and institutionalised and what trajectories municipalities choose to take to achieve this. In some instances, mainstreaming climate change adaptation could be a point of departure. This means starting from scratch with a predominant focus on developing relevant adaptation options, measures and policies, without cuing in the idea of ongoing or planned development activities (Organisation for Economic Co-operation and Development - OECD, 2009). In other instances, the process of mainstreaming of adaptation implies providing an overview of key vulnerability and climate adaptation needs in different sectors and communities within a given country, with the aim of adopting necessary adjustments to existing and future programmes and projects (OECD, 2009). The above views imply that the process of mainstreaming is not clearly defined as yet. Rather, adaptation needs, vulnerability, contexts, policies as well as programme on ground determine the process and scale of mainstreaming.

2.3.1 Attempts/guides towards adaptation and mainstreaming

A study conducted by Huq et al. (2004) in Mali, Bangladesh and India shows that there were different understanding and levels of mainstreaming of adaptation in these countries at the time of the study. For instance, in Bangladesh, the authors found that adaptation to climate change has been incorporated into some national policies and planning such as:

(a) Coastal resource management: Agreements have been reached with project managers to include climate change issues into project planning; Disaster mitigation stakeholders agreed to incorporate adaptation into their ongoing disaster-preparedness plans

(b) Freshwater resource management: The impacts of climate change are acknowledged, hence managers have agreed to incorporate adaptation into the 25-year water sector plan under development.

(c) Agriculture: Stakeholders recognized the importance of incorporating climate change considerations into their research programmes (especially those developing drought- and saline-tolerant rice varieties). However, those involved in agricultural extension work did not recognize the importance.

In Mali, the authors established that efforts (though these efforts were not identified) made to mainstream adaptation to climate change into national planning and activities have been fairly successful for the agricultural sector. In the energy sector it was moderately successful. However, in other sectors (such as water resources) and at the national policymaking and planning levels, it has been less successful (Huq et al., 2004, p. 37). Based on this study and the views expressed therein, one can interpret mainstreaming adaptation as decisions or agreements to incorporate climate change adaptations into various policies and projects within a country. However, this does not necessarily guarantee that such agreements are mainstreamed and operationalised.

The Organisation for Economic Co-operation and Development - OECD (2009) reveals that adaptation and mainstreaming happens at four levels – national level, sectoral level, project level and local level. However, the people at the local level are usually left out in the articulation of policies relevant to climate change adaptation. According to OECD (2009), though the local level is a critical level, given that the impacts of climate change are felt locally, however, individuals and entities at this level are not usually consulted in climate change policy decision making. Rather, decision making for local actors take place at higher levels, such as the provincial or national government levels – top-down decision making (OECD, 2009). When considered critically, this confirms the earlier submission by scholars such as Anguelovski et al. (2014) that there is little or no input from people at the level of local government in climate change adaptation and mainstreaming policy decisions. This means that a top-down approach is employed in the adaptation policy cycle (formulation). Perhaps this contributes to the failure or poor implementation of climate change policies at local government level. As Mogano and Mokoele (2019) state, the exclusion of local government during decision making about the environmental issues creates a policy implementation gap.

Against this background, OECD (2009) suggests that adaptation policies and programmes/incentives should be devised with participation and inputs from local actors themselves, in order to ensure their uptake, sustainability, inclusiveness and overall success (bottom-up). Notwithstanding this, OECD (2009) states that the local level (governments) oversee planning processes and construct, manage and deliver public services at local level. Additionally, the local government offers a supportive framework of norms, standards, financial incentives, and other types of knowledge, services and capacities to help individuals, households and community take decisions that reduce their exposure to climate risks. In this regard, the local level represents the most critical level in the mainstreaming process, given that the impact of climate change is felt mostly by people within this category/level.

Drawing from the literature reviewed, it can be said that climate change adaptation and mainstreaming require action at different levels/phases. These adaptation actions could be targeted towards new projects or existing/on-going projects. This implies that the process of mainstreaming adaptation can be novel or it can be a revamp of existing adaptation activities, from policy cycle and budgeting at the national and sector level to projection implementation and monitoring at local level. What has been re-established here is that a top down approach is usually adopted in most climate change adaptation and mainstreaming policy formulation. This means that there is little or no contribution from local levels (government) in adaptation decisions or policy formulation, even though the impact is mostly felt at this level. It is anticipated that this present study might open the space for the inclusion of local level in future adaptation and mainstreaming endeavours in South Africa.

2.3.2 Why mainstreaming through partnerships?

Multi-stakeholder partnerships have been recognised as the collaboration model of the 21st century needed to solve multifaceted problems that are beyond the capacity of any single sector (Backstrand, 2008; Warner & Sullivan, 2017). According to Pinkse and Kolk (2012), partnerships have received increased attention in discussions relating to sustainable development as a result of a global partnership for development being listed as the 8th Millennium Development Goal. Partnerships between the "Government and Non-Governmental" actors were recognised as an important implementation framework for sustainable development at the Rio de Janeiro conference (Warner & Sullivan, 2017). To Waddock (1991), a partnership is a voluntary collaborative effort of actors from two or more economic sectors in a forum in which they cooperatively endeavour to solve a problem of mutual concern to them and to the society at large. Similarly, Van Huijstee et al. (2007) describe partnerships as collaborative arrangements in which stakeholders from different spheres of the society (state, market and civil society) are involved in a non-hierarchical process, and through which these actors strive for a sustainability goal. One thing that is consistent in the above definitions is the fact that partnerships cut across different sectors and are geared towards achieving a common goal or interest. Also, it can be understood that all the partners have equal footing in the partnership, though their contributions differ.

According to Pinkse and Kolk (2012, p. 193), multi-stakeholder partnerships for climate adaptation can be divided into three types and each of the partners bring different things to the table. The three types of partnerships, according to Pinkse and Kolk (2012) are:

(i) Physical and institutional infrastructure investments: These partnerships focus on issues around coastal protection, flood defence, and disaster relief.

(ii) Insurance schemes: These type of partnerships focus on infrastructural investments and insurance schemes, explicitly designed for furthering climate change adaptation.

(iii) Research and development (R&D): These partnerships have interest in areas such as health and agricultural research.

Nonetheless, Pinkse and Kolk (2012) suggest that there seems to be a lack of discussion and action amongst developing countries on this subject. This view was echoed by Ziervogel et al. (2014), who reason that interactions between stakeholders such as government, civil society, researchers, practitioners, private sector are weak even though such relationships are critical in driving adaptation to climate change in South Africa. According to Pinkse and Kolk (2012), this explains the scarcity of empirical research and insight into how a multi-stakeholder arrangements might help address climate issues in developing countries. In contrast, a study conducted in Cameroon**,** by Ngum et al. (2019), found that partnerships do indeed exist between government NGOs and universities with respect to climate change adaptation. The study, which used a qualitative approach to generate data from 18 participants from the government, NGO and Government stakeholder groups, revealed that although policies, laws, strategies and institutional arrangements relevant for promoting an integrated approach to climate change are inadequate in Cameroon, however, some promising projects and activities that harness great potential for synergies on climate change adaptation exist. It is important, though, to note that these partnerships were found to be weak (Ibid.).

Similarly, Partey et al. (2018) conducted a study entitled 'Developing climate-smart agriculture to face climate variability in West Africa: Challenges and lessons learnt'. The study adopted the method of desktop review of appropriate literature relevant to five West African countries, namely, Ghana, Mali, Niger, Senegal and Burkina Faso. Specifically, the study employed Scopus for literature identification. The study found that different forms of partnerships, termed innovative platforms, are used as mechanisms to develop and promote CSA technologies and practices. The study further revealed that these multi-stakeholder platforms, consisting of academics, the media, researchers, NGOs, policy makers, farmer based organisations, traditional leaders, etc. are settings through which scientists and policy makers interact, and challenge each other's opinions to come up with jointly developed knowledge aiming at informing policy decision processes around CSA. Therefore, it can be said that there are indeed multi-stakeholder partnerships on climate change and sustainability in some sub-Saharan Africa countries.

The above perspectives show that mainstreaming of climate change adaptation in the form of climate smart agricultural technologies and approaches alone may not increase resilience or improve the livelihood of most smallholder farmers, looking at the severity and complexity of the impacts of weather and climate on agriculture (Sullivan, Mwamakamba, Mumba, Hachigonta, & Majele Sibanda, 2012). Hence, Sullivan et al. (2012) reason that climate-related issues facing farmers in Africa require novel approaches, partnership and opportunities to assemble people with multiple perspectives, roles and responsibilities. Similarly, Stephens et al. (2008) reason that the urgency to tackle sustainability challenges offers a great opportunity for different societal stakeholders and institutions to engage in new ways. In other words, the challenges of climate change require interdisciplinary synergies or partnerships. Again, Sullivan et al. (2012) emphasise the need for strategic partnerships between farmers, policy-makers, and researchers (across disciplines). According to Sullivan et al. (2012), this type of partnerships will aid in identifying and addressing the most important interactions, synergies and trade-offs between weather/climate change and agriculture. The type of partnership promoted in this study can be classified under the research and development category, in line with Pinkse and Kolk (2012, p. 193). This will draw partners from smallholder farming communities, agricultural extension lecturers from the university and agricultural extension practitioners from local government, who represents the government. It is anticipated that the partnership that may emerge from this study might contribute to climate change adaptation mainstreaming in rural Msinga by way of knowledge production, dissemination and interchange.

2.3.2.1 Academia

Higher education institutions as citadels of learning play a leading role in knowledge production, validation and dissemination (Odora Hoppers, 2001, p. 79). According to Cortese (2003), higher education has unique academic freedom and diversity of skills to develop novel responses, to comment on society and its challenges, and to engage in bold experimentation in sustainable living. Therefore, they bear a deep, moral responsibility to increase the awareness, knowledge, skills, and values needed to create a just and environmentally sustainable world (Cortese, 2003; McIntosh, Cacciola, Clermont, & Keniry, 2001). These roles are being fulfilled, according to Ngum et al. (2019) whose study in Cameroon revealed that universities are involved in climate change adaptation efforts through their research and training activities.

Besides research, education and training in agricultural extension, scholars such as Bangay and Blum (2010) are of the view that all levels and forms of education (formal and informal) play a crucial role in addressing the challenges of climate change. These views were echoed by Anderson (2012); Muttarak and Lutz (2014), who argue that the education sector offers a currently untapped opportunity to address the problems of climate change and vulnerability. Furthermore, Lowe, Foster, and Winkelman (2009) maintain that higher education institutions are appropriately positioned to provide requisite technical expertise and outreach and to offer a range of resources for local adaptation efforts. In this regard, Gruber et al. (2017) suggest that the university can help design the adaptation process to build capacity among the local partners and transfer ownership to them. Evidently, academia is a critical stakeholder in the development and dissemination of novelties on climate change adaptation in rural context.

2.3.2.2 Government

According to research by Agrawal, Kononen, and Perrin (2009) and Agrawal (2010), adaptation to climate change is mainly local, and its success depends on local and extra-local government institutions through which incentives for individual and collective action are structured. This perspective is in line with the prevailing opinions in adaptation literature that ‘adaptation is local’ (Measham et al., 2011). Local government, as represented by the agricultural extension practitioners in this study, is considered as a very important stakeholder in developing and disseminating knowledge/innovation on climate change adaptation. According to Anderson and Feder (2003), as well as Wright et al. (2014), local government policies and programmes on climate change cannot be successfully implemented and scaled-up without the agricultural extension services. Anderson and Feder (2003) expound that agricultural extension advisors serve as a direct link between governments and the farmers and thus implement government policies and provide feedback from the farmers to higher levels of government. In addition, extension advisors also observe emerging innovations in agriculture and educate the farmers accordingly (Ibid.).

Similarly, Anderson (2008) reasons that extension plays an important bridging function between scientists and farmers by disseminating innovations from research to farmers, and by helping to articulate for research systems the problems and constraints faced by farmers. Again, agricultural extension advisors facilitate both the adoption and adaptation of technology in rural contexts (Anderson, 2008). Furthermore, agricultural extension advisors facilitate both the adoption and adaptation of technology in rural contexts (Anderson, 2008). Again, Sulaiman and Van den Ban (2003), in their study of situation and functions of agricultural extension services in India, found that the main function of extension advisors is to work as knowledge brokers in facilitating the learning process among different types of farmers. Based on the above insights, one can hypothesise that having access to extension services enhances the adoption of new technologies and increases the likelihood of uptake of adaptation approaches in rural contexts.

Maddison (2007) acknowledges that extension services disseminate relevant information and knowledge about climate change to farmers. The author maintains that extension information specifically related to climate change shapes farmers' perception of climate change and positively influences farmers' adaptation processes and resilience. Likewise, the findings of the study conducted by Gbetibouo (2009a) in Limpopo Province confirm that farmers with access to extension services are likely to recognise changes in the climate because extension services provide information about climate and weather. Furthermore, Gbetibouo (2009a) posits that farmers use information and advice from the extension services to improve their land and resources management strategies, which often result in improved soil fertility and higher output. Therefore, Gbetibouo (2009a) concludes that farmers derive benefits from the extension services and, through use of this information, protect the environment from soil erosion and degradation. Based on the foregoing perspective, it can be said that extension services contribute to the adoption of climate change adaptation strategies/technologies, thereby increasing the resilience of smallholder farming systems to climate change impacts. In that regard, agricultural extension advisors are critical stakeholders (partners) in this research, given that they influence the implementation of local government climate change adaptation polices and program. It is anticipated that, through this research endeavour, the extension situation in Msinga municipality will be ascertained and, where improvement is needed, the study will offer pathways for improvement.

2.3.2.3 End-users

Smallholder farmers across the world have relied on their Indigenous Knowledge (IK) in agriculture as a means of mitigation, adaptation and building their climate resilience, even now when the impact of climate change is escalating (Codjoe, Ocansey, Boateng, & Ofori, 2013; Ajani, Mgbenka & Okeke, 2013). According to Gerrard (2008), the interest of indigenous people in climate change issues is not only because of their vulnerability to climate change, but also because they have a specialised ecological and traditional knowledge relevant to finding the 'best fit' solutions to environmental challenges. According to Rao, Ndegwa, Kizito, and Oyoo (2011) as well as Nwajiuba et al. (2015), rain-fed farmers in rainforest Agro-Ecological Zones (AEZ) make use of their IK in predicting the weather condition for correct timing of their planting. For instance, farmers in Bauchi State of Northern Nigeria estimates early or late commencement of raining season by the height at which birds chose to nest on trees (Nwajiuba et al., 2015, p. 18). In this instance, if the nests are located high up on trees, then it depicts late commencement of rains and if the nest is positioned below, it indicates early commencement of rains (Nwajiuba et al., 2015, p. 18).

Furthermore, Nwajiuba et al. (2015) content that though these IK practices may not be perfect, they have guided farming practices in most AEZs in Nigeria, hence, IK can be successfully used to support farmer's adaptation to climate change. Similarly, Ajani et al. (2013) argue that farmers in sub-Saharan Africa possess a wealth of knowledge in weather prediction. These farmers have developed intricate systems of gathering, prediction, interpretation and decision-making in relation to weather (Ajani et al., 2013). For example, farmers in Nigeria and some parts of Niger have always made decisions on cropping patterns based on local predictions of weather and decisions on planting dates, based on complex cultural models of weather (Ajani et al., 2013). This implies that the end-users as represented by Msinga smallholder farmers (MSF) in this study are very knowledgeable about agriculture and their environment and are therefore positioned to contribute to the discussions on climate change adaptation in Msinga.

2.3.2.4 Benefits of partnerships for climate change adaptation

According to Pinkse and Kolk (2012) one of the benefits of partnerships is that each actor involved in a partnership plays a different role to help the group in achieving its common goal. For instance, in a trilateral partnerships between the industry, NGOs and government, industry brings specific knowledge and expertise, NGOs provide local embeddedness and contacts, and supporting activities such as training and capacity building; while the government provides funding, usually to reduce risks and facilitate the partnership activities (Kolk, Levy, & Pinkse, 2008). Similarly, Sullivan et al. (2012) opine that partnerships offer the appropriate platform for interaction, negotiation, understanding and exploration amongst different stakeholders to source the information necessary for diagnosis and decision making in the agricultural sector.

In concurring with the above perspectives, Bryan et al. (2009) argue that partnership present the platform for different stakeholders to develop and share relevant knowledge on issues affecting them. In the same vein, Lawrence, Hardy, and Phillips (2002), as well as (Hardy, Phillips, & Lawrence, 2003) reveal that partnerships can create new knowledge, practice and technology that neither of the partners previously possessed. Similarly, Selsky and Parker (2005) argue that one of the roles of partnerships is to provide a platform for partners to share critical knowledge and competences, especially when individual actors cannot develop such knowledge on their own or in a timely manner (Selsky & Parker, 2005). It is evident that partnerships on climate change are beneficial as they present the opportunity for stakeholders to develop new innovations and or share existing knowledge in relation to climate change and climate change adaptation.

According to Gruber et al. (2017), partnering with local communities can also result in benefits for the university. Such partnerships can provide faculty with meaningful research and outreach opportunities (Ibid.). Similarly, Homann-Kee Tui et al. (2013) consider partnerships as innovative platform which is very beneficial to individual stakeholders and the entire group, as well as the society. Explaining further, Homann-Kee Tui et al. (2013) state that partnerships develop capacity of different stakeholders in order for them to succeed. For instance, farmers may require training in new practices or technologies while companies may need help with bookkeeping, or even how to multiply and distribute seedlings. Hence, innovative platforms help to identify these needs and also develop the capacity required by each stakeholder group (Ibid.). Again, Homann-Kee Tui et al. (2013) expound that partnerships help stakeholder to identify best adaptation options. These platforms help members to decide on what they want to do to solve the problems or take advantage of the opportunities that they have identified from a range of options available to them. For example, they may decide to test new varieties of a crop, explore ways to improve supplies of inputs, promote the marketing of a product, or press for a change in government policy (Ibid.).

In Senegal, the study conducted by Sanogo et al. (2017) reported that innovation partnerships contributed to the promoting of economic activities, managing of protected areas and improving of farmers' accessibility to loans and insurance, as part of a local development initiative in promoting CSA. Additionally, Homann-Kee Tui et al. (2013) reason that partnerships present the platform for implementation and scaling up of knowledge and innovation. If innovation is successful, the actors works with its member groups to get it adopted widely (Ibid.). That may mean documenting and publicising the innovation, arranging training and study visits, and perhaps persuading other groups and society at large to adopt it (Homann-Kee Tui et al., 2013, p. 4). The foregoing shows that partnership are very beneficial to stakeholders within the context of climate change, hence, the choice of adaptation mainstreaming through partnerships in this study. The next section discusses the place and space of IKS in the anticipated partnerships towards mainstreaming climate smart technology adaptation.

2.4 THE PLACE AND SPACE FOR INDIGENOUS KNOWLEDGE SYSTEM IN MAINSTREMING CLIMATE SMART TECHNOLOGY ADAPTATION

Over the years, indigenous knowledge systems have served as a sustainable means of livelihood in poor and rural traditional Africa societies (Chanza, 2015a). This section will discuss how smallholder farmers across Africa have been coping with the challenges of climate change using their indigenous knowledge systems. The indigenous knowledge systems/strategies applied before (*mitigation*), during and after (*adaptation*) the occurrence of climate change event will be the focus of the discussion in this part. The main purpose of this section is to advance the space and place (relevance) of indigenous knowledge system in the mainstreaming of climate smart adaptation through partnerships.

2.4.1 Mitigation/preventing the impact of climate change using IKS

A study piloted by Nyantakyi-Frimpong and Bezner-Kerr (2015) in Ghana found that smallholder farmers employ their IK in predicting the commencement of raining season. For instance, by observing the flowering of certain tree species, migration pattern of birds and the position of a cluster of stars, the farmers are able to predict the start of the raining season, which automatically signifies the beginning of a new farming season (Nyantakyi-Frimpong & Bezner-Kerr, 2015). Interestingly, these West African indigenous methods of weather prediction are similar to the methods found in Muzarabani area of Zimbabwe in the Southern African regions (Chanza, 2015b). Through the study of the behaviour of migratory birds (*mashuramurove*) and the flowering pattern of certain tree species, farmer in the Muzarabani area can predict the occurrence of floods and then take timely actions or decisions (Chanza, 2015b). In South Africa, Anderson et al. (2009, pp. 36-37), examined farmers' response to drought in Southern Africa and found that "transhumance", or the seasonal migration of livestock, has long been recognized as an effective means of avoiding adverse climatic effects, such as drought (O'farrell, Anderson, Milton, & Dean, 2009).

Agreeing to the above views, Luseno, McPeak, Barrett, Little, and Gebru (2003) contend that pastoralists (farmers) in Africa have always employed their traditional, indigenous forecasting methods to predict future season events, hence weather and climate forecasting is not new to smallholder farmers in Africa. Some of these indigenous forecasting strategies used in countries like Ethiopia and Kenya include observation of clouds, wind or lightning, stars or the moon, while others watch the behaviour of livestock, wildlife and local flora as well as slaughtering animals to study their intestines (Luseno et al., 2003). Interestingly, 94% of the participants/respondents in this study by Luseno et al. (2003) expressed confidence in these traditional forecasts over western or scientific weather forecasts. This is because indigenous forecasts are familiar and accessible in terms of having the forecaster personally present the forecasts in the community and using their local languages (Luseno et al., 2003). Similarly, a study conducted by Dube, Moyo, Ndlovu, and Phiri (2016) in Matobo district of Zimbabwe shows that majority of smallholder farmers in Matobo district use indigenous climate knowledge for mitigation and adaptation purposes. According to Dube et al. (2016), 52% out of the 400 respondents uses indigenous knowledge systems exclusively for making farming decision. The study further shows that another 26% use a combination of indigenous forecasting and meteorological knowledge systems in making farming decisions. This points to the fact that indigenous knowledge systems for seasonal climate forecasting play a key role in agricultural decision making for climate change mitigation and adaptation in the Matobo district of Zimbabwe and in other parts of Africa (Dube et al., 2016). The above views show that smallholder farmers in Africa have been mitigating climate change with their indigenous knowledge. In other words, the place and space for indigenous knowledge systems in the mainstreaming of climate change adaptation are crystal clear. However, Luseno et al. (2003) point out that these traditional methods are perceived by scientists as becoming less reliable these days, given that climate variability is increasing in magnitude.

Again, Chanza (2015b) argues that sub-Saharan African farmers practise sustainable forest conservation through their customary forestry arrangements and restrictions. These restrictions are important mitigation measures that could enhance carbon sinking and sequestration (Chanza, 2015b). In concurring to the above view, Ajani et al. (2013) explain the importance of forests has long been recognized by traditional institutions in sub-Saharan Africa, to the extent that communal forest reserves were very common in traditional societies. Ajani et al. (2013) further reason that these well managed forests not only provide food and timber resources to the indigenous communities but they also serves as carbon sinks. In the light of the above views, Mochizuki and Bryan (2015) argue that indigenous knowledge systems and practices are indispensable tools for mitigation and adaptation to climate change. Therefore, educational responses and policies on climate change are likely to be more meaningful, and participation in learning processes more active, when schools deliver knowledge and skills that are relevant to local contexts and needs (Mochizuki & Bryan, 2015). In consideration of the above views, one can say that there is a space and place for indigenous knowledge system in climate change mitigation. Therefore, the various indigenous knowledge forms (such as highlighted above) employed in climate change mitigation should be considered in discussions/arrangements around climate change mitigation, especially in the African contexts.

2.4.2 Adapting to the impacts of climate change using IKS

As earlier indicated, mitigation and adaptation to climate change are not a new phenomenon amongst smallholder farmers in Africa. As far back as the 1700s, African farmers have devised means of adapting to harsh realities of weather and climate uncertainties (Ballard, 1986). The study conducted by Ballard (1986) found that rural communities in Kwazulu-Natal, South Africa adopted a variety of indigenous strategies to adjust to drought during the 1800s, and up until 1939. According to Ballard (1986), the adaptation strategies include diversification of crops adapted to drought conditions; migration to non-drought affected areas and market exchange (Ballard, 1986). More than two decades late, Hassan and Nhemachena (2008) confirm that, though African farmers possess a low capacity to adapt to present-day varying weather and climate patterns, they have managed to survive and cope over time using their own initiatives (indigenous knowledge systems). Such adaptation initiatives include diversifying into multiple crops and mixed crop-livestock system, switching from crops to livestock and from dry-land to irrigation (Hassan & Nhemachena, 2008, p. 87). Other adaptation strategies highlighted in the study conducted by Hassan and Nhemachena (2008, p. 87) include varying planting dates, making use of different crop varieties, fertilizers, pesticides, practising soil and water conservation. Similarly a study conducted by Shisanya (2015) in the uMzinyathi district municipality of KwaZulu-Natal found that smallholder farmers rely on their indigenous knowledge for adaptation to the impacts of climate change. Some of the adaptation techniques employed by the farmers include rainwater harvesting for irrigation, growing of different crop varieties, intercropping, mixed farming, tree planting alongside crops, etc.

Additionally, the study piloted by Chanza (2015b) in Zimbabwe found that farmers in Muzarabani area employ a dry planting technique locally known as (*Kuparira*) to adapt to climate impacts. According to the author, this technique entails that farmers would start sowing their seeds before the commencement of rainfall, so that by the time the rainy season starts, the seeds would fully utilise all the available moisture for fast germination and plant growth. This practice enables the crop to fully harness all the rainfall received throughout its life cycle (Chanza, 2015b). The participants in this study affirmed that through the dry planting technique, the effects of crop damage by pests are reduced. Again, Ajani et al. (2013) reveal that smallholder farmers in the Sahel region of Africa have developed and used a variety of traditional/innovative rainwater harvesting system to adapt to climate change. According to Ajani et al. (2013), smallholder farmers in semi-arid regions of Niger Republic use planting pits to harvest rainwater and rehabilitate degraded land for the cultivation of millet and sorghum. This indigenous technology improves penetration and increases nutrient availability on sandy and loamy soils, leading to significant increases in yields, improved soil cover and reduced downstream flooding (Ajani et al., 2013) . Equally, Knox et al. (2012) reason that some domestic adaptation measures such as shifting planting dates, modifying crop rotations or the uptake of pre-existing crop varieties will help offset some negative impacts of climate change. In concurring with the above views, research done by Agrawal, Mearns, Perrin, and Kononen (2011) identified the following climate adaptation strategies amongst farmers in sub-Saharan Africa:

- Mobility: This strategy helps households adapt to risks distributed across space. It is especially important as an adaptation strategy for agro-pastoralists in sub-Saharan Africa, west and south Asia, and in most dry regions of the world.
- Storage: This assists a farmer to deal with risks and hazards experienced over time.
- Diversification: This approach helps in addressing risks that affect different asset classes owned by households, or the different goods they consume or sell.
- Communal pooling: This strategy helps to address risks distributed across households.
- Market exchange: This a highly versatile mechanism to address many different types of risks for those households that have the wherewithal to participate in markets (Agrawal et al., 2011, pp. 18-21).

In keeping with the above perspective, Nwajiuba et al. (2015) reveal that farmers in Nigeria and other African countries employ their indigenous farming strategies (knowledge) to adapt to the negative impacts of climate change. Such indigenous strategies include water harvesting, rotational grazing, planting of crop varieties that are tolerant to variable rainfall patterns and construction of waterways to manage flooding etc (Nwajiuba et al., 2015). Additionally, Speranza (2010) reveals that African farmers employ adaptation techniques such as conservation tillage (zero-tillage), mulching and organic manure in the farming practices. Zero tilling entails the minimisation of soil disturbance and exposure by reducing tillage and using crop residues to cover the soil (Speranza, 2010). Continuing, the author explained that this technique increases the retention of soil water, improves soil structure and biotic activity. Mulching involves the use of plant residue to cover soils and in order to facilitate their incorporation during tillage into the soils as organic matter (Speranza, 2010). These practices improve soil resilience to climate change (Speranza, 2010). Organic manure or composts helps to improve soil fertility and simultaneously enhance soil structure (Speranza, 2010).

Again, Ajani et al. (2013) suggest that indigenous adaptation techniques such as revising planting dates, plant densities and crop sequences can help cope with delayed rainy seasons, longer dry spells and earlier plant maturity are already being used across parts of Africa including Malawi, Mozambique, Zambia and Zimbabwe. However, the main challenge is how to integrate modern scientific knowledge into indigenous knowledge systems in climate change adaptation, so as to safeguard biodiversity for food and agriculture. It is evident that rural smallholder farmers within the African context have constantly relied on their indigenous knowledge to adapt to the adverse impacts of climate change. However, these indigenous adaptation strategies are yet to be recognised and integrated into mainstream adaptation policies and programmes of relevant institutions. In this regard, Speranza (2010) argues that adaptation can only be sustainable if local knowledge is combined with other knowledge systems. According to Speranza (2010), local systems should not be mainly dependent on external intervention, as this is one factor that already spells the failure of adaptations in rural contexts. In other words, there should be room for cross-vegetation of ideas and an overlapping of knowledge systems and adaptation policies and programmes in the African contexts.

As a first step towards bridging IKS and public policies on climate change adaptation, Chari, Mulaudzi, and Masoga (2016) recommend the integration of indigenous media systems (known as ‘oramedia’, informal media or traditional media) with the mass media in disseminating information on climate change. Basically, oramedia or traditional media embody informal or context-based means of communication. These media include a repertoire of traditional modes of communication that evolve from the everyday interactions such as puppet shows, proverbs, song, dance, drama, street theatre and others (Chari et al., 2016). Chari et al. (2016) maintain that indigenous media have the ability to integrate the socio-economic and language milieu of indigenous communities and their historical position in searching for indigenous solutions to indigenous and global problems. The authors argue that indigenous media remain relevant in addressing the information deficit about environmental science issues such as climate change, because of their capacity to address issues in an idiom that resonates with African people's culture and cosmology. By implication, indigenous knowledge systems such as indigenous media are relevant in contemporary climate change adaptation programmes and policies.

2.4.1 Locating the space and place for indigenous knowledge systems in climate change adaptation mainstreaming partnerships

Based on the literature reviewed above, it is clear that African farmers have well-organised and contextualised weather- climate mitigation and adaptation strategies embedded in their indigenous knowledge. This shows that indigenous knowledge has been proven to be successful and important in rural agriculture. By implication, one can conclude that there is a space and place for indigenous knowledge systems in climate change adaptations policies and partnerships in sub-Saharan Africa. Nonetheless, these systems (spaces) are yet to be mainstreamed into contemporary weather and climate adaptation policies and programmes in relation to agriculture. Hence, Parkinson (2010, p. 102) argues that there is a lack of organised effort to collect and utilize indigenous knowledge regarding climate change. Equally, Nyong et al. (2007) submit that little or no effort has been made to incorporate indigenous knowledge and coping strategies into formal climate mitigation and adaptation strategies. Locally, Ngcoya (2017) found that there is little research in South Africa on the translatability of climate change adaptation and its complex language and power dimensions to local socio-economic conditions. The author reasons that local farmers' experiences and practices of climate change are not taken into account by climate change policymakers and practitioners. When considered in the light of the foregoing, the question is not if there is a space and place for IKS in adaptation mainstreaming, rather the challenge is that policy makers are yet to consider IKS as a viable solution to the negative impacts of climate change in rural sub-Saharan Africa. It is hoped that the outcome of this study might further direct or re-direct the attention of climate change adaptation policy makers and stakeholders to this currently untapped space(s).

Interestingly, this situation of neglecting IKS climate change adaptation endeavours is not peculiar to Africa. Research conducted in Australia by Gerrard (2008) found that there has been little space afforded for dialogue and collaboration with indigenous peoples about responses to climate change. This means that rural African contexts and countries are not alone in this. Moving forward, Ziervogel and Opere (2010) posit that integrating different types of knowledge and bringing different stakeholder groups together to tackle the challenges of climate change pose significant challenges in Africa. Back to the South African context, Makhubele et al. (2016) observe that steps have been taken to understand, recognise and address the challenges that climate change poses. According to (Makhubele et al., 2016), these steps are evident in the National

Climate Change Response Strategies (DoEA, 2010) and Climate Change Green Paper. However, the authors argue that little has been done to incorporate indigenous knowledge into formal climate change adaptation strategies. In the light of the foregoing, Chari (2016) suggests that indigenous knowledge systems such as "indigenous media" is an integral component of the people's culture and hence should be considered in every plan and policy made towards adaptation to climate change. According to Chari et al. (2016), indigenous media in their various forms have served the indigenous populations of Africa from time immemorial. They have been used to express social, ritual, moral and emotional needs of the people and can still be utilised to address the myriad of environmental challenges confronting the continent today (Chari et al., 2016). Consequently, Agrawal, Kononen, and Perrin (2009) reveal that the utility and success of these historically developed adaptation practices among the rural poor depend critically on the nature of prevailing formal and informal rural institutions and polices. In other words, institutionalisation of indigenous adaptation methods is crucial for successful adaptation in rural contexts.

As a way forward, Agrawal, Konoen and Perrin (2009) suggest that historical practices and knowledge about adaptation possibilities are crucial to future policy formulation regarding adaptation. This view is consistent with Adger, Huq, Brown, Conway, and Hulme (2003), who reason that developing countries should organize more detailed assessment of all forms of adaptation to climate change, including policies, and should ensure that these strategies synchronize with action plans of other multilateral environmental agreements and sustainable development strategies. Again, Hassan and Nhemachena (2008) are of the view that proper documentation and understanding of these indigenous knowledge systems is essential for designing and scaling-up incentives to enhance local adaptation systems. This is important, because not all indigenous practices/knowledge can a priori provide the right solution for particular climate change impact/problems (Ajani et al., 2013). Thus, before adopting indigenous knowledge, integrating it into climate change policies and programmes or disseminating it, such practices (knowledge) need to be scrutinized for their appropriateness, just as any other technology (Ajani et al., 2013). In this regard Hassan and Nhemachena (2008), as well as Bryan et al. (2009), conclude that supporting the coping strategies of local farmers through appropriate public policy and investment and collective actions can help increase the adoption of adaptation measures.

According to Ajani et al. (2013), for any project to be successful and sustainable, the local experience and population must be seen as partners in the project with joint ownership. In other words, local input is very essential in all forms of projects and partnerships towards adaptation to climate change especially in rural contexts. In this regard, Ajani et al. (2013) posit that climate change adaptation efforts can be enhanced if the local knowledge of indigenous people is taken into consideration before the development of appropriate modern technologies to suit the needs of the end-users. Ajani et al. (2013) maintain that modern scientific knowledge should complement indigenous knowledge rather than replacing it. This will in turn help to achieve better results in coping with challenges of climate change (Ibid.). Therefore, Berkes (2009) recommends that partnerships that allow for the coproduction of knowledge, where both conventional science and indigenous knowledge systems practitioners develop working partnerships and mutual respect, are what is needed at this time. According to Dube et al. (2016), this partnership towards knowledge coproduction is crucial because it will bring together different types of knowledge in order to strengthen resilience against climate change (Ibid.). However, these authors argue that the proposed coproduction of knowledge should not be seen as something entirely new that researchers formulate from some kind of "super wisdom". Rather, the general frame of procedure should be initially extracted from what communities are already doing and then perfected through partnerships (Dube et al., 2016). Based on the above views, the following conclusion can be reached:

(i) Partnerships towards climate change adaptation are imperative at this point given the severity of climate change impacts in rural sub-Saharan Africa. These partnerships will evidently increase the resilience of smallholder farmers and in turn enhance their mitigation-adaptation efforts.
(ii) The proposed partnerships could lead to production of new knowledge on climate change mitigation and adaptation in the African context.
(iii) The proposed partnerships and knowledge production towards climate change should not only consider inputs from smallholder farmers, rather, they must be framed and guided by current indigenous mitigation-adaptation knowledge/techniques, such as highlighted above.

The implication of the foregoing is that there is a space and place for indigenous knowledge systems in current weather and climate change discussions. However, it is not clear at this point whether this space and place will facilitate or hinder the mainstreaming of climate change adaptation in rural contexts such as Msinga. Perhaps exploring this space should be the point of departure in the multi-stakeholders partnerships and policies/programmes on climate adaptation designed for smallholder farming contexts across sub-Saharan Africa. It is hoped that the findings in this research might advance the currently untapped space and place of IKS in all forms and shapes of partnerships towards adaptation mainstreaming in the South Africa context, starting from Msinga.

2.5 CONCLUSION

This chapter explored the mainstreaming of climate smart adaptation technologies through partnerships, as well as the place and space for IKS in climate change adaptation discussions. The chapter started by highlighting the impacts of climate change in Africa, with particular emphasis on South Africa, and also advanced the argument that poverty, lack of access capitals and resources put individuals and communities in a vulnerable position with respect to climate change impact. The second part discussed climate Smart Agriculture (CSA) as a solution to the effects of climate change within the context of agriculture. The third part addressed mainstreaming climate change adaptation through partnerships. It was argued in this part that there is not yet a clear-cut process and tool on how to mainstream adaptation given the variations in context and impact. This part further emphasised that mainstreaming adaptation cannot be successfully realised by one single sector, hence, the need for mainstreaming through partnerships was highlighted. The last part outlined the relevance of IKS in the partnership towards adaptation mainstreaming. It was argued that IKS should not only be accorded a space and place especially within the African contexts, rather it should be the underpinning framework for constituting programmes, polices and partnerships on adaptation mainstreaming.

The above review shows that mainstreaming of climate change adaptation through partnerships has been researched, however, none of these studies have explored the mainstreaming of climate smart technology adaptation through partnerships between university, government and smallholder farmers in South Africa. Even if there may be a study, it may not have engaged the same set of stakeholders with a focus on Msinga. Furthermore, such studies may not have explored the place and space accorded to indigenous knowledge systems in these partnerships on CSA. Again, while there are several studies on climate smart agriculture/technologies across sub-Saharan Africa, there appears to be no work or not much work on the use of climate smart agriculture as solution to the problems of climate change in Msinga Local Municipality. The implication is that most studies reviewed dwell on certain aspects of mainstreaming, partnerships and climate smart agriculture, without due consideration of the collaboration amongst these specific stakeholders in a single study, such as this, thereby creating room for more empirical research. Therefore, this study seeks to address these gaps by specifically responding and by exploring the mainstreaming of climate smart technology adaptation in Msinga's everyday agricultural practices through partnerships.

CHAPTER 3
THEORETICAL FRAMEWORKS

INTRODUCTION

This chapter presents the two theoretical frameworks that underpinned the study, namely, the Sustainable Livelihood Approach (SLA) and the Quintuple Innovation Helix Model (QHIM). The literature reviewed in the previous chapter underlines the fact that indigenous knowledge and indigenous knowledge systems are critical components or means of livelihood (capital) in a rural context such as Msinga, KwaZulu-Natal, and therefore should be accorded a space in current discussions on climate change adaptation. In line with the focus of the study, the Sustainable Livelihood Approach (SLA) and Quintuple Helix Innovation Models (QHIM) were employed to guide the theoretical and analytical aspects of the study. This study is premised on the fact that multiple factors such as education, food security, climate change adaptation and mitigation, and indigenous knowledge systems are intertwined in the mainstreaming of climate smart technology adaptation through partnerships.

Sustainable livelihood approaches explore ways through which individuals and governments address livelihood challenges in a rural context, in order to achieve livelihood outcomes such as food security, education, healthcare, reduced vulnerability etc. The Quintuple Helix Innovation Model focuses on creating knowledge and innovation in a sustainable manner (in order to address sustainable development challenges) through partnerships. The two theories will be used to analyse the livelihood challenges faced by Msinga smallholder farmers and how they can access livelihood capitals through existing and new partnership arrangements to overcome these challenges. The chapter is divided into three broad sections in line with the two frameworks underpinning the study. Section 3.1. discusses the Sustainable Livelihood Approach (SLA) and the discussion is done in three subsections. Subsection 3.1.1 offers a brief historical background of SLF. Section 3.1.2 focuses on definitional aspects of the sustainable livelihood approaches and the link between components/building blocks of SLF and IKS. The last part in this section presents how the theory will be used to analyse the data generated in this study. The framework is applied in theorising and addressing the three questions asked in the preliminary study and research questions three, as well as research question four in the main study. Section 3.2

presents the Quintuple Helix Innovation Model (QHIM), the second framework used in this study. This section is further divided into two subsections, namely, subsections 3.2.1 and 3.2.2. Subsection 3.2.1 discusses the QHIM while 3.2.2 presents the interface between the two frameworks, namely, the SLA and QHIM.

3.1 DISCUSSION ON SUSTAINABLE LIVELIHOOD APPROACH (SLA)

3.1.1 Brief historical background of Sustainable Livelihoods Approach

The Sustainable Livelihood Approach (SLA), also known and used as the Sustainable Livelihood Framework (SLF), predates the 1992 influential Chambers and Conway paper (Scoones, 2009). Scoones (2009) posits that there is a rich and important history that goes back to 50 or more years ago, where a cross-disciplinary livelihoods perspective profoundly influenced rural development thinking and practices. These interdisciplinary collaborations brought together ecologists, anthropologists, agriculturalists and economists looking at changing rural systems and their development challenges (Fardon, 1990). According to Norton and Foster (2001), the Sustainable Livelihood Framework (SLF) is conceptually rooted in various traditions, such as applied social science, agro-economic systems or farming systems analysis and especially participatory approaches to rural development. The concept evolved within the context of the intentional development approach, by which development practitioners were seeking to maximise the effectiveness of their interventions to address poverty (Morse & McNamara, 2013). Intentional development is a focused and direct process whereby governmental and non-governmental departments intentionally implement projects to support the poor (Morse & McNamara, 2013).

Sustainable livelihood approaches came under the spotlight in the UK Department for International Development (DFID) as a follow-up process to the White Paper on International Development of 1997 (Norton & Foster, 2001). It has been widely applied by developmental agencies and NGOs such as Cooperative for Assistance and Relief Everywhere (CARE International), Oxford Committee for Famine Relief (Oxfam), the World Bank and United Nations Development Programme (UNDP) (Krantz, 2001 & Thieme, 2008). Again, Morse and McNamara (2013) suggest that the Sustainable Livelihood Approach (SLA) resonates with older ideas on poverty eradication but was mainly popularised by the United Nations Development Programme (UNDP) concept of ‘human development’ in the 1980s. Morse and McNamara (2013) further explain that sustainable livelihood came to prominence through the Agenda 21 of the Rio 1992 UN earth summit.

According to Morse and McNamara (2013), the aim of Agenda 21 is to ensure that everyone has the opportunity to earn a sustainable livelihood. Agreeing to the above perspective, Scoones (2009) states that the sustainable development agenda popularly known as "Agenda 21" is concerned with sustaining the livelihoods and priorities of local people.

Still on the historical antecedents of sustainable livelihood approaches, Scoones (2009) affirms that discussions around SL approaches gained traction as a result of the publication of the 1987 World Commission on Environment and Development 1992: Our Common Future, or the 'Brundtland report', as it is commonly recognised. Today, the SLA is widely recognised and used by development agencies, governments departments, international and national development agencies and NGOs to address poverty. This is achieved by making critical livelihood components or resources such as economic and physical capitals to be more accessible to the poor in order to improve their living conditions. Clearly, the SLF is not a new construct in research. Though the concept is rooted in development studies, it has however been adopted and applied across many disciplines as well as agencies. The emphasis on the framework lies in poverty eradication in poor and rural contexts.

3.1.2 What is the Sustainable Livelihood Approach?

Before, addressing the above question, it is important to first explicate the concept "livelihood". Simply put, livelihood is the means of gaining a living or a combination of the resources used and the activities undertaken in order to live (Chambers 1995). Correspondingly, Scoones (2009) reasons that livelihood is about how different people in different locales live. According to Farrington, Carney, Ashley, and Turton (1999), a livelihood consists of the capabilities, assets (including both material and social resources) and activities required for survival. A livelihoods approach challenges fundamentally single-sector approaches to solving complex rural development problems, hence a diversity of approaches is emphasised (Scoones, 2009). This implies that a livelihood can be likened to the survival strategies of individuals and groups. Beyond that, livelihoods emphasise the use of multiple means or processes for sustenance and survival.

Explaining further, Chambers and Conway (1992), as well as Farrington et al. (1999), state that a livelihood is sustainable when it can cope with and recover from stresses and shocks, and maintain or enhance its capabilities and assets both in the present and in the future, while maintaining the natural capital base. In concurring with the above view, Scoones (1998) expounds that the ability of a livelihood to cope with and recover from stresses and shocks is a key definitional component of sustainable livelihood. Those who are able to cope with or adapt to stress and shocks are more likely to achieve a sustainable livelihood. In contrast, those that are unable to cope or adapt to shocks and stress are inescapably vulnerable and perhaps unlikely to achieve a sustainable livelihood (Ibid.). When considered in the light of the present study, the participants, Msinga smallholder farmers (MSF), have constantly drawn on their indigenous knowledge to cope with adverse effects (stress and shocks) of climate change in agriculture within their locale. This could mean that these farmers are most likely to sustain their livelihood. However, attaining sustainable livelihood perhaps goes beyond the use of IKS to cope with the effects of climate change, given its severity, even though it is a significant step. Therefore, a more robust approach is needed to help them adapt and by implication sustain their livelihood. This would mean that other aspects or components of the sustainable livelihood would be activated in order for the smallholder farmers in Msinga to sustain their livelihoods. The next section discusses the components of a sustainable livelihood.

3.1.2 Livelihood building blocks/components

According to Farrington et al. (1999), every society is in constant pursuit of livelihood outcomes such as healthcare, income, education, reduced vulnerability and many more, by drawing on a range of assets to pursue a variety of activities. Sub-Saharan Africa countries are in desperate need for livelihood outcomes, given that climate change tends to worsen their vulnerability by bringing about stress and shocks that destabilise livelihoods (IPCC, 2014). However, the failure or success of these desires for livelihood outcomes is influenced by factors such as the types and levels of vulnerability, including shocks (such as drought), overall trends (for instance, resource stocks) and seasonal variations (Ibid.). Also, people's choices are influenced or determined by societal structures such as the institutions, policies and cultural factors that they face. Hence, a combination of these factors determines people's access to assets and livelihood opportunities, and the way in which these can be converted into outcomes (Ibid.). Additionally, the attainment of sustainable livelihoods is dependent on the livelihood strategies adopted/employed by individuals and groups. Within the sustainable livelihoods framework, three broad spheres of livelihood strategies are identified (Scoones, 1998). These are:

- Agricultural intensification/extensification,
- Livelihood diversification and
- Migration (Scoones, 1998, p. 3)

According to Scoones (1998), these three livelihood strategies cover the range of options open to rural people.

Agricultural intensification is defined as increased regular inputs of labour or capital on a smallholding, either cultivated land alone, or on cultivated and grazing land, for the purpose of increasing the value of output per hectare (Carswell, 1997). On the other hand, agricultural extensification involves increased agricultural productivity and production through the increase in or expansion of agricultural land. With respect to livelihood diversification, it is understood as the means by which poor or rural families construct a range of activities and social support capabilities in their struggle for survival and in order to improve their standards of living (Ellis, 1998). Migration in the context of sustainable livelihoods would mean relocating or the movement of people and livestock from one place to another in order to sustain your livelihood. Relating the above concepts to KwaZulu-Natal, Msinga municipality to be specific, research shows that diversification and migration are old and popular livelihood pathways amongst smallholder farmers. According to Ballard (1986), rural communities in Kwazulu-Natal, South Africa employed livelihood strategies such as diversification of crops adapted to drought conditions and migration to non-drought affected areas to survive the scourge of climate change. In Msinga, research by Rukema (2010) confirmed that crop diversification is a widely used climate change adaptation strategy amongst smallholder farmers.

In line with the above explanations, farmers gain more of their livelihood from agriculture (including livestock rearing, aquaculture, forestry, etc.), either through processes of "intensification" (more output per unit area through capital investment or increases in labour inputs) or "extensification" (more land under cultivation). Otherwise, the farmers may "diversify" to a range of off-farm income earning activities, or they "migrate" to seek a livelihood, either temporarily or permanently, elsewhere. Or, more commonly, they pursue a combination of strategies together or in sequence (Scoones, 1998). As earlier indicated, smallholder farmers in rural contexts such as Msinga are known to adopt livelihood pathways or strategies such as diversification and migration in order to adapt or cope with the negative effects of climate change in their communities (Ballard, 1986; Hassan & Nhemachena, 2008; Shisanya, 2015). By implication, livelihood outcomes such as health, economic income, education, adaptation to adverse conditions (climate change) and many more are determined by people's ability or inability to assess and harness important assets/capitals and opportunities as well as strategies. This is further influenced by contextual factors such as the institutional and cultural positionalities of the people. In the long run, poverty, and the opportunities to escape from it, depend on all of the above (Farrington et al., 1999).

According to Krantz (2001), the strengths of sustainable livelihood approaches are rooted in the following three philosophies, as reflected in Figures 1 and 2 below. First, SLA pays attention to the array of assets that people draw on when constructing their livelihood. It offers a more holistic view of what resources or combination of resources are needed by the poor to sustain their livelihood (Ibid.). Second, SLA facilitates the understanding of the root causes of poverty by focusing on the variety of factors that directly or indirectly influence poor people's access to assets of different kinds, and thus their livelihoods. Lastly, the framework offers a more realistic framework for assessing the direct and indirect effects of poverty on people's living conditions than, for example, one dimensional productivity or income criteria (Krantz, 2001).

In the same vein, Farrington et al. (1999) suggest that SLF by principle recognises multiple actors/sectors from the private sector to national ministries, from community-based organisations to newly emerging decentralised government bodies. Agreeing to this view, Woolcock and Narayan (2000) suggest that no single sector or actor possesses the resources needed to achieve and promote sustainable development. Therefore, partnerships forged both within and beyond these different sectors are required to achieve sustainable livelihood for all concerned (Woolcock & Narayan, 2000). In other words, sustainable livelihood approaches acknowledge the importance of partnerships in enhancing and sustaining livelihoods of the poor. This is particularly significant given that "global partnerships for development" is one of the sustainable development goals (SDG 17). So, in this study, the framework is employed as a roadmap to facilitate the proposed partnerships for mainstreaming of climate change adaptation in rural Msinga.

Equally, SLA acknowledges the multiple livelihood strategies or pathways that people adopt to secure their livelihoods and seek to achieve multiple livelihood outcomes (Farrington et al., 1999). Nonetheless, achievement of livelihood may be hampered by macro-micro institutional factors (Farrington et al., 1999). For instance, natural capital may be threatened by flash-flooding, which will be influenced by the design and implementation of policies to prevent deforestation. Similarly, access to financial capital might be influenced by policies towards credit and the rural banking sector more generally. Again, vulnerability may increase or decrease depending on, for instance, how well emergency feeding and employment schemes are designed and implemented (Ibid.). This means that decisions that are made at a macro level affect livelihood opportunities and outcomes at the micro-level. Therefore, macro level decisions such as national or sectoral government policies and programmes on climate change, for instance, should be informed and influenced by micro level (local) experiences and activities. This will mean a bottom-up approach to programmes and policies on climate change. In concurring with the foregoing perspectives, Scoones (1998) asserts that the ability to pursue different livelihood strategies is dependent on the basic material and social, tangible and intangible assets that people have in their possession. Scoones (1998) went on to explain that livelihood resources can be described as "capital" base through which different productive streams derive their livelihood. These capitals are categorised into the following:

- Natural capital: This include natural resource stocks such as soil, water, air, genetic resources, etc. and environmental services, like hydrological cycle, pollution sinks, etc., from which resource flows and services useful for livelihoods are derived.
- Economic or financial capital: This includes but is not limited to capital base (cash, credit/debt, savings, and other economic assets, including basic infrastructure and production equipment and technologies) that are essential for the pursuit of any livelihood strategy.
- Human capital: Human capital include the skills, knowledge, ability to labour and good health and physical capability important for the successful pursuit of different livelihood strategies
- Social capital: The social resources are networks, social claims, social relations, affiliations, associations upon which people draw when pursuing different livelihood strategies that require coordinated actions.
- Physical capital: This includes infrastructure such as buildings, roads, etc. and production equipment and technologies (Morse & McNamara, 2013, p. 19; Scoones, 1998, p. 8)

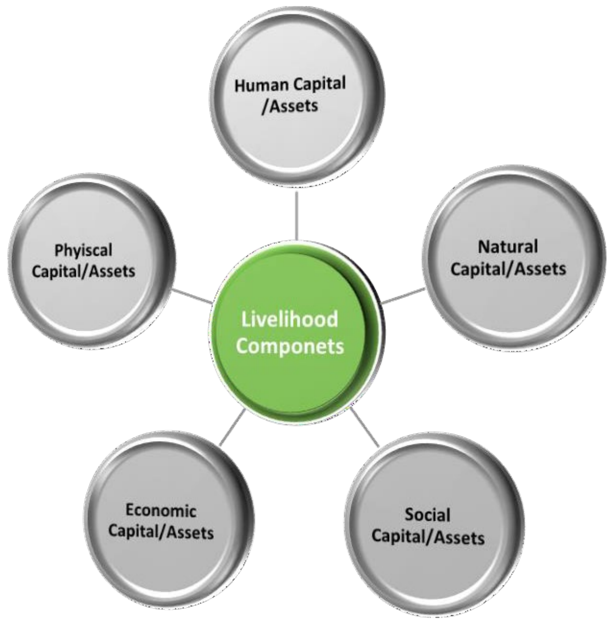

Figure 3: Diagrammatic representation of sustainable livelihood building blocks (adapted from Morse & McNamara, 2013)

As can be seen from the above figure and explanations, people's livelihood consists of different building blocks or components. Evidently, each of the components is important in sustaining people's livelihood. If people have access to these building blocks, it will mean that their livelihood may be sustained. On the other hand, lack of access to these building blocks will mean that a person or people's livelihood will be adversely affected. Also, the achievement of sustainable livelihood may be hampered by macro-micro links or factors (Farrington et al., 1999). Hence, the SLA approach x-rays a range of policy issues relevant to the poor, such as access to health, education, finance, and how these issues can help poor people to adjust to changing living conditions and in turn sustain their living (Sanderson, 2000). In this regard, Scoones (1998, p. 8) outlines a list of critical questions and ideas that must be addressed to enable the implementation of sustainable livelihood framework:

- Sequencing: What is the starting point for successfully establishing a particular livelihood strategy? Is one type of livelihood resource an essential antecedent for gaining access to others?

- Substitution: Can one type of capital be substituted for others? Or are different capitals needed in combination for the pursuit of particular livelihood strategies?
- Clustering: If you have access to one type of capital, do you usually have access to others? Or is there a clustering of particular combinations of livelihood resources associated with particular groups of people or particular livelihood strategies?
- Access: Clearly, different people have different access to different livelihood resources. This depends on institutional arrangements, organisational issues, power and politics. Therefore, a socially differentiated view to analysing livelihoods is critical, one that separates the chosen unit of analysis – whether community, village or household – and looks at individuals or groups of social actors and their relationships, in relation to the range of relevant dimensions of difference (wealth, gender, age and so on) and the distribution of control over resources.
- Trade-offs: In pursuing a particular range of livelihood strategies, what are the compromises faced by different people with different access to different types of livelihood resource?
- Trends: What are the trends in terms of availability of different types of livelihood resource? How are different capital assets being depleted and accumulated, and by whom? What are the trends in terms of access? What new livelihood resources are being created through environmental, economic and social change? (Scoones, 1998, p. 8).

In explicating the livelihood building blocks and inadvertently addressing some of the above critical questions, Farrington et al. (1999) posit that one asset or capital can be substituted or exchanged by the other. For instance, the poor may draw on social capital such as family or neighbourhood security mechanisms at times when financial capital is in short supply (Ibid.). This implies that one can exchange one's human capital such as labour in exchange for economic or financial capital. In this regard, people are likely to pursue multiple activities and livelihood outcomes at a time (Farrington et al., 1999). It can be inferred that a combination of the different livelihood components will make people's livelihoods to be more sustainable.

Going by the assertions of Farrington (1999) and Scoones (1999) above, it is clear that the chances of improving and sustaining one's livelihood depend on one's access to "assets"

(Farrington et al., 1999) or "capital" (Scoones, 1998) as well as decision or factors at different levels (macro-micro links), as attested by (Farrington et al., 1999). Thus, standing on the tenets of the framework, I argue that indigenous knowledge/indigenous knowledge systems are critical component or means of livelihood (capital) in a rural context such as Msinga. How so? From a definitional and practical point of view, IKS embodies key components of sustainable livelihood, such as social, natural, economic and human capitals. IKS exemplifies ways in which the people of a given locality have come to understand themselves in relationship to their natural environment and how they organize their traditional knowledge or understanding of flora and fauna, cultural beliefs and history to improve their living (Semali & Kincheloe, 1999). IKS encompasses knowledge and practices related to agriculture and animal husbandry, hunting, fishing and gathering, disease control, naming and explaining natural phenomena, and strategies for coping with adverse changes in their environments (Korina & Habiyaremye, 2017). They also include types of knowledge about traditional technologies of agriculture, climate, subsistence, midwifery, ethnobotany, traditional ecological knowledge, traditional medicine, celestial navigation, ethno-astronomy, and others (Ibid.).

It is widely acknowledged that smallholder farmers across the globe have constantly relied on their indigenous knowledge of agriculture and environmental management to mitigate and adapt to the adverse effects of climate change (Ajani et al., 2013). This knowledge of agriculture and environment can be described or linked to the "human capital" component of the sustainable livelihood approaches. As a social capital, indigenous knowledge system represents the way in which the inhabitants of a particular locale understand and relate with each other and the environment and how they harness such relationships to improve their living conditions (Semali & Kincheloe, 1999). In times of lack, poor and rural people draw on their social capital for survival and sustenance. For example, the study conducted by J. Rukema (2010) revealed that smallholder farmers in Msinga relied on donations/goodwill from friends and family to survive the 2003- 2004 drought that affected Msinga and its environs. In other words, their social capital (relationship with one another) helped them to get through the time of lack. Still, Light (2005) argues that relationships with one another offer various mechanisms for adjusting to uncertainties and shocks. Explaining further, Light (2005) suggests that, in time of lack /scarcity, women turn to other women within their community to borrow small amounts of foodstuffs and money while richer relatives often extend charity to their poor kin. This means that social capital is one of the critical components of indigenous knowledge system. With respect to natural capital, indigenous medicinal plants are used by more than 60% of South Africans in their health care, nutritional needs or cultural practices (Chinsamy & Koitsiwe, 2016). According to Chinsamy and Koitsiwe (2016), there are approximately 3,000 plant species that are used by an estimated 200,000 indigenous traditional healers. Also, it is common knowledge that traditional medicine and its trades contribute significantly to the economic development of South Africa. Mander, Ntuli, Diederichs, and Mavundla (2009) reveal that the traditional medicine trade contributes to an estimated R2.9 billion to the national economy. By implication, indigenous knowledge and application of medicinal plants can be recognised as a natural capital. Also, indigenous knowledge of medicinal plants and herbs can be described as an economic capital given that its trade has lifted a number of households out of poverty in South Africa. It can be seen that IKS has been successfully applied as a means of livelihood in many spheres of life, such as health, agriculture, climate change adaptation and mitigation. In this regard, this framework is employed as a lens to explore the livelihoods of smallholder farmers in Msinga in the context of climate change. The livelihood explored is related to indigenous knowledge systems and its roles in climate change adaptation. Furthermore, the place and space accorded to indigenous knowledge systems (being a critical means of livelihood) in mainstreaming climate change adaptation partnerships is analysed.

3.1.3 Sustainable Livelihood as a framework

Sustainable livelihood approaches can be explained as a framework that supports the eradication of poverty by making the enhancement of poor people's livelihoods the central goal of development endeavours (Farrington et al., 1999). In a similar vein, Norton and Foster (2001) posit that a sustainable livelihood approach is an analytical framework that analyses the dynamic dimensions of poverty and well-being, by exploring a typology of assets that poor households and rural communities deploy to sustain and maintain their well-being under changing living conditions. Agreeing to the above views, Hoon, Singh, and Wanmali (1997) reason that the framework aligns together the thinking and practice of poverty eradication strategies, sustainable development, participation and empowerment processes into a framework for policy analysis and programming. It is an analytical tool for understanding the complexity of livelihoods, understanding influences on poverty and identifying where interventions can best be made (Farrington et al., 1999).

Moving forward, Farrington (2001, p. 3) argues that SLA is characterised by the following definitional components :

- **As a set of principles**: Development interventions in a rural context, or otherwise, should be guided and must be people-centred rather than take a top-down fashion, without adequate knowledge of the local communities. Hence, SLF is interpreted as a loose checklist of points that need to be considered before an intervention is planned.

- **As a formal analytical framework**: It helps to appreciate the capitals and constraints available to households, their vulnerability and the involvement of institutions. To understand what 'is' and what can be done with that.
- **As a developmental objective**: Improvement of level and sustainability of livelihoods. In this sense, development is seen as the improvement of livelihood sustainability, by making capital less vulnerable or by enhancing the contributions that some capitals can make (Farrington, 2001, p. 3).

Again, Farrington (2001) reveals that SLF plays a role in the design and implementation of country/sector level development strategies by helping identify groups of people according to their main sources of livelihood. The framework highlights the main sources of vulnerability associated with these livelihoods, which are not normally considered systematically in planning processes (Ibid.). Also, it identifies the main assets relating to these livelihoods, which would include the normally considered physical/natural assets such as land, water and forest, as well as economic assets, namely employment opportunities, and social assets such as informal safety nets (Farrington, 2001). Besides identifying the livelihoods, assets and vulnerabilities embedded, SLF can also support implementation of livelihood strategies by highlighting the conditions that cause poverty and ways of addressing such. The different aspects of sustainable livelihood framework are presented in the diagram below.

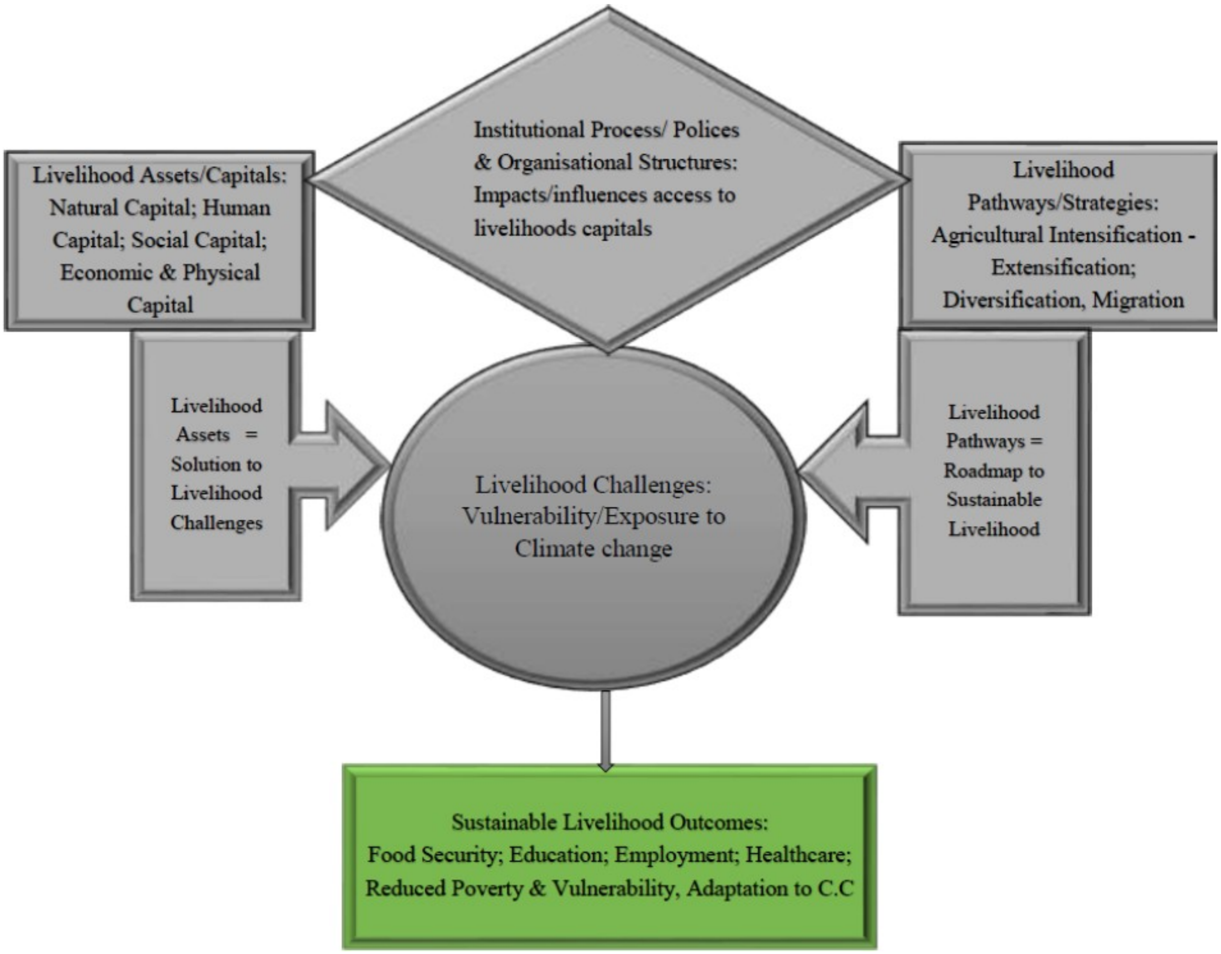

Figure 4: Diagrammatic representation of the Sustainable Livelihood Approach

(adapted from Krantz, 2001 & Scoones, 2009)

Drawing from the above figure, it can be said that the SLA is a framework for addressing livelihood challenges as depicted in figure 2. The framework evaluates livelihood challenges such as vulnerability or exposure to climate change, food insecurity, poverty, etc. and offers insight on how to harness livelihood capitals or building blocks, as well as pathways to address those challenges. In a rural context such as Msinga, livelihood capitals embedded in IKS, such as human capital, natural capital and social capital have always been used to address challenges/risks arising from climate change. By implication, an understanding and successful application of the sustainable livelihoods approach will enhance or promote the adaptation to climate change which will in turn improve livelihood outcomes in rural contexts such as Msinga.

3.1.4 Limitations /weakness of SLA

Though the SLA is widely accepted and applied by institutions and societies, it however has certain limitations that perhaps make it unsuitable or difficult to implement in all contexts and situations. According to Krantz (2001), the SLA does not make provision on how to identify the poor whose livelihoods it sought to sustain. The author further argues that the way resources and other livelihood opportunities are distributed locally is often influenced by informal structures of social dominance and power within the communities. In other words, power relations, such as the one that exists between men and women, are not often taken into consideration in SLA. This means that those that are more powerful or those that are ranked higher in the social structures/order (within a particular locale) will often have easier and better access to livelihood opportunities. On the other hand, those that are less powerful will struggle more to gain access to livelihood opportunities.

Krantz (2001) further argues that, though developmental agencies such as UNDP, DFIP, etc., give some consideration to gender in the application of SLA, still women are not given sufficient time and space in distribution of livelihood opportunities. Similarly, Wong (2015) suggests that the limitation or challenges of livelihood approaches lies in the conceptualization of livelihood mediation processes and in the understanding of the link between livelihood opportunities and decision-making. Wong (2015) maintains that livelihood thinking does not consider structural factors that come into play in decision making that affects allocation of capitals and consequently livelihood opportunities. This means that structural factors may lead to inclusion of some individuals and the exclusion of others, thereby limiting the attainment of livelihood outcomes for those individuals. Drawing from the above views, it can be concluded that the lack of clear consideration of the impact of structural factors in the distribution of livelihood opportunities is a major limitation in SLA.

3.1.5 Application of sustainable livelihood approaches in the study

The SLA, though originally located in development studies, was carefully selected to guide this study. It is widely acknowledged that education is fundamental to development and growth in every society (Gibbs, 2018). Whether it is in the form of economic development, human development or development in terms of food security through climate change adaptation mainstreaming, as articulated in this study, education remains relevant to development. Hence, one can say that education is the panacea for development and growth in rural contexts. Given that the present study engages different stakeholders and addresses multiple factors such as education programmes and policies, practices around sustainable development and climate change adaptation, the framework was carefully selected to guide the first part of the study. Furthermore, the choice of the theory was influenced by the assumption that improvement in the education and training of agricultural extension practitioners will facilitate adaptation to climate change in rural contexts and the mainstreaming of adaptation strategies into policies and programmes of government. This will, in turn, bring development and growth.

Having said that, the present study is focused on the place and space of indigenous knowledge systems in climate change adaptation mainstreaming through partnerships. In this regard, the study is divided into two broad sections; the preliminary study and the main study. The preliminary study addressed three questions while the main study examined four main questions. The place and space of indigenous knowledge system was central in both sections of the study. As indicated earlier, indigenous knowledge systems are a means or source of livelihood in farming communities such as Msinga. Therefore, the application of SLF in this study can assist farmers in a rural context, such as Msinga, to not only adapt to climate change, but to equally achieve a sustained livelihood through the adaptation to climate change. However, this may not be achievable if indigenous knowledge systems are not accorded a place and space in the partnership arrangements, policies and programmes of government and universities. Bearing the above explanations in mind, this study adopted and adapted the lens of sustainable livelihood approaches, to explore whether the livelihoods and adaptation of smallholder farmers in Msinga are enhanced or reduced by universities, farmers and government partnerships on climate change adaptation. Most significantly, the place and space accorded to indigenous knowledge systems as the principal means of livelihood in rural contexts is explored in these partnerships. Hence, the framework is applied in analysing and discussing the data that emerged in this study. The next section presents the Quintuple Helix Innovation Model (QHIM).

3.2 USING QUINTUPLE HELIX MODEL (QHIM) TO EXPLORE PARTNERSHIPS EXISTENCE AND REALITIES FOR CLIMATE CHANGE ADAPTATION MAINSTREAMING.

As indicated in the introduction, this study was grounded on two theoretical perspectives. These are, the Sustainable Livelihood Framework (SLF) and Quintuple Helix Innovation Model (QHIM). The SLF is applied in the two sections of the study, that is the preliminary and the main study. However, the QHIIM is employed only in the main study, given that the main study focuses on mainstreaming climate smart adaptation strategies through partnerships. Basically, the QHIM promotes a five-legged relationship among institutional spheres, namely, university, industry, society, government and the environment, as depicted in the diagram below (Carayannis et al., 2012). It is important to note that the QHIM emerged from the triple helix model (Carayannis et al., 2012).

3.2.1 Quintuple Helix Innovation Model

The Quintuple Helix Innovation Model (QHIM) is an innovative institutional configuration comprising of five helices, namely, the education system, the economic system, the natural environment, the media- and culture-based public and the political system (Carayannis et al., 2012). According to Grundel and Dahlström (2016), these helices originates from the earlier triple helix model propounded by Henry Etzkowitz and Loet Leydesdorff in the 1990s, in that the education system is represented by academic and higher education organizations, the economic system comprises industry, banks and services and the political system represents the public authorities or the government and their policies and laws. Similarly, Carayannis and Campbell (2010) argue that the QHIM contextualizes the triple helix and quadruple helix by further adding on the helix of the "environment" (natural environments). By implication, QHIM emphasises the need for societal transformation and the current economic system to become more sustainable. In this regard, Carayannis and Campbell (2010) reason that the Quintuple Helix offers an analytical frame where knowledge and innovation, on the one hand, are being connected with the environment on the other hand. By this the QHIM addresses and incorporates features of social ecology (Ibid.). Further, the QHIM underlines the socioecological perspective of the natural environments of society (Carayannis & Campbell, 2010). Social ecology is concerned with the interaction, co-development and coevolution of society and nature (Ibid.). The progressions from the knowledge economy (triple helix) to sociological transformation (quintuple helix) is captured in the diagram below.

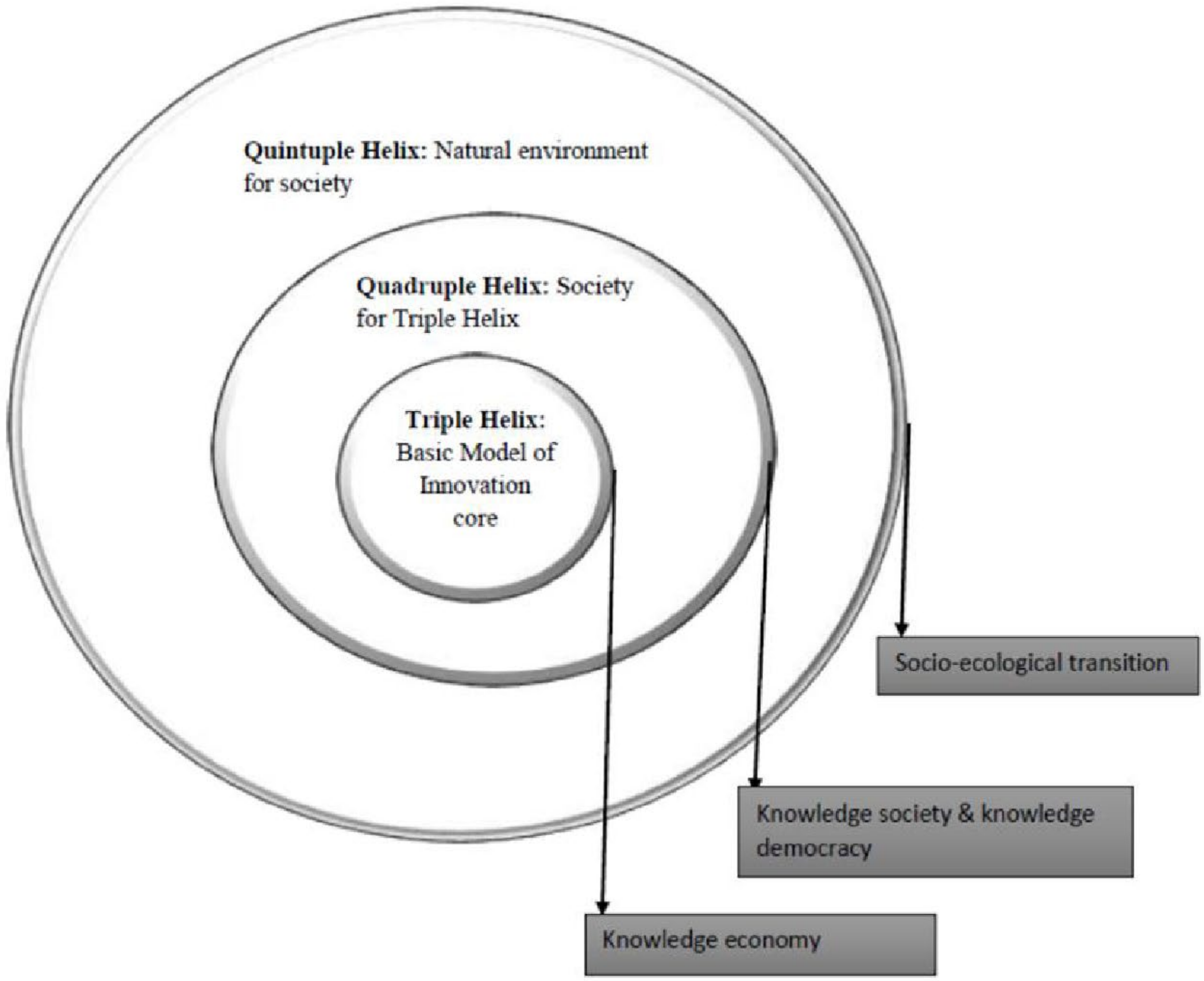

Figure 5: Diagrammatic representation of knowledge production and innovation in the context of the knowledge economy, knowledge society (knowledge democracy), and the natural environments of society. Adapted from Carayannis et al. (2012)

According to Carayannis et al. (2012), the progression of the quintuple helix can be related to the development of a knowledge society. Under this arrangement, the triple helix system relates to the knowledge economy, the quadruple helix represents the knowledge society and knowledge democracy while the quintuple helix underlines the perspective of socioecological transformations and natural environments (Ibid.). Furthermore, Carayannis and Campbell (2010) explain that the quintuple helix represents a framework for interdisciplinary analysis and transdisciplinary problem-solving in relation to sustainable development. The comprehensive understanding of the Quintuple Helix clearly implies that knowledge production and use as well as innovation must be set in context or must be contextualized by the natural environment of society. To this end, the main goal of the quintuple helix is to include natural environment as a new subsystem for knowledge and innovation models, so that nature becomes established as a central and equivalent component of and for knowledge production and innovation (Carayannis et al., 2012).

The QHIM, thereby, visualizes the collective interaction and exchange of knowledge in a state/nation by means of the following five helices/ subsystems (Carayannis et al., 2012, p. 6).

1. The education system: The education system, as the first subsystem, defines itself in reference to 'academia', 'universities', 'higher education systems', and schools. In this helix, the necessary 'human capital' (for example: students, teachers, scientists/ researchers, academic entrepreneurs, etc.) of a state (nation-state) is being formed by the research into and diffusion of knowledge.
2. The economic system: The economic system, as the second subsystem, consists of 'industry/industries', 'firms', services and banks. This helix focuses on the 'economic capital', such as entrepreneurship, machines, products, technology, money, etc. of a state (nation-state).
3. The political system: The political system is of crucial importance, because it formulates the polices and determines where the state (nation-state) is heading toward in the present and future, thereby also defining, organizing as well as administering the general conditions of the state (nation-state). Therefore, this helix has a 'political and legal capital', such as policies, laws, programmes, politicians, etc.
4. The media-based and culture-based public: This subsystem integrates and combines two forms of 'capital'. On the one hand, this helix has, through the culture-based public (for example: tradition, values, etc.), a 'social capital'. On the other hand, the helix of media-based public (for example: television, internet, newspapers, etc.) contains also 'capital of information' (for example: news, communication, social networks).

5. The natural environment: The natural environment is decisive for a sustainable development and provides people with natural capitals such as natural resources, plants, variety of animals, water, etc. (Carayannis et al., 2012, p. 6).

The five helices function as "subsystems" in which knowledge moves from one subsystem to another subsystem in a circular manner (Grundel & Dahlström, 2016). If knowledge is input into one subsystem, a process of knowledge creation leads to new knowledge or innovations**.** For instance, investment in education for the promotion of sustainable development will create desires and suggestions for knowledge creation in the education system (Carayannis et al., 2012). This investment will produce new equipment, new places for scientists/teachers and a higher research opportunity. In return, there will be a larger output of innovations from science and research, given that teaching and training has been improved (Ibid.). The authors further reason that the output of investment in education will be reflected/visible in human capital (knowledge and skills) because teaching and training will become more effective thereby allowing the human capital to achieve its targets. Then, the output (knowledge and skills) that arises from human capital (as a result of investment in education) for a sustainable development is, in turn, also an input in the helix of the economic system (Carayannis et al., 2012). The input of new knowledge through human capital in the helix of the economic system will lead to an increase in the value (values) of the knowledge economy or of an advanced knowledge economy. Consequently, such advanced knowledge will contribute to the economic system by way of new types of jobs, new green products and new green services (Carayannis et al., 2012). This means that the process of knowledge creation and relationship amongst the sub-system is cyclic in nature. An investment or input in one helix leads to an output of knowledge creation. This output of knowledge automatically becomes an input in another helix.

Moving forward, it is important to note that the fifth helix (natural environment) is not an actual actor or stakeholder but rather it is a driver for new knowledge and innovations in response to environmental challenges (Grundel & Dahlström, 2016). The natural environment stands for the process of knowledge production, and the creation of innovations. This implies that the quintuple helix model recognizes or considers the natural environment as a critical component in the process of innovation and knowledge creation. A diagrammatic representation of the model is presented below.

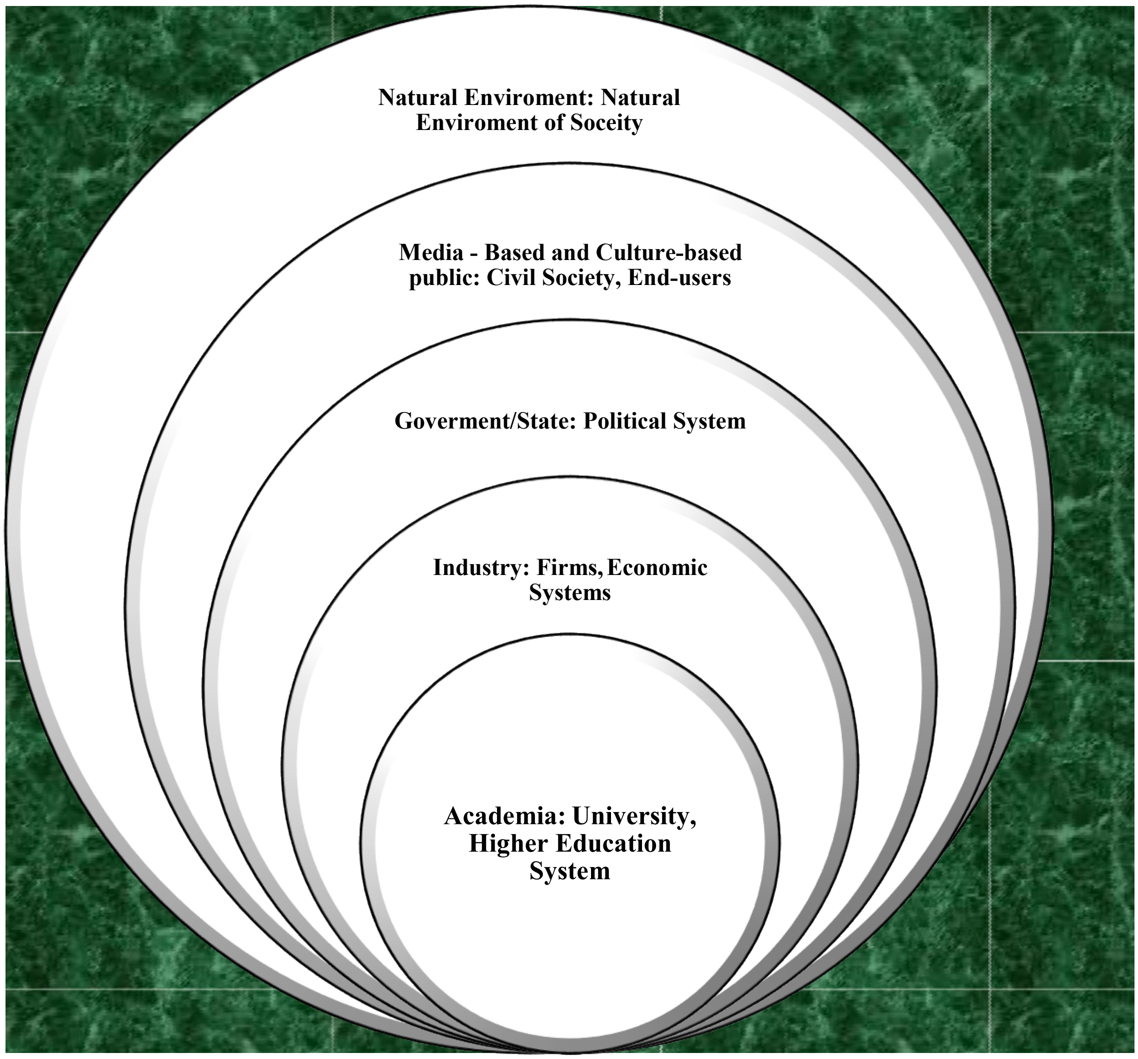

***Figure 6*: Diagrammatic representation of the subsystems of the Quintuple Helix model.**
Adapted from (Carayannis et al., 2012)**.**

In summary, the QHIM is conceived as a theoretical and practical model for the exchange of the "resource of knowledge", based on five social (societal) subsystems with "capital" at its disposal, in order to generate and promote a sustainable development of the society (Carayannis et al., 2012).

3.2.2 Application of the Quintuple Helix Model in the study

Drawing from the foregoing perspectives, it is evident that the QHIM places the natural environment at the core of knowledge creation and innovation. Therefore, the environment must be taking into consideration in the partnership arrangement between the social sub-systems. The present study aligns itself with the principles underpinning the quintuple helix model, given that the end-users/public and their indigenous knowledge systems (human, social and natural capitals), as well as the effect of climate change on their "environment", are issues being addressed in the study. Therefore, addressing the effects of climate change in rural contexts such as Msinga demands a framework that considers and includes the society/public as well as the environment in all arrangements. Hence, the choice of QHIM is based on the fact that it allows for the inclusion of critical sub-subsystems or actors such as the public/end-users and the environment in the processes of innovation. However, the present study focuses on four sub-systems, namely, academia, government, public and environment, even though the QHIM involves five actors or helices. So, the emphasis on the present study dwells on four sub-systems. The four helices are interpreted as following:

- Academia: This helix is represented by the university. Here, agricultural extension programme (curriculum) and lecturers are considered.
- Government: This is represented by staff of the Department of Agriculture, specifically, in-service agricultural extension practitioners
- The media-based and culture-based public: This is represented by smallholder farmers in rural context.
- The natural environment: This speaks to the natural environment which drives the partnerships amongst the sub-systems (Carayannis et al., 2012, p. 7)

The model was applied at theoretical and analytical levels in this study. At theoretical level, the theory was used to understand how partnerships or alignments such as the one proposed in this study could lead to innovations, knowledge generation, dissemination and interchange in relation to climate change. At an analytical level, the theory was used to understand and assess realities (data) based on the types of partnerships that exist between university, government and smallholding communities in the context of climate change in Msinga. It was used to analyse the strengths and limitations of these partnerships and to explore how such partnerships can be used to promote climate smart adaptation in rural contexts such as Msinga.

3.2.3 Interfacing the two theories: Research model

These two frameworks, the Sustainable Livelihood Approaches (SLA) and Quintuple Helix Innovation Model are appropriately positioned to guide this study from a theoretical and analytical point of view, given that the tenets of both theories are in sync with the research phenomena of this study. Therefore, the two theories were combined to answer the critical research questions posed in this study.

The SLA focuses on the ability of individuals or groups to recover from stress and shocks and maintain their assets without deflating the natural resource base (Scoones, 1998). The theory emphasises that the achievement of livelihood outcomes/sustainability development goals such as education for all, food security, reduced vulnerability, etc., depends on the access to livelihood capitals and livelihood strategies adopted by individuals/groups. In other words, livelihood outcomes, such as education, healthcare, food security, reduced vulnerability, etc. can only be achieved when people access and harness livelihood capitals such as natural capital, human capital social capital, etc. However, in a rural context such as Msinga, some of these capitals such as social capital, human capital and natural capital are embedded in their indigenous knowledge and practices in agriculture. Therefore, this study not only highlights these capitals as evident in IK/S, it also argues for their place and space (inclusion) in current discussions and partnerships on climate change adaptation.

Similarly, the QHIM is concerned with the development of knowledge and innovation (co-evolution) through synergies between different sub-systems or helices, while taking the natural environment (context) into consideration. Knowledge moves from one sub-system to another sub-system in a circular manner, with the natural environment at the core of knowledge creation (Grundel & Dahlström, 2016). Furthermore, the circulation of knowledge in QHIM shows that an input or investment in one helix will produce/yield a capital (innovation, knowledge or skills) in that helix and this output will become the building block or input in the next helix. For instance, an input or access to the helix of education/academia will produce result in the form of human capital (knowledge and skills). This human capital automatically becomes an input in the economic system helix (industry) and in return economic capital will be achieved (Carayannis & Grigoroudis, 2016). A diagrammatic representation of the combined research model in mainstreaming climate change adaptation through partnerships is presented below. The acronym

P.C as shown in the diagram means political (legal) capital; H.C means Human Capital; S.C represents Social Capital; N. C means Natural Capital,; while E.C denotes Economic Capital.

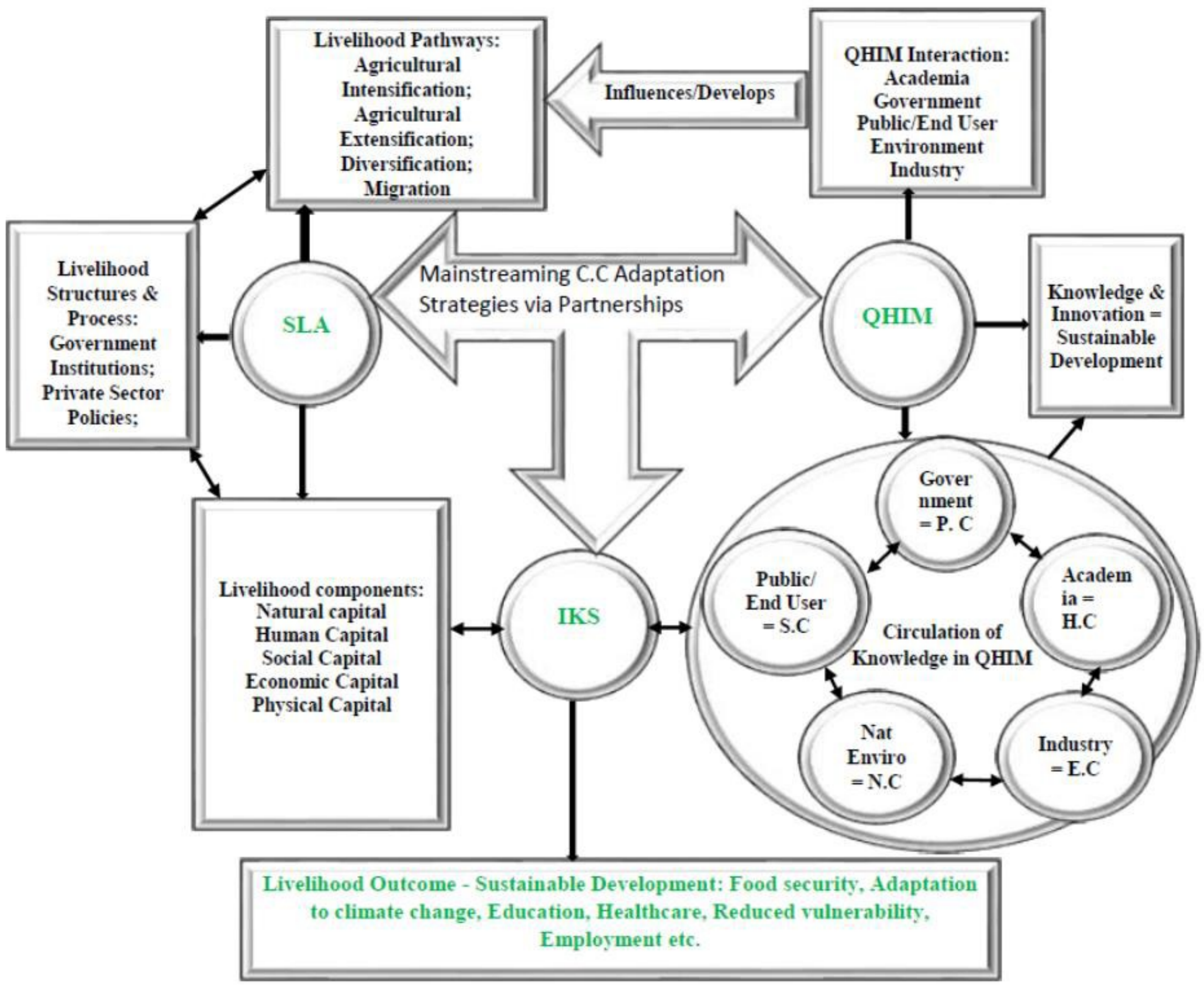

Figure 7: Interactive Model for climate smart adaptation through multi-stakeholder partnerships in the context of climate change (Nwokocha, 2019).

The common factor in the two models is that the public/end-user (SHF) and the environment are considered in the process of knowledge creation unlike in the other models such as triple helix. Furthermore, the partnerships in QHIM and livelihood strategies in SLA as well as livelihood capitals are all geared towards improving the livelihoods outcomes of individuals (poor/marginal) and sustainability of the environment. In other words, the purpose of innovation and knowledge is to improve the society and livelihoods of people. Again, the helices or sub-systems in QHIM develop and influence livelihood pathways in one way or the other. For example, the knowledge and innovation wrought by the interaction amongst the helices in QHIM is applied in (influences) livelihood pathways/strategies. Also, when new forms of agricultural technologies and innovation are developed from the alignments in the QHIM, the farmers acquire such technologies and apply them in their agricultural practice in order to improve their livelihoods. Further, the individual sub-systems/helices impact on livelihood pathways significantly. For instance, the government helices and its policies affect livelihood pathways such as agricultural extensification/intensification in terms of access to agricultural loans, access to land and farm inputs. When there is an investment or input in the education system (academia), it will produce an output or improve livelihood resources/capitals, such as human capital. Also, the helices of education are linked to livelihood pathways, in terms of the knowledge and skills development required for agricultural diversification. Thus, QHIM and SLA are closely related/linked in principle. In this regard, the four sub-subsystems in the QHIM is combined with the SLA to form/create a partnership model for mainstreaming climate change adaptation strategies in rural contexts such as Msinga. Most importantly, the outcome of the interface between the two models highlights the importance of indigenous knowledge systems (IKS) in sustaining livelihoods. The livelihood capitals such as human capital, natural capital and social capitals that are reflected in IKS will enhance the attainment of livelihood outcomes, as can be seen in figure 7 above. Therefore, the inclusion of IKS in the partnership arrangement for mainstreaming of climate change adaptation strategies should be sacrosanct.

3.3 CONCLUSION

This chapter has presented the frameworks that guided the study. The first section discussed the sustainable livelihood approach as an analytical lens for exploring and addressing livelihood challenges in a rural context, such as Msinga, in order to achieve livelihood outcomes. Firstly, the historical background of the frameworks and definition of different components of the frameworks were presented. From a definitional point of view, the reviews suggested that sustainable livelihood is a way of making a living, especially in poor and rural contexts. This meant that IKS is a sustainable livelihood method. The five sustainable livelihood capitals or assets were outlined and briefly explained. It was argued that, when people have access to some or all of these capitals/assets, their livelihood improves. However, when they are unable to access them, they become prone to numerous livelihood challenges, such as the vulnerability to climate events/shocks as experienced in rural Msinga. Therefore, as an analytical framework, the sustainable livelihood approach advocates for making poverty eradication the central focus of developmental policies and programmes.

In order to achieve that, it was argued that interventions in a rural context should take the bottom-up route instead of the usual top-down fashion that does not take cognizance of rural realities. The framework was employed in both the preliminary and main study. The second section presented QHIM. The QHIM consists of five helices, namely, the education system (academia), the culture and media based public (society/end-users), the economic system (industry), the political system (government) and the natural environment. These helices work together to ensure that knowledge/innovation are achieved in a sustainable manner in the society. The need to create knowledge and innovation that take the context (environment) into consideration necessitated the development of and transition into QHIM. The underpinning principles of these two models aligned with the focus of this study; hence, the two models were combined to create a model for the study.

CHAPTER 4

RESEARCH METHODOLOGY

INTRODUCTION

This chapter presents the research methodology that guided the study. First, the chapter discusses the research method or approach that underpinned the study. Second, a detailed explanation of the method of sampling is presented. Furthermore, the chapter explains the procedure for data collection and analysis. The last part of this chapter offers a detailed account of ethical issues, such as validity, reliability and rigour.

4.1 RESEARCH METHODOLOGY

According to Lapan et al. (2011), research methodology or research design refers to the approaches that the researcher(s) employs to ensure that their research work is critiqued, repeated and adapted. These approaches guide the choices of sampling, data collection and analysis (Lapan et al., 2011). Similarly, Rajasekar, Philominathan, and Chinnathambi (2013), as well as Taylor, Bogdan, and DeVault (2015), suggest that the research methodology is the science of studying how a research is to be conducted. It is the procedures that researchers follow in describing, explaining and predicting the research phenomena (Rajasekar et al., 2013).

Furthermore, Rajasekar et al. (2013) argue that the following questions or issues are important when selecting the research methodology and the researcher should be able to address them:

a) Which is a suitable method for the chosen problem?

(b) What is the order of accuracy of the result of a method?

(c) What is the efficiency of the method?

Additionally, research methodology is determined by the type of questions asked and initial hypothesis (Lapan et al., 2011). According to De Vos, Strydom, Fouche, Poggenpoel, and Schurink (2011), there are many approaches or styles that can be employed to conduct a study depending on the research phenomenon. These approaches include but are not limited to the quantitative approach, qualitative approach and mixed method approach (Ibid.). In the next section, the research methodology that guided the study is explained.

4.2 QUALITATIVE RESEARCH METHOD

This study is located within the critical paradigm. Cohen, Manion, and Morrison (2011) argue that the critical paradigm aims not just to understand or describe a phenomenon or situation but to bring change to society. This change can be achieved through the findings of the research or through the research process by empowering people to research and act in their own situation and context (Cohen, Manion and Morrison, 2011). Hence, a critical paradigm endeavours to bring about educational changes in contexts that require action or intervention.

To answer the critical research questions for this study, a qualitative research methodology was adopted. According to Creswell (2009), the qualitative method is a research approach concerned with the meanings that people attach to their experiences of the social world and how they make sense of that world around them. Similarly, Hammarberg, Kirkman, and de Lacey (2016) contend that qualitative methods are research methods used to answer questions about experience, meaning and perspective, often from the perspective of the research participants. Furthermore, Cohen et al. (2011) expound that the qualitative research approach gives voices to the respondents and uncovers issues that lie beneath the surface. In keeping with the foregoing perspectives, Merriam and Tisdell (2015) reason that qualitative research seeks to understand how people make sense of their experiences, how they construct their worlds and what meaning they attribute to their experiences. Additionally, Pope and Mays (2006) opine that one of the strengths of qualitative research is that it studies people and events in their natural setting, rather than in an experimental or artificial setting. Drawing from the above explanation, it can be said that a qualitative research methodology is a research approach that enables the participants to share their experiences and realities about the phenomenon under investigation in their natural setting – the local community. This then justifies the choice of research method for this study.

It is important to point out that there are different types of qualitative research. According to Hammarberg et al. (2016), as well as Astalin (2013), the qualitative research method comprises different designs and any of the designs can be applied in a qualitative research study, depending on the phenomenon under investigation. These designs include ethnography, phenomenology, grounded theory and case study (Astalin, 2013; Hammarberg et al., 2016). Having said that, this study is underpinned by the qualitative exploratory case study design. Exploratory qualitative case studies are conducted when there is need for an in-depth, detailed and complex understanding of a certain issue (Creswell, 2009). Explaining further, Creswell (2009) argues that such detailed understanding of the phenomenon can only be achieved when the participants are engaged directly in their homes or institutions, allowing them to narrate their experiences or stories, irrespective of the researchers' prior knowledge. Furthermore, Yin (2009) expounds that that an explorative case study serves as a suitable means of eliciting information in order to seek new insights and clarify one's understanding of a process or problem being researched.

In line with the above insights, Cohen et al. (2011) conclude that the exploratory qualitative case study approach seeks to answer the crucial 'what', 'how' or 'why' of the phenomenon under investigation and also provides a detailed explanation of the phenomenon being explored by focusing on specific instances in a bounded system. The method also empowers the participants to share their stories, hear their voices and minimize the power relationships that often exist between the researcher and the participants (Ibid.). It can thus be argued from the above perspectives that the qualitative exploratory case study research approach allows for in-depth, thick rich descriptions that will generate words, vivid descriptions, and insightful personal comments, which will facilitate an understanding of the phenomenon under investigation within a particular context. The phenomenon under investigation this study is the mainstreaming of climate smart technology adaptation. The exploratory qualitative case study design thus offers the researcher an opportunity to engage the three stakeholder groups in the real context where the phenomenon exists, which helps in gaining a deeper understanding of the phenomenon under investigation. Given that the concept of mainstreaming climate smart technology adaptation through partnerships in rural contexts such as Msinga is not well researched and established in the literature, an exploratory qualitative research design was deemed most appropriate for this study. It is hoped that, through this critical exploration of the "what", "how" and "why", questions on mainstreaming climate smart technology adaptation in everyday agriculture practices of rural Msinga, existing partnerships will be addressed. This would offer the road-map for an effective way of laying the groundwork that would lead to future studies.

Having said that, this study was divided into two broad sections, namely, the preliminary study and the main study. The preliminary study consisted of three main phases and three questions were addressed in this section. However, it is important to point out that initial visits (pre-interview phase) were made before the commencement of data collection. This phase was dedicated to gaining entry into the study context. No research question was addressed in this phase, rather, the demographic information of the participants such as age, gender and level of education were elicited. The three questions that guided the preliminary study were generated in phases one, two and three. The three phases were presented in three separate chapters, namely, Chapter 5, 6 and 7. Similarly, the main study was carried out in three phases or parts and these three phases relate to the four research questions. The phases and corresponding research questions are presented below.

Preliminary study

The following questions were addressed in the preliminary study:

1. What is the awareness and knowledge of Msinga smallholder farmers of climate change?
   (i) If yes, what is their awareness and knowledge of climate change?
2. Are in-service agricultural extension practitioners in rural contexts adequately trained to offer extension services related to climate change adaptation to smallholder farmers?
   (i) What is the level of education and training of extension practitioners?
   (ii) Does their education and training expose these extension practitioners to knowledge of climate change?
   (iii) Have the extension practitioners received in-service training on climate change?
   (iv) How does the extension practitioners rate their competency level in disseminating climate change information?
3. Is climate change adaptation being accommodated in the Agricultural Extension and Rural Development Programme?
   - If yes, to what extent?
   - If not, what areas are foregrounded?
   - Why are those areas foreground?

In order to address the above questions, both qualitative and quantitative approaches were used to generate data for analysis in this phase of the study.

Main study

1 Do partnerships exist amongst universities, government and small-holding communities?

- If so, what type of partnerships exist amongst these actors with respect to changing weather and climate patterns and its impact on agriculture in South Africa?
- If not, what does exist? What is its nature?

2 What are the roles of each of these actors in these partnerships and why are these roles foregrounded?

3 Do these partnerships promote climate smart adaptation practices in everyday agricultural practices?

- If so, what CSA practices are being promoted?

4 Do these partnerships promote the use of indigenous knowledge systems in everyday agricultural practices?

(i) If so, what IKS practices are promoted?

4.3 SAMPLE AND SAMPLING METHOD

According to Onwuegbuzie and Collins (2007) as well as Creswell (2009), sampling involves making decisions about which people, settings, or events to include in the study. Sampling in qualitative research, emphasis is placed on the distinctiveness of the phenomenon, the people or groups engaged in the study (Creswell,2011). Hence, qualitative research seeks to explore a particular group under study and not to generalise, as the individual or groups represent themselves and nothing or nobody else in the study (Ibid.). Given that everyone and every event cannot be studied, due to issues such as research time and accessibility, researchers sample their respondents to represent individuals, groups or institutions in relation to a certain phenomenon. In the context of this research, a combination of purposive, convenience and snowball sampling were used to generate data for analysis for both the preliminary and main study.

The sampling method employed in each phase and stage of the study is explained below.

4.3.1 Preliminary study

This phase consisted of three phases, namely phases one, two and three. Samples for each phase were determined by the nature of question addressed.

4.3.1.1 Phase 1

The sampling in this phase was selected to respond to preliminary research question one. As a result, both purposive and convenience sampling methods were adopted for this phase. According to Kumar (2011), purposive sampling is a type of sampling where the participants or respondents are selected specifically and systematically because they are most likely to generate the data useful to the research. With respect to convenience sampling, Cohen et al. (2011) reason that convenience sampling is a sampling approach where the respondents are selected based on the fact that they meet certain criteria such availability and accessibility to the researcher. The forgoing characteristics justifies the choice of purposive and convenience sampling in this phase of the study. Having said that, the participants that took part in this phase of the study were drawn from the Asisikume Msinga smallholder farming cooperative. These particular group of farmers were conveniently and purposively selected because they are smallholder farmers within a rural context and they possess in-depth knowledge and experience about the research phenomenon hence are in a position to offer in-depth information. A total of 40 participants from the Asisikume Msinga smallholder farming cooperative took part in this phase of the study.

The nature of data generated in this phase is both numerical (statistical) and textual, using semi-structured questionnaires and focus group interviews.

4.3.1.2 Phase 2

In this phase, three sampling approaches were employed to address preliminary research question two. These are purposive sampling, convenience and linear snowballing sampling. The purposive and convenience sampling were used to identify the Bachelor of Agriculture Programme Template (BAPT, 2009). These three sampling approaches were chosen because of the nature of question posed at this phase of the study and because the participants were able to offer relevant information about the research phenomenon. In choosing a document for analysis, Bell (2014) explains that the document must be relevant to the phenomenon under investigation and also accessible to the researcher. In this regard, the BAPT (2009) document was chosen because it contains relevant information with respect to the inclusion or non-inclusion of climate change and climate change adaptation in the Agricultural Extension and Rural Development Programme. Furthermore, the BAPT (2019) document was made available and accessible to the researchers, hence the reason for selecting it.

With respect to linear snowball sampling, Faugier and Sargeant (1997) argue that snowball sampling is an approach used to obtain research and knowledge, from extended associations, through previous connections, which could be colleagues, friends, associates and so on. This means that snowball sampling uses recommendations to find people with the specific range of skills and knowledge that has been determined as being useful for the research (Atkinson & Flint, 2001). In applying linear snowball sampling in this study, one academic staff member in the department of agriculture and rural development from the higher education institution was identified and approached first to participate in the study. The academic staff is also involved in a direct partnership with an NGO-Trust with respect to agriculture. This academic staff member then recommended six other academic staff members within the Agricultural Extension and Rural Development Programme. However, only thee academic staff members availed themselves for the study. So, three academic staff members from the Agricultural Extension and Rural Development Programme participated in the study (and constituted the sample from the education systems/academia), even though seven staff members were approached. The linear snowballing sampling approach was adopted for this phase of the study because I could not personally reach the desired population with the requisite knowledge and information.

4.3.1.3 Phase 3

Similar to phase 1 and phase 2, both purposive and convenience sampling were employed for this phase of the study. The two sampling methods were adopted to respond to preliminary research question 3, which focused on the level of preparedness of extension practitioners to offer extension services related to climate change adaptation to smallholder farmers (end-users). A total of 17 agricultural extension advisors with the Department of Agriculture and Rural Development in Msinga Local Municipality were engaged in this stage.

A summary of the sample distribution for the preliminary study is presented in table 4.1 below.

Table 1 : Sample distribution for the prelii inary study

Stakeholder group	Stakeholder	No. of Stakeholders	Total no. of Stakeholders per group

End-users/Culture-Based Public	Msinga smallholder farmers	Part 1: 10 Part 2: 13 Part 3: 17	40
Education system/Academia	Part 1: Bachelor of Agriculture Programme Template (BAPT, 2009) Agricultural Extension snd Rural Development academic staff members	3	3
Government/Political system	Agricultural extension practitioners in the Department of Agricultural and Rural Development	17	17
Grand Total			60

4.3.2 Main study

This section of the study consisted of four phases, namely phases one, phase two, phase three and four. Sampling in this section follows the exploratory case study design. A combination of qualitative and quantitative information was elicited. The sample for each phase was determined by the nature of the question (or the different components/aspects of the question) addressed in that phase.

4.3.2.1 Phase 1

This phase addressed main research question one of the study, which focused on partnerships in existence between the stakeholders engaged in the study. The phase is further broken down into two parts, namely part 1 and part 2. Part 1 explored the type of partnership existing amongst these actors with respect to changing weather and climate patterns in South Africa. On the other hand, Part 2 ascertained what existed and its nature in the case where there was no partnership amongst the stakeholder groups. The purposive, convenience and snowballing sampling methods were adopted for this phase.

The sample (participants) for this phase consists of stakeholder representatives from the following categories of institutions, namely:

Education System/Academia (College of Agriculture)

- **Academic staff members** (Agricultural Extension and Rural Development lecturers)

Government (Department of Agriculture and Rural Development)

- Staff members of the Department of Agriculture and Rural Development (Agricultural extension advisors)

Culture-Based Public/End-users

- Msinga smallholder farmers

A total number of 31 stakeholders (participants) from the above listed institutions were purposively and conveniently selected in this phase and section of the study. A breakdown of the sample is presented in Table 2 below. The choices of these stakeholders were premised on the following:

Education System/Academia (College of Agriculture)

- The stakeholders (participants) from the College are heavily involved in curriculum development and training of agricultural extension advisors
- The stakeholders are involved in research on climate change and climate change adaptation and its interception with agriculture; hence, they were systematically selected because they were capable of providing the information needed to answer the research questions likely to generate the data useful to the research
- They are involved in partnerships with NGOs/Trust on community food security and agriculture
- They were willing to participate in the study.

Government (Department of Agriculture and Rural Development)

- The stakeholders/partners from the government are in partnership with culture-based public/end-users in rural communities
- They showed willingness to participate in the current study
- The stakeholders are responsible for providing agricultural extension services to farmers, both commercial and smallholder farmers
- They assist and guide locally the implementation of climate change adaptation activities
- They serve as a direct link between government and the farmers and implement government policies

- They provide feedback from the farmers to higher levels of government
- They serve as a bridge between scientists and farmers by disseminating innovations from research to farmers, and by helping to articulate for research systems the problems and constraints faced by farmers.

Culture-Based Public/End-users

- The stakeholders from the culture-based public (end-users) are most disproportionately affected by the effect of climate change
- They showed willingness to participate in the study
- They are involved in rain-fed/substance farming
- They are in partnership with government stakeholder groups.

4.3.2.2 Phase 2

Sampling at this phase was aimed at responding to main research question two, which focused on the roles of each stakeholder group in the partnerships. The purposive and convenience sampling approaches were adopted for this phase of study. As explicated earlier, purposive sampling is a sampling approach that selects respondents based on their characteristics and ability to offer useful information to the researcher. On the other hand, convenience sampling is a sampling approach that selects participants based on their willingness to participate in the study and their accessibility to the researcher.

4.3.2.3 Phase 3

Purposive sampling was adopted for this phase of study. The sampling responded to research question three of the main study. Research question three inquired if the partnerships existing amongst the stakeholders in this study promoted climate smart technology adaptation in everyday agriculture and what type (s) of technologies were promoted.

4.3.2.4 Phase 4

Similar to phase 3, purposive sampling was adopted for this phase of study. The sampling responded to research question four of the main study. Research question four explored if the partnerships existing amongst the stakeholders in this study promoted indigenous knowledge systems in everyday agriculture and what type (s) of IKS were promoted. A summary of the sample distribution of the main study is shown in Table 2 below.

Table 2: Sample distribution for the main study

Stakeholder group	Stakeholder	No. of stakeholder	Total no. of stakeholder per group
Education system/Academia	Agricultural Extension and Rural Development academic staff members	3	3
Government/Political system	Agricultural extension practitioners in the Department of Agricultural and Rural Development	13	13
Culture-Based Public/End-users	Msinga smallholder farmers	15	15
Grand Total		31	31

4.4 METHOD OF DATA COLLECTION: PRESENTATION OF INSTRUMENTS

According to Cohen et al. (2011), data collection in explorative qualitative case studies can be conducted through the use of document analysis, questionnaires, individual interviews as well as focus group discussions. Similarly, Pope and Mays (2006) suggest that instruments such as interviews, document analysis and questionnaires can be used to generate data in an exploratory case study. Pope and Mays (2006) further reason that the questionnaire can be semi-structured or unstructured. In line with the above explanations, the following instruments were used to generate data for analysis.

1. Semi-structured questionnaire containing close-ended and open-ended questions
2. Document analysis
3. Focus group interviews.

4.4.1 Questionnaire

According to Bertram and Christiansen (2014), questionnaires are one of the best instruments that can be used to generate data for analysis in research, as they allow for the collection of textual and numerical data. They can be administered to a large number of people or a small group of participants, depending on the research phenomenon and the sampling approach adopted (Ibid.). Semi-structured questionnaires, also known as open-ended questionnaires, ask more open-ended questions and allow the respondents to answer the way they like, but in line with the question asked (Bertram & Christiansen, 2014). This implies that they are not confined to answer in a particular way (Bertram & Christiansen 2014, p. 77). In contrast, closed-ended questionnaires or structured-ended questions require respondents to answer in a certain way (Cohen, Manion & Morrison, 2011). According to the authors, a closed-ended and open-ended questionnaire recommends the range of responses from which the respondent may select. In addition, Cohen et al. (2011) assert that open-ended responses most of the time hold the "gems" of information that may not be provided by other types of questionnaire, such as closed-ended questionnaires.

In the context of this study, the structured, semi-structured and unstructured questionnaires were used to generate data in different stages of the study for analysis. The structured questionnaire was used in the pre-interview visit to elicit the demographic information of the farmers and in research question two in the preliminary study. Equally, the structured and semi-structured questionnaires, which allowed for closed-ended and opened ended questions, were used to generate data for research question two in the preliminary study. Also, closed-ended questionnaires were used to generate data in part 1 of research question 1 of the main study. This part explored whether a partnership existed between the three stakeholder groups engaged in this study. On the other hand, unstructured questionnaires were used to generate data for part 1 of research question 3. This question explored whether the partnerships existing amongst the three stakeholder groups promoted climate smart technology in everyday agriculture. In the same vein, part 1 of research question 4 of the main study used the semi-structured questionnaire to explore whether the partnerships existing amongst the three stakeholders promoted indigenous knowledge systems in everyday agriculture. The open-ended questionnaire was completed by stakeholders from the education system and government. The data elicited from the open-ended questionnaire was used to expand and complement the data generated from focus group discussions with these stakeholder groups.

4.4.2 Document analysis

Bowen (2009) reasons that document analysis is a qualitative research approach in which documents are interpreted by the researcher in order to understand the research phenomenon. In this study, document analysis was used in the preliminary study to address a section of research question two. The electronic version of the Bachelor of Agriculture Programme Template (BAPT, 2009) document was consulted as a source of data for the first part of research question 2 in the preliminary study. This part explored whether climate change and climate change adaptation were accommodated in the Agricultural Extension and Rural Development programme.

4.4.3 Focus group interviews

A focus group is a small gathering of people with common interests or characteristics, assembled by the interviewer (researcher) in a comfortable atmosphere where people can share their opinion, ideas or experiences with the purpose of gaining information about a particular issue (Williams & Katz, 2001). Focus group interviews allow the participants to respond to questions in the way they would like to as long as the response relates to the question asked (Bertram & Christiansen 2014; p. 81). According to Du Plooy-Cilliers, Davis and Bezuidenhout (2014), focus group interviews offer the researcher the opportunity to obtain rich and detailed information on the research issue as participants can build on or counter each other's contributions, which may lead to debates and discussions that could not have occurred in individual interviews. A total of seven focus group interviews were conducted in this study. Four focus group interviews were conducted in the preliminary study while two focus group interviews were conducted for the main study in the order shown below.

- **Focus Group 1**: Msinga smallholder farmers
- **Focus Group 2**: Msinga smallholder farmers
- **Focus Group 3**: Msinga smallholder farmers
- **Focus Group 4:** Agricultural extension advisors from the Department of Agriculture and Rural Development in Msinga municipality
- **Focus Group 5:** Agricultural Extension and Rural Development lecturers from Cedara College of Agriculture

- **Focus Group 6:** Msinga smallholder farmers
- **Focus Group 7:** Agricultural extension advisors from the Department of Agriculture and Rural Development in Msinga municipality.

As indicated above, seven focus group interviews were conducted in this study. Four (three in the preliminary study and 1 in the main study) of those interviews were held with Msinga smallholder farmers (end-users). Two focus group interviews were held with the extension practitioners while one focus group interview was held with the academic staff members. The researcher did not originally set out to conduct seven focus group interviews in this study. However, due to poor turn-out of participants during the scheduled dates of the interviews, it was necessary to repeat the focus group interviews held with Msinga smallholder farmers during the preliminary study. So, instead of having one focus group interview with the farmers (end-users) in the preliminary study, the researcher ended up conducting three focus group interviews. All the focus group interviews lasted for about 50 minutes and the information was audio recorded. The questions asked were open and explorative in nature, thereby allowing the participants to express themselves. The summary of the data collection methods is presented in table 4.3 below.

Table 3: Summary of data collection methods

Phases/parts	Research Question	Data Source	Instrument
		Preliminary Study	
Phase 1	*What is the awareness and knowledge of Msinga Smallholder Farmers on Climate Change?*	- Msinga smallholder farmers	- Closed-ended & open-ended questionnaires - Focus group interviews
Phase 2 - **Part 1** - **Part 2** - **Part 3** - **Part 4**	*Are in-service agricultural extension practitioners in rural contexts adequately trained to offers extension services related to climate change adaptation to smallholder farmers?* *a. What is the level of education and training of extension practitioners?* *b. Does the education and training expose these extension practitioners to knowledge of climate change?* *c. Have the extension practitioners received in-service training on climate change?* *d. How do the extension practitioners rate their competency level in disseminating climate change information?*	- Agricultural extension advisors/ practitioners from the Department of Agricultural and Rural Development Msinga Local Municipality	- Closed & open-ended questionnaires
Phase 3 - **Part 1** - **Part 2** - **Part 3**	*Is climate change and climate change adaptation being accommodated in the Agricultural Extension and Rural Development Programme?* *a. If yes, to what extent?* *b. If not, what areas are foregrounded* *c. Why are those areas foregrounded?*	- Bachelor of Agriculture Programme Template (BAPT, 2009) - Agricultural Extension and Rural Development academic staff members	- Document analysis - Focus group interview
		Main Study	

Phase 1 **- Part 1** **- Part 2**	Do partnerships exist amongst universities, Government and Smallholding Communities with respect to climate change? *a. If so, what type of partnership exists amongst these actors with respect to changing weather and climate patterns and its impact on Agriculture in South Africa?* *b. If not what exists? What is its nature?*	- Agricultural extension and rural development academic staff members (Education system/Academia) - Agricultural extension advisors/ practitioners from the Department of Agricultural and Rural Development Msinga Local Municipality (Government) - Msinga smallholder farmers (End-users)	- Closed-ended questionnaire - Open-ended questionnaire - Focus group interview
Phase 2	What are the roles of each of these actors in these partnerships and why are these roles foregrounded?	- Agricultural extension and rural development academic staff members (Education system/Academia) - Agricultural extension advisors/ practitioners from the Department of Agricultural and Rural Development Msinga Local Municipality (Government) - Msinga smallholder farmers (End-users)	-Focus group interviews -Open-ended questionnaire
Phase 3 **-Part 1**	Do these partnerships promote climate smart adaptation practices in everyday agricultural practices? - If so, what CSA practices are promoted?	- Agricultural extension and rural development academic staff members (Education system/Academia) - Agricultural extension advisors/ practitioners from the Department of Agricultural and Rural Development Msinga Local Municipality (Government) - Msinga smallholder farmers (End-users)	-Closed-ended questionnaire -Focus group interviews -Open-ended questionnaire
Phase 4 **- Part 1**	Do these partnerships promote the use of indigenous knowledge systems in everyday agricultural practices? - If so, what IKS practice is promoted?	- Agricultural extension and rural development academic staff members (Education system/Academia) - Agricultural extension advisors/ practitioners from the Department of Agricultural and Rural Development Msinga Local Municipality (Government) - Msinga smallholder farmers (End-users)	- Focus group interviews - Open-ended questionnaire

4.5 DATA ANALYSIS

According to Cohen et al. (2011), qualitative data analysis involves organizing, accounting for and explaining data in terms of the participants' views of the phenomenon being explored, noting patterns, themes and categories and regularities. Lapan et al. (2011) point out that the first level of data analysis involves classifying or coding qualitative data from interviews and other sources. This implies pulling the data apart to examine them in their smallest components to enhance understanding and interpretation of the data. In order to make sense of the data generated in this study and to seek for variations in responses of the participants, the researcher and the supervisor engaged in a rigorous and iterative analysis of the data. The data was read many times in order to gain deeper insight and to identify the key ideas in the data. Subsequently, the data was organised and sorted into codes (inductive coding) or categories to bring out the themes. The quantitative (numerically) data was analysed statistically using the Statistical Package for Social Sciences (SPSS). A breakdown of the data analysis is presented below.

4.5.1 Preliminary study

Data analysis in this phase of the study was done in three phases, namely phases one, phase two and phase three. Phase 1 analysed the first preliminary research question. Phase two analysed the second preliminary research question while phase three addressed the third research question.

4.5.1.1 Phase 1

Two sets of data were collected in this phase, using closed-ended questionnaires and focus group discussions. The quantitative data collected from closed-ended questionnaires was analysed statistically using the (SPSS) to determine the descriptive statistics. The results were presented in tabular and bar chart/graph form to aid the interpretation and discussion. On the other hand, the qualitative data generated from focus group discussion was analysed thematically. Braun and Clarke (2006) reason that thematic analysis is a qualitative analysis method in which patterns or themes within a data are identified, analysed and reported. Similarly, Lapan et al. (2011) explain that thematic data analysis involves classifying or coding qualitative data from interviews and other sources into themes. This requires the researcher to pull the data apart to examine them in their smallest components to enhance understanding and interpretation of the data (Lapan et al., 2011). In this regard, data from the focus group interviews were coded into themes and categories and the results were presented in the same way. The themes that emerged from the data was given critical analysis in Chapter 5.

4.5.1.2 Phase 2

The data generated in this phase explored whether the in-service agricultural extension practitioners in rural contexts were adequately trained to offer extension services related to climate change and climate change adaptation to smallholder farmers. The phase is broken down into three parts and the questions were analysed quantitatively, given that the nature of data generated were quantitative. The data was analysed using the Statistical Package for Social Sciences (SPSS). The results were presented in tabular and bar chart/graph format to aid the interpretation and discussion.

4.5.1.3 Phase 3

Two sets of qualitative data analysis were done in this phase. The first part analysed the Bachelor of Agriculture Programme Template (BAPT, 2009) to ascertain if climate change and climate change adaptation were accommodated in the Agricultural Extension and Rural Development Programme. The document analysis was completed through the use of Jansen and Reddy's (1994) ideas on policy and document analysis. The document analysis process was guided by suggestion and ideas from Jansen and Reddy (1994) on policy. The tool focuses on four key aspects or components to be considered when analysing policy documents. These are:

Context: This refers to the sources of the document, and the context in which it was produced. In other words, it considers the historical background of the document and the rationale for its formulation.

Recommendations: This aspect addresses the rationale behind the recommendations made, also the conception and implication of the recommendations according to the policy.

Skills, knowledge, values and attitudes (SKAV): This aspect focuses on the outcomes in the form of knowledge, skills, attitudes and values that should be achieved through the policy recommendations. It considers how the recommendations will be achieved practically.

Implementation: This looks at measures to be taken to ensure successful implementation of the recommendations made.

For the purpose of this study, the analysis focused on the third factor, which relates to the skills, knowledge, attitudes and values that are targeted to be achieved in a programmes. In addition to this, the content coverage of the programme was analysed to ascertain if climate change and climate change adaptation were accommodated in the programme. The other components were exempted from the study because this phase of the study is primarily concerned with policy content and practice, which were foregrounded in the BAPT (2019) document. In addition, the qualitative data generated from focus group discussions were analysed thematically. It is important to point out that the data was read many times in order to gain deeper insight and to identify the key ideas in the data. Subsequently, the data from the focus group discussions were organised and sorted into themes for discussion.

4.5.2 Main study

The data analysis in this phase of the study was done in four phases, namely phases one, phase two, phase three and phase four in relation to the four main research questions addressed in this study. Phase 1 analysed the first research question. Phase analysed the second question while phase three addressed the third research question. Lastly, phase four analysed the fourth and last research question.

4.5.2.1 Phase 1

The data analysis in this first phase was guided by main research question one. The question inquired if partnerships exist between universities, government and smallholding farming communities with respect to climate change. This question was further broken down into two parts, with the first part exploring the type of partnerships that exists between the stakeholders with respect to changing weather and climate patterns and its impact on agriculture in South Africa. The second part explored the nature of what exists amongst the stakeholders where there was no partnership. The data was collected by means of closed-ended questionnaires, open-ended questionnaire and focus group discussions. The closed-ended data that was analysed statistically using the Statistical Package for Social Sciences (SPSS) to determine the number of stakeholder groups that are in partnerships with other institutions. The results were then presented in tables and bar charts to illustrate the existence and types of partnership within each stakeholder group. The second part of the question, which was split into part one and part two, was addressed through open-ended questionnaires and focus group discussion. The data was analysed thematically. The analysis at this stage was guided by the Quintuple Helix Innovation Model (QHIM). The frameworks were used to examine the types of partnership that exists amongst stakeholders.

4.5.2.2 Phase 2

This second phase adopted thematic data analysis approach to address research question two. As explained previously, thematic analysis is a qualitative analysis method in which themes within data are identified and analysed in order to address the qualitative research question (Braun & Clarke, 2006). The Quintuple Helix Innovation Model (QHIM) and the Sustainable Livelihood Approaches (SLA) were employed in analysing the data generated at this stage. The two frameworks were used to unearth the roles of each stakeholder group in their respective partnerships.

4.5.2.3 Phase 3

The question in this phase explored if the partnerships amongst the stakeholder groups promoted climate smart adaptation technology in everyday agricultural practices and what CSA practices were promoted. The data for this phase was generated through open-ended questionnaire and focus group discussions. Like the previous phase, the data generated from the open-ended questionnaire and focus group discussions were analysed thematically. Again, the analysis was guided by the Quintuple Helix Innovation Model (QHIM) and the Sustainable Livelihood Approaches (SLA).

4.5.2.4 Phase 4

Data collected from the open-ended questionnaires and focus group discussion at this stage was analysed using the thematic method and the theoretical framework employed in the study. Thematically, data generated was sorted into categories and the results were presented and discussed in themes. The analysis was equally guided by the Quintuple Helix Innovation Model (QHIM) and the Sustainable Livelihood Approaches (SLA).

4.6 VALIDITY AND RELIABILITY

To ensure credibility and reliability – dependability and trustworthiness in this work – there was detailed description of settings, participants and themes that were used in the study. Also, member checking (Creswell, 2012) was used to ensure the credibility and dependability of the research. The interview transcripts were taken back to the participants to crosscheck and confirm their accuracy. Member checking is a research procedure used to ensure credibility and validity of the research. According to Carlson (2010), member checking involves taking back the interview transcript or particles from the narratives /accounts they contributed during interview sessions and asking participants to check their accuracy. In this process, participants are given the opportunity to elaborate, clarify or confirm aspects of the interview, in order to ensure that their views, experiences and perceptions were captured accurately during the interview. Thus, member checking was adopted to guarantee the credibility of the research. Furthermore, triangulation through a combination of qualitative and quantitative data, which involved the use of different instruments to generate data, was adopted to increase the validity and reliability of this study. Triangulation is a process used to ensure validity in a research. Methodological triangulation ensures the validation of data and also produces more comprehensive, internally consistent, and valid findings (Johnson & Onwuegbuzie, 2004).

According to Creswell and Miller (2000), triangulation is used to increase credibility and check dependability by sourcing for information from different sources to form themes for the study. In this study, data was generated through closed ended/structured questionnaires, open-ended questionnaires, document analysis and focus group interviews. Additionally, Lapan et al. (2011) suggest that the validity and credibility of research can be ensured by undertaking an external review and interpretations of the findings. By implication, it is important for other researchers in the field to carry out a critical review of the findings of a research study to ensure its credibility. Therefore, the findings from this study were critiqued extensively by my supervisors and other researchers from the cluster of Science and Technology Education in my School to ensure that the findings are accurate and credible. The critical issues in the data were identified, recorded and applied, and adjustments were made where necessary to arrive at accurate categories of description and results.

4.7 RIGOUR

The results of the data collected and analysed as well as the findings of this research were open to critique by other academics and other researchers in this field of study. This is to ensure the soundness, accuracy of the findings and conclusions reached, as emphasized by (Nixon & Power, 2007).

4.8 ANONYMITY/INFORMED CONSENT

According to Du Plooy-Cilliers, Davis and Bezuidenhout (2014), all participants or respondents in a study must be officially informed and they should give their consent before the commencement of data collection. The participants should be made to understand *"what will be required of them during their participation, whether their identities will be protected and how the results will be used"* (Du Plooy-Cilliers, Davis, & Bezuidenhout, 2014; p 264). In this regard, all participants in the study were duly informed about the research and what was required of them, hence they gave their consent. Furthermore, the participants were assured of the anonymity of their identity (protection of identity) before and after the data collection. This enabled them partake willingly and freely in the research. Again, the study adhered strictly to the University's ethical research standards. Hence, ethical clearance was obtained from the University before the commencement of data collection in adherence to the University research ethics.

4.9 LIMITATIONS OF THE STUDY

The major limitation experienced in this study was getting the participants assembled for the focus group interviews. As indicated earlier, the focus group interviews with the smallholder farmers were repeated three times due to poor turn out of the participants. The same challenge was experienced during the interviews with the other stakeholder groups. The focus group interview with the stakeholders from academia was rescheduled twice, because the participants did not avail themselves at the agreed date and time for the interview.

Furthermore, it was a very daunting task to get the desired and anticipated number of respondents for the study. During the earlier stages of the research (proposal development), about 100 farmers associated with the Msinga smallholder farming cooperative had indicated their interest to participate in the study, hence, the study was initially designed to be a mixed method research. However, when the study started, this number could not be reached. This necessitated the change in the research method and sampling method. Changing the research methodology from mixed method to qualitative research and reducing the number of participants limited the depth and breadth of the research.
Also, there was a language barrier between the researcher and some of the participants, especially the Msinga smallholder farmer participants, given that most of the participants were IsiZulu language speakers while the researcher is not an IsiZulu speaker. However, this limitation was

reasonably overcome by hiring a research assistant who is an IsiZulu speaker. In addition, the industry stakeholder group who was supposed to be represented by meteorologist and climatologists from the Council for Scientific and Industrial Research (CSIR) pulled out of the study after the proposal defence. This was a major setback for the study, as the desired partnership configuration had to be altered.

4.10 CONCLUSION

This chapter offered a detailed description of the methodology employed in this study. The chapter explained the methods of data collection, instruments used, sampling and sampling techniques, and data analysis. Furthermore, the measures taken to ensure validity and reliability, rigour, anonymity were expounded. In addition, the chapter shared the limitations encountered in this study. The next chapters will present and analyse data generated in the preliminary and main study.

CHAPTER FIVE
THE PRELIMINARY STUDY
BIOGRAPHICAL DATA OF MSINGA SHFs AND THEIR LEVEL OF AWARENESS & KNOWLEDGE OF CLIMATE CHANGE

INTRODUCTION

The concern of this study is twofold. The first concern is the challenges faced by smallholder farmers in South Africa and Africa, in general, in adapting to the negative impacts of climate change (Turpie & Visser, 2013; FOA, 2015). The second concern is the neglect of IKS in various contemporary adaptation policies and programmes in the African context even though the IK adaptation technique is perhaps the most widely used technique in rural African contexts (Nyong et al., 2007; Ngcoya, 2017). Against the above background, this chapter offers insights on these issues from an empirical point of view, by addressing the following preliminary research study question:

Are Msinga smallholder farmers aware of climate change? If yes, what is their awareness and knowledge of climate change?

The objective of this preliminary chapter was to generate the biographical data of MSFs and to establish if they are aware of climate change. Furthermore, the chapter seeks to elicit what exactly their awareness and knowledge of climate change is. In order to achieve that, data was generated through focus group interviews and questionnaires.

Bearing the foregoing in mind, this chapter presents results relating to the above research question. The data is presented in the form of categories using excerpts from the focus group interviews and descriptive statistics such as frequencies, tables and charts. The chapter is organised into six main sections namely, 5.1, 5.2, 5.3, 5.4, 5.5 and 5.6. The first section offers a brief demographics or profile of the participants. The demographics described include gender, age, and level of education. Section 5.2 presents a statistical analysis of the participants' awareness and knowledge of climate change. This is followed by sections 5.3, 5.4, 5.5 and 5.6. These last four sections address the four categories of description that were delineated from the responses of the participants with respect to their awareness and knowledge of climate change. In each of these four sections, transcripts of the data generated from the focus group interviews will be presented and analysed, in accordance with the categories and sub-categories that emerged.

5.1 UNDERSTANDING THE RESEARCH CONTEXT: WHO ARE THE MSINGA FARMERS?

As indicated in the previous chapter, the purpose of the first visit was to gain entry into the study. This required me to me elicit the demographic information (such as age, gender, level of education) of the participants. The subsequent visits (two, three and four), sought to understand the knowledge and awareness of MSFs about climate change. Drawing from my interactions with the participants during these visits I noted that the people of Msinga were predominantly subsistence farmers and they make extensive use of their indigenous knowledge systems in their farming activities. Interestingly, there are more women involved in farming activities than men in these communities. According to the participants, "most men are working in cities", hence more women are involved in subsistence farming. In terms of economic status, the people of Msinga are mostly poor and there are very few economic activities happening in the area (besides substance farming). The closest economic activities (trade/commerce) in the area occurs within Tugela Ferry, then in farther places such as Greytown, Dundee, etc. Greytown and Dundee are about 10km to 15km drive from Tugela Ferry.

With respect to settlement, the settlement in Msinga is mainly rural and scattered. Each household is about one kilometre away from the other. The topography is largely mountainous with a few table (stable land) used for farming activities. Next, the demographic profile of the participants is presented.

5.1.1 Demographic profiles of the participants

The participants were asked questions that elicited their personal information, such as gender, age and level of education. This biographical data was used to describe the demographic profile of respondents who participated in the study.

5.1.1.1 Gender of respondents

As indicated earlier, there were a total of 40 participants (the end-users) that took part in the first preliminary interaction. Based on the information elicited from the demographics of the participants, there were more female participants that opted to participate in the study than males. 55% (22) of the participants were female while 45% (18) were males. This result is similar to the findings of other studies conducted in other smallholder farming contexts. For example, a study conducted by Elisa (2013), which sought to understand information dissemination for adaptation to climate change and variability, in Maluga and Chibelela villages in Tanzania, found that more women were involved in smallholder agriculture/farming than men. The study, which sampled 84 farmers, had 69% females involved in agricultural activities against 31% males. Similarly, a study done by Zafezeka, (2016) highlights that black African female farmers dominate the agricultural sector of South Africa. Table 4 below shows the gender representation of the participants.

Table 4: Gender of Respondents

Gender	Frequency	Valid Percent	Cumulative Percent
Male	18	45.0	45.0
Female	22	55.0	100.0
Total	40	100.0	

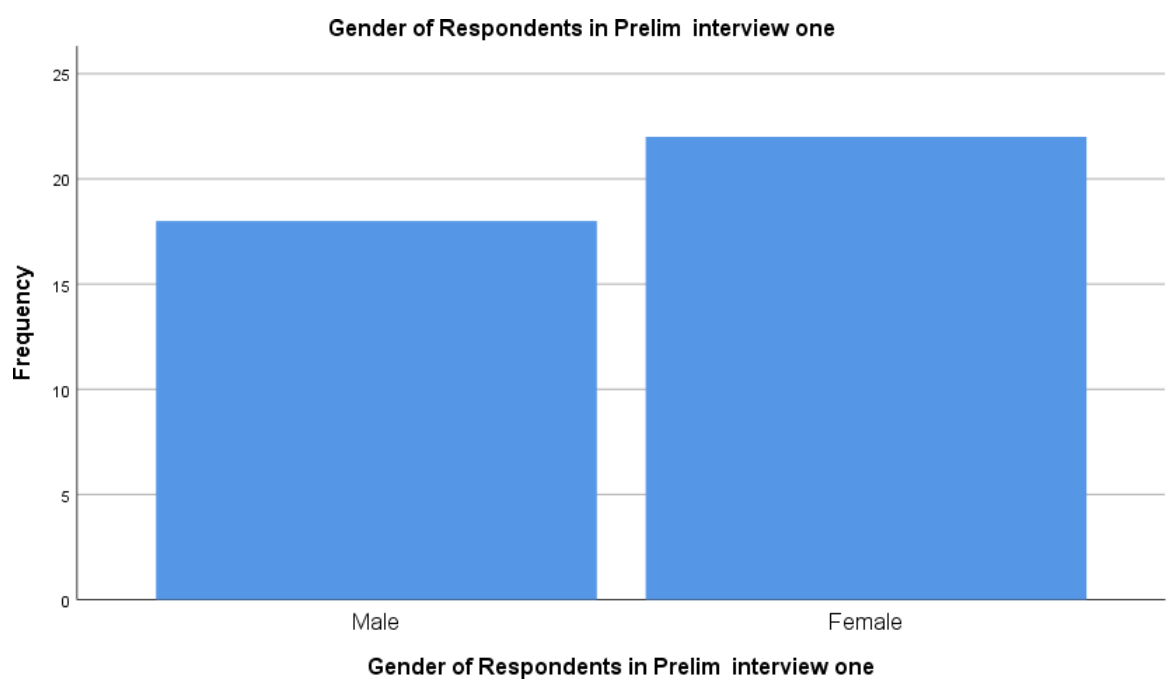

Figure 8: Gender of Respondents

5.1.1.2 Age of respondents

The findings from the interview reveals that the largest group of the participants in this case, 50% (20), were between the ages of 46-55 years. This was followed by those between the ages of 36-45 years, at 30% (12). The third group of respondents was those between the ages of 26-35 years, at 12.5% (5). The next group of participants were those between the ages of 56-65 years, at 5% (2). The last group of participants in terms of percentage and frequency are those between the ages of 21-25 years, at 2.5% (1). The ages of the participants are recorded in the table below and represented in the chart that follows.

Table 5: Age of respondents

Age	Frequency	Valid percent	Cumulative Percent
21- 25	1	2.5	2.5
26 – 35	5	12.5	15.0
36 – 45	12	30.0	45.0
46 – 55	20	50.0	95.0
56- 65	2	5.0	100
Total	40	100	

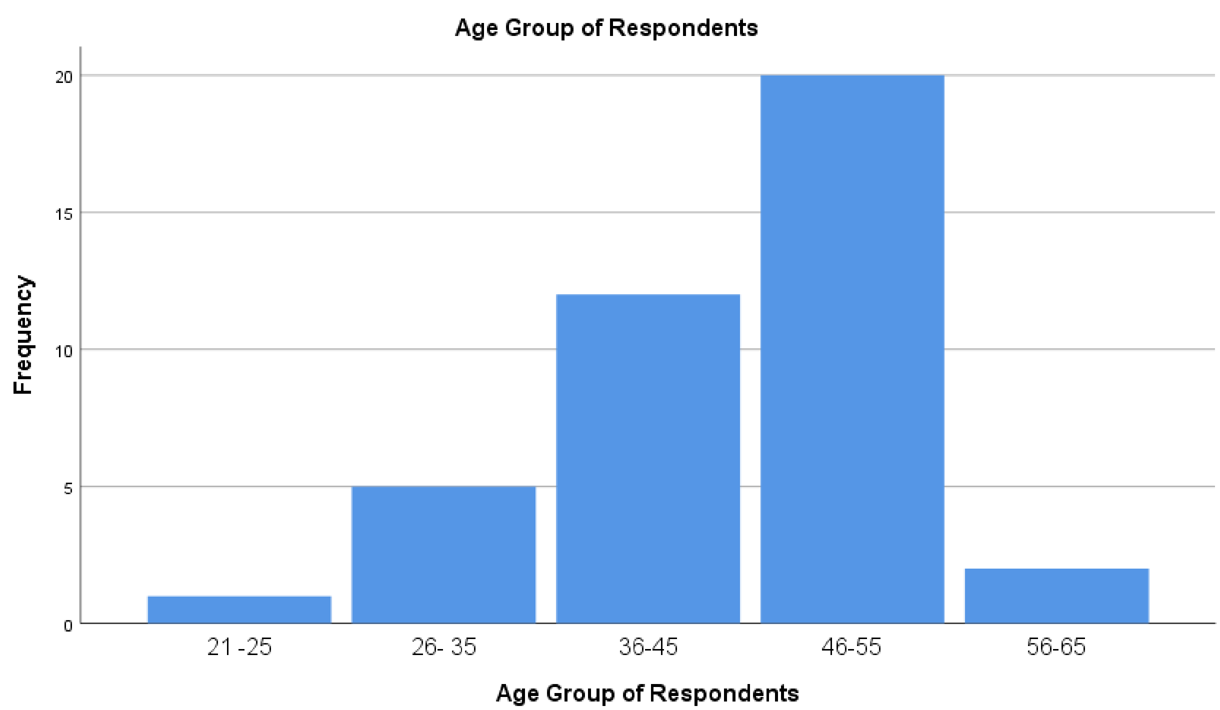

Figure 9: Age of respondents

5.1.1.3 Level of Education of Respondents

The result of the analysis shows that the number of participants without formal education and those with primary education are equal 35% (14) respectively. Both groups make up 70% (28) of the total number of participants. Next to them are those participants with secondary education. This group makes up 20% (8) of the total population. Lastly, 10% (4) of the sampled population attained University education. It is important to clarify that University education in this context represents all higher education institutions such as colleges. The level of education of the participants is captured in the table and charts below.

Table 6: Level of education of respondents

Level of Education	Frequency	Valid Percent	Cumulative Percent
No Formal Education	14	35.5	35.0
Primary Education	14	35.5	70.0
Secondary Education	8	20.0	90.0
University Education	4	10.0	100.0
Total	40	100.0	

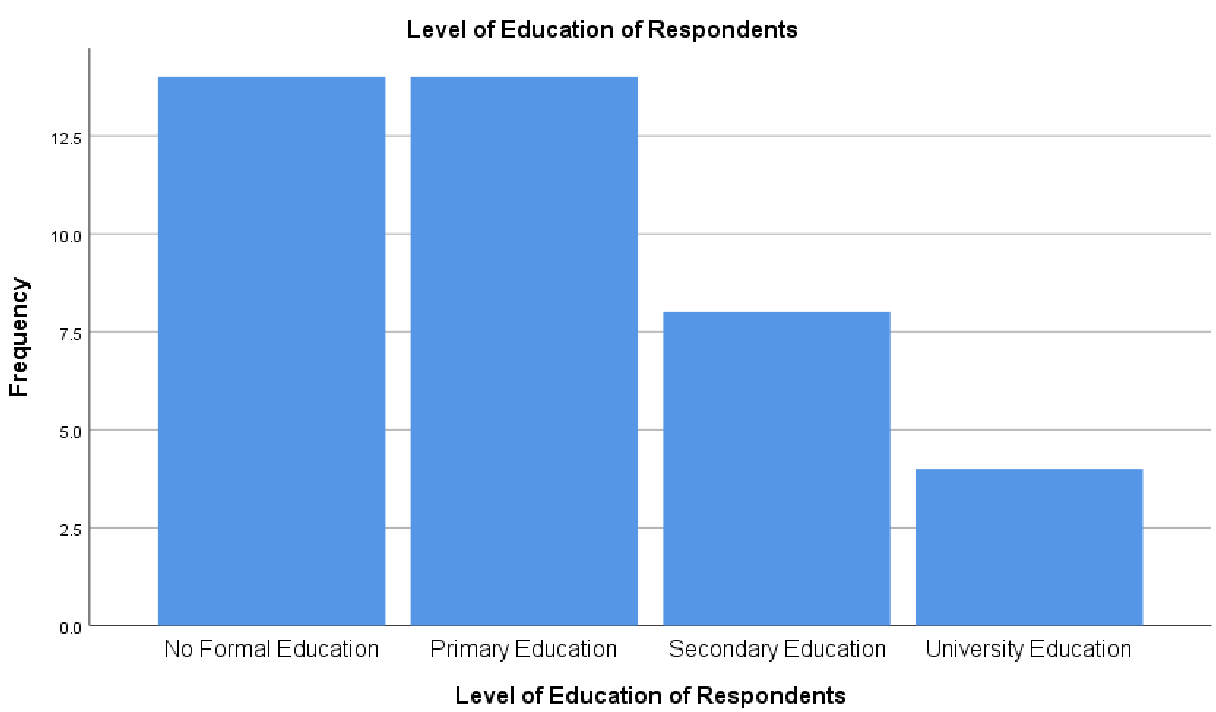

Figure 10: Level of education of respondents

5.2 Msinga smallholder farmers' (MSF) awareness and knowledge of climate change

The participants were asked to share their ideas on their awareness and knowledge about climate change, as can be seen in the underpinning research question above. The question aimed to gain deeper insight into Msinga Smallholder Farmers' (MSF) awareness and knowledge of climate change. In this regard, the questions were designed to measure the participants' conceptions, beliefs and perceptions about climate change, their experiences of climate change, their behaviour as well as attitude/practices towards climate change. In order to achieve that, the participants were required to respond to this Likert-type statement measuring their awareness and knowledge about climate change. Likert is one of the rating scales used to measure attitudes or opinions (Bowling, 1997). This measures opinions or attitudes by asking people to respond to a series of statements about a topic, in terms of the extent to which they agree or disagree with them. A Likert-type scale assumes that the strength of experience is linear or is in a continuum from strongly agree to strongly disagree, and makes the assumption that attitudes can be measured (Burns & Grove, 1997; Joshi, Kale, Chandel, & Pal, 2015). According to Bowling (1997), as well as Burns and Grove (1997), respondents are offered a choice of five to seven or even more pre-coded responses, with the neutral point being neither agree nor disagree. Bearing the above explanation in mind, the participants' awareness and knowledge is represented by a mean score on a 5-point scale, where 5 (very good) represents the maximum score of the scale and 1 (very poor) represents the minimum score.

Analysis of the data shows that a high percentage of the participants are aware and knowledge about climate change. The analysis shows that 34.3% (12) of the participants possess **very good** level of awareness and knowledge, while the same percentage (34.3%) have **good** knowledge and awareness about climate change. These two figures represent 68.6% of the entire population and by implication more than half of the sampled population. The percentage of the participants with poor and average levels of awareness were 14.3% (5) each. 2.9% (1) of the participants had very poor level of awareness and knowledge of climate change, as can be seen in the table and chart below.

Table 7: Awareness and knowledge of Msinga SHF on climate change

Aware & Know	Frequency	Valid Percent	Cumulative Percent
Very Good	12	34.3	34.3
Good	12	34.3	68.6
Average	5	14.3	82.9
Poor	5	14.3	97.1
Very Poor	1	2.9	100.0
Total	35	100.0	
Missing	5		
Total	40		

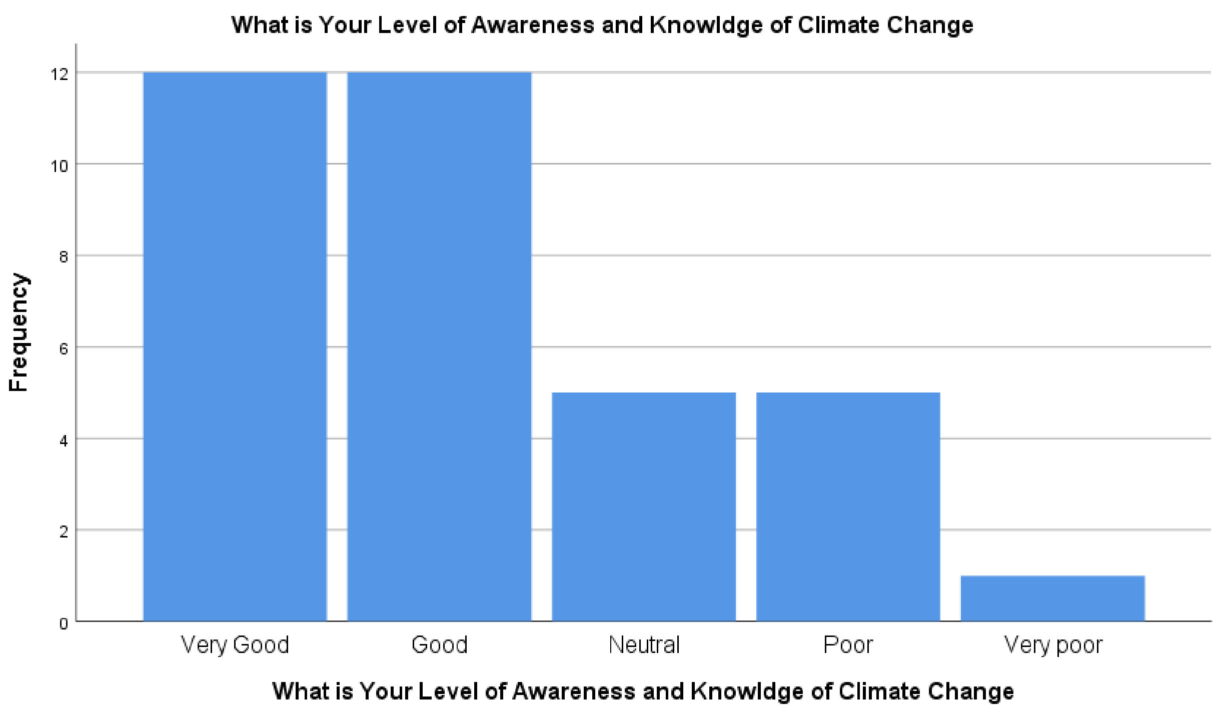

Figure 11: Awareness and knowledge of MSF on climate change

As can be seen from the analysis, 34.3% of the participant possessed good knowledge and awareness of climate change. Additionally, 34.3% of the participants indicated that they have good knowledge of climate change. This means that a total of 68.6% of sampled population had above average knowledge and awareness of climate change. By implication, Msinga smallholder farmers are knowledgeable about climate change. This result was later confirmed in the focus group discussions, where the awareness and knowledge of climate of MSFs were elicited and elucidated. The result of the qualitative analysis reveals that the participants associate their awareness of climate change to climatic phenomenon like drought and other extreme events. For instance, some of the participants linked their awareness and knowledge of climate change to different climatic events/phenomena (drought, heavy rainfall) in their locale, while other participants related their awareness and knowledge of climate change to the impacts of climate change in their lives. Yet, other participants responded to the question on "awareness and knowledge" by referring to the causes of climate change. Drawing from the data that emerged from the focus interviews, the awareness and knowledge of Msinga smallholder farmers was classified into four broad categories of description and nine sub-categories. The categories and subcategories are presented in the table below.

Table 8 Categories and sub-categories of awareness & knowledge of climate change

What is the awareness and knowledge of Msinga smallholder farmers on climate change?	
Categories of description	**Sub-Categories**
▪ **Evidence of climate change**	*Drought (rise in temperature) - sun*
	Heavy rainfall
	Extreme conditions - wind, hailstorm, lightning,
▪ **Causes of climate change**	*Dust/dirt*
	Human activities - exhaust fumes (cars)
▪ **Effects of climate change**	*Loss of agricultural inputs – mielies/maize, sweet potatoes, tomatoes*
	Damage to skin
	Loss of agricultural input – seasonal income
	Loss of agricultural input – livestock
	Loss of live – humans
▪ **Solution to climate change**	*No till planting*
	Sustainable farming – shifting cultivation
	Contour ploughing - erosion/flood mitigation & adaptation

In the sections that follow, each of the four categories and the subcategories embedded will be presented and analysed.

5.3 ANALYSIS OF CATEGORY ONE: EVIDENCE OF CLIMATE CHANGE

The above category indicates that the participants' awareness and knowledge of climate change is linked to "**evidence of climate change".** A further analysis of this category reveals that the evidence is associated with climatic events such as drought and heavy rainfall. So, with respect to the above category of description, three sub-categories of description linked to awareness and knowledge were elicited as can be seen in the table below.

Table 9: Delineation of Category 1: Evidence of climate change

What was foregrounded? Aware & Know	Links	Delineations of sub-categories
Evidence of climate	Drought	*Rise in temperature (due to the sun)*
	Heavy rainfall	_
	Extreme condition	*Wind, hailstorm & Lightning*

As presented in the table above, three sub-categories of description were given by the participants as **"evidence"** of their awareness and knowledge of climate change. In the next section, the sub-categories will be analysed.

5.3.1 Drought

As indicated earlier, drought was identified as one of the "**evidences"** of knowledge and awareness of climate change. Interestingly, the participants did not just mention drought as an evidence of their awareness and knowledge of climate change. Rather, they further identified "*temperature increase"* as the most prevalent aspect of drought in their locale. Four participants specifically mentioned that there is an increase in the degree of hotness of the sun in recent times as compared to before. This implies that they have a sound understanding and knowledge of climatic occurrences. The specifics or variations identified under this sub-category (drought) is presented and discussed below.

5.3.1.1 Rise in temperature

Further analysis of the data shows that the participants made several references to the rise in temperature as an aspect of drought prevalent in the Msinga area. In the third preliminary interview participant one (P1) spoke about how extreme the sun is nowadays. The participant emphasised that the sun use to be hot in the past, but "***not in this extreme way***". This implies that the participant has witnessed an increase in temperature due to the sun. This view was echoed in the comments made by participant two (P2) during the fourth preliminary interview. Again, participant one (P1) and participant three (P3) in the third preliminary interview mentioned the increase in temperature due to the sun and linked it to drought. The views of the participants are reflected in excerpts in the table below.

Table 10: Drought as an evidence of climate change

Know & Aware	**Links**	**Comments**
Evidence of C.C	Drought linked to rise in temperature	*"It gets too hot in the summer time to the point that the sun burns our crops" (P1, prelim interview 2. June 2017).* *"The sun has really affected me" (P4, prelim interview 2, June 2018).* *"The sun is extremely hot now" (P2, prelim interview 3, July 2017).* *"The changes I've seen in the weather are how the sun is hot now. The sun used to be hot but not in this extreme way..." (P1, prelim interview 3, July 2018).*

Drawing from the above comments, it is clear that the participants are aware and are knowledgeable about climate change. The knowledge and awareness were presented in the form of "**evidence**" of climatic events in their communities. First, the participants associate climate change with drought. In other words, drought is an evidence that the climate has changed. Correctly so, drought is one of the major indicators of climate change, according to Lipper et al. (2014). Furthermore, the participants linked drought to increase in temperature due to the hotness of the sun. Interestingly, the views of the participants concur with the findings of previous research conducted in Msinga area. For instance, a study conducted by Vanderhaeghen and Horny (2016) based on the 2010 and 2016 drought in Msinga municipality found that *there has been a constant increase in drought in the Msinga geographical area*. Similarly, Rekuma (2010) in his study of rural communities and Government response strategies to drought in South Africa found that *Msinga is highly susceptible to drought*. Again, a study piloted by Mthembu and Zwane (2017), found that *drought affected some communities in Msinga between 2010 and 2014-2015*. This implies that drought is a major challenge in Msinga and its surroundings. Therefore, the participants were not out of place to link drought to climate change and the rise in temperature as a major element in drought in their communities.

5.3.2 Heavy rainfall

Participant 8 (P8) in preliminary interview four mentioned that heavy rainfall is another key evidence of climate change in their community. In other words, the awareness and knowledge of climate change amongst MSF is linked to heavy rainfall. This view is presented in the table below.

Table 11: Heavy rain as evidence of climate change

Know & Aware	Links	Comments
Evidence of C. C	Heavy rainfall	*"We also experience heavy rains here at uThukela as well" (P8, prelim interview 3, July 2018)* *My knowledge about climate change is that rain patterns have changed. The only season where rain was expected is summer but now you find that it only rains in winter" (P7, prelim interview 3, July 2018).*

5.3.3 Extreme conditions

With respect to the above sub-category, the participants' responses show that climate change is associated with extreme events in the form of wind, hailstorm and lightning. Also, the comments made by the participants show that these extreme events bring negative consequences. These views are captured in the comments presented in the table below.

Table 12: Extreme condition as evidence of climate change

Know & Aware	Links	Comments
Evidence of C. C	Extreme events such as:	
	Wind	*When this wind come it pushes down the crops (P5, prelim interview1, Nov 2016)*
	Hailstorm	*When this hailstorm comes it pushes down our crops (P5, prelim interview 1, Nov 2016)*
	Lightning	*When the lightning comes the hut catches fire (P6, prelim interview 1, Nov 2016)*

5.4 ANALYSIS OF THE SECOND CATEGORY: CAUSES OF CLIMATE CHANGE

As indicated earlier, the participants awareness and knowledge of climate change was classified into four broad categories. With respect to the second category namely, *causes of climate change*, the participants highlighted the main causes of climate change in their locale to show that they are aware and knowledgeable about climate change. A further analysis of the above category reveals two sub-categories of explanation with regard to the causes of climate change. The sub-categories include ***Dust/dirt*** and ***Human activities***. The category and sub-categories are delineated in the table below.

Table 13: Delineation of category 2: Causes of climate change

What was foregrounded? Knowlege & Awareness	Links	Comments
Causes of climate change	Dust/dirt in ozone layer	*I think climate change is caused by dust or dirt in the ozone layer. The number of cars in this area has increased the dust ozone layer (P1, prelim interview 2, June 2017).*
	Human activities	*Cars give off exhaust fumes and that also causes climate change (P8, prelim interview 2, June 2017).*

As can be seen from the above comments, the participants have good knowledge and understanding of the causes of climate change. The views of the participants are consistent with the views of scholars on the causes of climate change. For instance, Stern (2006) argues that that unsustainable human activities or practices contribute massively to climate change. According to Stern (2006), activities such as electricity generation, land-use changes (particularly deforestation), agriculture and transport result in the emission of high concentration of greenhouse gases and these contribute to climate change (Stern, 2006). Similarly, The United Nations Framework Convention on Climate Change (2007) and National Research Council (2012) found that continuous fossil fuel burning and land use changes have emitted, and continues to emit, increasing quantities of greenhouse gases into the Earth's atmosphere. The increase in these greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), nitrogen dioxide (N_2O) and Water vapor has caused a rise in the amount of heat from the sun withheld in the Earth's atmosphere, thereby contributing to climate change. When considered appropriately, it can be seen that the responses of the participants correspond with research conducted by other scholars on climate change and its causes.

5.5 ANALYSIS OF THE THIRD CATEGORY: EFFECTS OF CLIMATE CHANGE

With respect to the above category, the participants' responses show that their knowledge and awareness of climate is linked to the negative effects of climate change. For example, participant 6 (P6) in preliminary interview 2 indicated that the wind and hailstorm tampers with farming activities and *"**destroys infrastructure**"*. The participant went on to explain that the "***lightning***" that accompanies these climate events *"**kills people**"*. In concurring to the above perspective, participant 5 in preliminary interview 2 explained that climate change destroys agricultural inputs such as ***maize*** and ***livestock***. The views of the farmers are captured in table 8 below.

Table 14 Delineation of category 3: Effects of climate change

What was foregrounded? Know & Aware	Links	Comments
Effects of climate change	Loss of agricultural inputs: mielies, sweet potatoes and tomatoes	*"When this wind and this hailstorm comes, presses it down, you know the wind it pushes the maize down & so all the maize stock are lying down instead of growing upwards" (P5, prelim interview 1, Nov 2016)* *"The sun has really affected me. The sun burnt my mealies" (P4, prelim interview 2, June 2018)* *"This thing hit us again with my sister, we were harvesting sweet potatoes the other day and found that it was destroyed "(P4, prelim interview 2, June 2018).* *"There are worms that eat away our crops especially tomatoes. It gets too hot in the summer time to the point that the sun burns our crops, therefore this shows that the climate has changed" (P1, prelim interview 2, June, 2017)* *"The climate change I have seen is the rainstorm that had a negative impact on our plants, and that tomatoes have become infected with a certain disease and even the mealies was also diagnosed with a disease." (P3, Prelim 3, July, 2017).* *"It gets too hot in the summer time to the point that the sun burns our crops" (P1, prelim interview 2. June 2017).*
	Damage to skin	*"The sun burnt my neck and it's itching" (P1, prelim interview 2, June. 2017)*
	Loss of agricultural inputs: Loss of income	*"The Sun burnt my mielies. The only money I made out of it was R1000" (P4, prelim interview 2, June, 2018).*
	Loss of ;ives (*human*) & livestock (*goats*)	*"Another danger that comes with this climate change is that the lightning kills. It does not only kill the livestock, that is animals, goat and stuffs, but it also kills people" (P6, prelim interview 1, Nov 2016).*
	Loss of infrastructure: houses	*"When the lightning comes, the hut catches fire and it burns down the hut. Ultimately it destroys infrastructure" (P5, prelim interview 1, Nov 2016).*

The above result shows that climate change has a destructive effect on the livelihood of MSFs. As explained earlier, climatic events such as lightning destroy infrastructures such as houses and farm inputs. In extreme cases, the lightning kills people, as evident in the above table. It is important to highlight that this result is consistent with the findings of other studies conducted in the Msinga area, KwaZulu-Natal and South Africa at large. For instance, a study done by Madzwamuse (2010) reveals that increases in temperature and reduction in rainfall will collectively impact the agricultural systems in South Africa, by reducing the amount of land suitable for arable and pastoral agriculture. Similarly, the Food and Agricultural Organization (FOA) (2008) states that climate change impacts negatively on all four components of food security in South Africa – food availability, food accessibility, food utilisation and food systems stability. Again, Mugambiwa and Tirivangasi (2017) found that food availability and utilization in South Africa will be highly compromised as a result of decreases in crop yield caused by climate change.

Furthermore, a study done by eThekwini municipality in 2014 found that changes in climate scenarios, such as increased flooding, will result in water-logged soils and leaching of nutrients, resulting in low agricultural yields. The study revealed that projected climate inconsistency may compromise both commercial and small-scale farming and affect food security across the country (eThekwini Municipality, 2014). When you narrow these trends down to Msinga, a study conducted by Rukema (2010) in Msinga Local Municipality found that many households have suffered loss of agricultural inputs such as crops, livestock and seasonal employment because of climatic events such as drought. Additionally, the study by Rukema (2010) found that smallholder farmers in Msinga areas lost 70% of their crop production between 2004 and 2007 due to drought and other climate related events. Drawing from the findings of these studies and the views of the participants in the present study, it can be said that the negative effect of climate change is a huge challenge to smallholder agricultural practices in Msinga municipality and other smallholder farming communities in South Africa.

5.6 ANALYSIS OF THE FOURTH CATEGORY: SOLUTIONS TO CLIMATE CHANGE

With regard to this category, it is evident that the participants linked their awareness and knowledge of climate change to their mitigation and adaptation practices. The data that emerged from the discussions with the farmers shows that the participants find **solution to climate change** in various ways depending on the climatic event. In total, four solutions to climate change were elicited from the analysis. These are:

- **No till planting**
- **Sustainable farming**
- **Contour ploughing**
- **Rituals**

In the next section, I will present an analysis of each solution.

5.6.1 No till planting

With respect to the above **solution to climate change**, the participants, explained that they use the method of **"no till planting"** as a solution to drought and erosion. This method requires that crops are planted without tilling the ground/soil. The process of implementing the no till planting is captured in table 12 below:

Table 15: Solution to climate change: No till planting

What was foregrounded? Know & aware	Links	Comments
No Till Planting	Drought & erosion	"*What is done on the farms now, especially in Msinga Top where we are now, our cooperative has done away with this thing of tilling the soil and we are using the system which is called "the no till planting…"(P6, prelim interview 1, Nov 2016)* "*The idea is to keep the top of the soil covered, so that whether wind, heat, the sun or drought none of them will have that much effect on the soil. Because with the top that is a little bit tightened, it will allow the root to penetrate and fetch the water which has been absorbed by the top of the soil. So even if there is drought, the plants won't be affected that much because of a number of residues on top of the soil. So that is the change that we have adopted, that we are now trying and it does help to keep the soil covered" (P6, prelim interview 1, Nov 2016).* *"..Yes. You know tilling the soil for planting causes erosion and the eh erosion washes away the soil nutrients. So now we no longer till the soil before planting (p6, prelim interview 1, Nov 2016).*

As can be seen from the above table, **no till planting** was developed as solution to climatic events such as drought and erosion. The idea behind this solution "***is to keep the top of the soil covered, so that whether wind, heat, the sun or drought none of them will have that much effect on the soil. Because with the top that is a little bit tightened it will allow the root to penetrate and fetch the water which has been absorbed by the top of the soil***". The participants went on to explain that ***"tilling the soil for planting causes erosion and erosion washes away the soil nutrients".***

5.6.2 Sustainable farming

The participants stated that they employ a sustainable farming approach which is likened to shifting cultivation as a solution to climate change. Though the participants highlighted that leaving out one parcel of land was for ritual purposes**,** they however clarified that the field replenished all the soil nutrients within that year because it was left fallow for a year.

Shifting cultivation is a farming method whereby certain portions of the land/farm are left uncultivated (fallow) for one farming season or more to enable it replenish or regain its soil nutrients/fertility (Mertz et al., 2008). According to Mertz et al. (2008), this method of farming is widely adopted by farmers in tropical regions of Africa, America and Asia. It is clear that the participants were practising shifting cultivation without recognizing it.

Table 16: Solution to climate change: Sustainable farming

What was foregrounded? Know & Aware	**Links**	**Comments**
Sustainable farming	Shifting cultivation	"*People used to go out and plant and they leave one field for the ritual purposes and after that, when you plough or plant in that field the next year you find out that the yield will be enormous. Because the field was left for one year so it replenished all the soil nutrients with that year". (P2. prelim interview 1, Nov 2016).*

As indicated in the above except, living out certain portions of the filed/farm is a solution to **climate change.** The data further shows that this method of ***shifting cultivation*** also increases productivity. P2 specifically stated that when ***you plough or plant in that field the next year you find out that the yield will be enormous.***

5.6.3 Contour Ploughing

Still on the ***solution to climate change***, the analysis revealed that the participants employ the method of ***contour ploughing*** to prevent water from washing away their seeds/crops. The views of the participants are presented in table 14 below.

Table 17: Solution to climate change: Contour Ploughing

What was foregrounded? Know & Aware	Links	Comments
Contour Ploughing	Flood Control	*"When the oxen were used, not the tractors, they use to keep the areas which have got hedges in between; you know here you plant the upper part of the land, and then you leave the middle one, so that when the swale comes, it compacts on that part and when the water comes, it doesn't penetrate, the land or wash away the soil that has been blocked by this hedge and at the end of the field, there is going to be some trenches that are dug. So that when the water comes, it will go through the trenches to the duggers (holes) and it will not destroy the whole land" (P4, prelim interview 1, November 2016).* *"The idea here is, is not even an idea, is a comment, we have observed the commercial farmers. The commercial farmers when the plough their farms, they don't plough the land in a straight line, they go zigzag and that is called the contour and now we realize that they are also preventing the same thing to happen so that when the water comes it doesn't go in a straight line, but it is going to be barred by these contours" (P6, prelim interview 1, November 2016).* *"….you know here you plant the upper part of the land, and then you leave the middle one, so that when the swale comes, it compacts on that part and when the water comes, it doesn't penetrate, the land or wash away the soil that has been blocked by this hedge and at the end of the field, there is going to be some trenches that are dug. So that when the water comes, it will go through the trenches to the duggers (holes) and it will not destroy the whole land/field and crops" (P4, prelim interview 1, November 2016).*

As indicated in the above table, contour ploughing is one of the solutions to climate change that were developed by the participants. P4 from preliminary interview two, indicated that they ploughed their field in a pattern that does not allow water to flow easily through the field. This is done by using ***oxen to create hedges and pathways for water to flow*** in a zigzag pattern instead of flowing in a straight line. Through this process, the participants were able to control erosion and floods in their field.

5.6.4 Rituals

Again, the participants stated that they **invite experts** to perform certain rituals for protection against climate events like thunderstorm. The views of the farmers with respect to **rituals** as **solution to climate change** are presented in the table below:

Table 18: Solution to climate change: Rituals

What was foregrounded? Know & Aware	Links	Comments
Rituals	Protection of lives & livestock	*When such conditions occur a day before, there were people with expertise of knowing how to tie the knots on the grass. You have to call them to tie the knots. So that is a way of stopping or preventing the disaster from happening again" (p2, prelim interview 1, Nov, 2016).*

As can be seen from the foregoing analysis, the participants developed several **solutions to climate change** depending on the climatic event. These **solutions** were used to explain their awareness and knowledge of climate. Ranging from **no till planting in** order to control erosion and drought to **rituals** for protection of lives and properties from disaster; this implies that the farmers are knowledgeable about climate change and corresponding adaptation. These findings validate the result of the qualitative data which shows that 68.6% of the respondents were aware and knowledgeable about climate change.

5. 7 SOURCES OF INFORMATION AND KNOWLEDGE OF CLIMATE CHANGE

While the participants were responding to questions relating to their awareness and knowledge of climate change, it became imperative to probe for the source of their knowledge of climate change as this will have a huge influence on their becoming aware of climate change. The data that emerged from the questions relating to the source of awareness and knowledge was analysed using descriptive analysis with the aid of SPSS. Afterwards, the data was analysed thematically by way of content analysis. The result of the analysis shows that 64.7% accessed climate change information through electronic media. The radio accounted for the highest percentage with 41.2% (14) followed by television 20% (8). Workshops accounted for 12.5% (5) while newspapers were 10% (4). The least source of information and knowledge about climate change was family and friends with 7.5% (3). Based on the above result, it is evident that the electronic media is the dominant source of information about climate change. The data is summarized in the table below.

Table 19: Source of knowledge and information about climate change

Source of knowledge and information	Frequency	Percent	Cumulative Percent
Radio	14	41.2	41.2
Television	8	23.5	64.7
Newspaper	4	11.8	76.5
Workshop	5	14.7	91.2
Family & Friends	3	8.8	100.0
Total	34	100.0	
Missing	6		
Total	40		

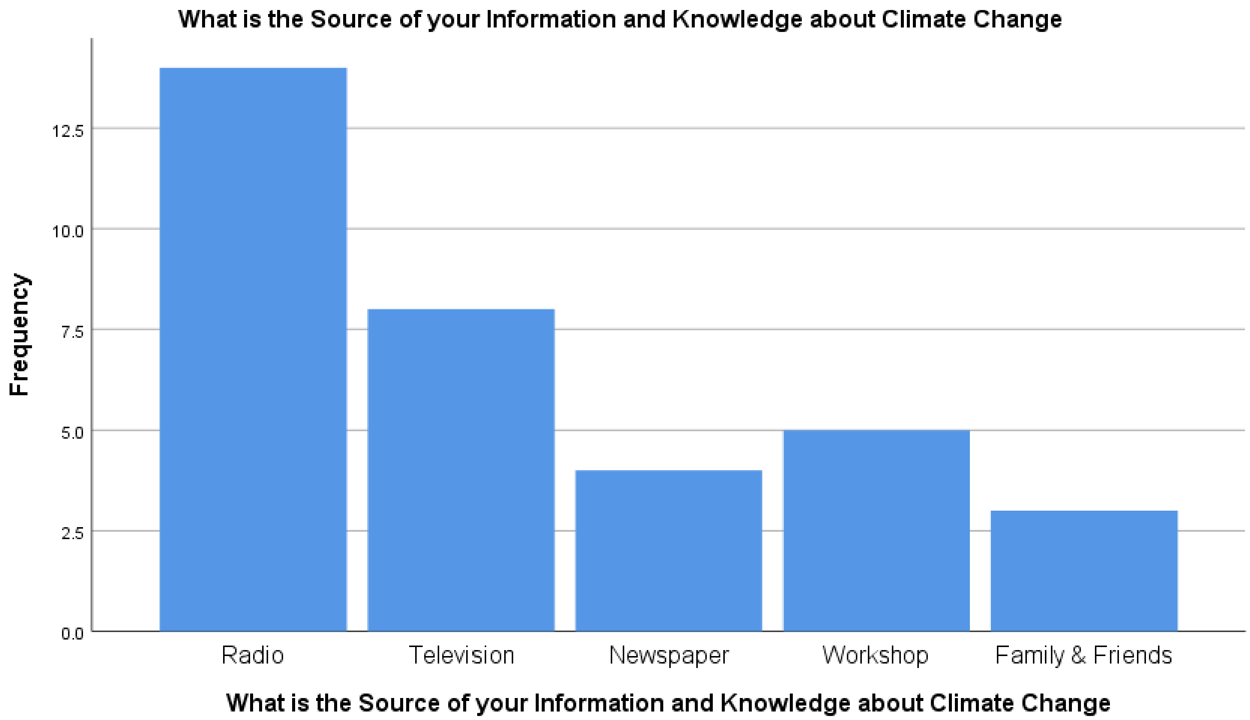

Figure 12: **Source of knowledge and information about climate change**

It is worth noting that the result of the quantitative analysis as per source of knowledge and awareness matches that of the qualitative data. Most of the participants that took part in the focus group discussions commented that they heard about climate change from the radio. Therefore, it can be said that the electronic media, radio and television to be specific, were the main source of knowledge and awareness of climate change. Other sources of information and knowledge of climate change identified by the participants are workshops and meetings. These views are captured in the excerpt below.

Table 20: Source of knowledge and awareness of climate change

Aware & Know	Source of Awareness & Knowledge
Radio	*"I heard about climate change from the radio" (P5, prelim interview 3, July 2017).* *"I also heard about it from the radio" (P6, prelim Interview 3, July, 2017).* *"We've heard on the radio when they alert us about the weather. There is nothing else we know" (P11, prelim interview 3, July 2017).*
Television	*"I saw a heavy rain on TV and people were drowning. We also experience heavy rains here oThukela as well" (P8, prelim interview 3, July 2018).*
Workshop	*I heard about climate change from a workshop which took place in Sedabe. They took us here to teach us about climate change and a lot of things related to it and weather conditions". (P8, prelim interview 3 June, 2018).* *"Commercial famers do come to us and host workshops where they inform us about climate change and they tell us the different methods of planting crops". (prelim interview 3, June 2018).*

As evident in the quotes above, the electronic media, radio to be specific, was the participants' main source of acquiring information (knowledge) and awareness of climate change. Another participant linked the source of his knowledge of climate change to the television. These findings resonate with the findings of studies done elsewhere on the source of knowledge and information about climate change. According to Boykoff (2008), the mass media such as radio, television, newspapers and the Internet has been at the forefront of climate change awareness and information dissemination in western societies. Similarly, a study piloted by Elia (2013) revealed that smallholder farmers in Tanzania are of the view that extension officers are unreliable in terms of information dissemination, hence they are inclined to depend more on mass media to access information on climate change and variability. In this regard, Boykoff (2008) concludes that the mass media are critical elements in public understanding and engagement with climate change.

5.8 CONCLUSION

The result of the preliminary research one question offered insight into the demographics of MSFs and their awareness and knowledge of climate change. Based on the quantitative and qualitative data presented above, it is evident that participants have a high level of knowledge and awareness of climate change. The result of quantitative analysis showed that 68.6% possess above average level of awareness and knowledge about climate change. As earlier indicated, this figure represents more than half the total population. Similarly, the findings from the qualitative data confirmed that the participants are aware and knowledge about climate change. Their awareness and knowledge were linked to their personal experiences of climate change in their localities. Drawing from the data that emerged, four categories of description (see section 5.3-5.6) were elicited with respect to awareness and knowledge of climate change. These are evidence of climate change, causes of climate change, effects of climate change, and solutions to climate change. With respect to the first category, evidence of climate change, the farmers linked climate change to drought and extreme condition. They stated that the continuous rise in temperature due to the sun was as a result of climate change. The participants also linked extreme conditions such as hailstorm, lightning and wind to climate change. Moving forward, the analysis revealed two main causes of climate change. These are *dust/dirt* and *human activities* such as exhaust fumes from cars.

In terms of the effects of climate change (category three) on the agricultural activities of MSFs, the analysis revealed that climate change had a very destructive effect on the livelihood of MSFs. Apart from the destruction in their farms, the participants stated that climate change is a major cause of death as a result of lighting and thunder storm. Nonetheless, this chapter revealed that MSFs employ various adaptation strategies (solutions) in their farming activities. This was categorised as solutions to climate change. Under this category of description, the analysis showed the participants have very advanced mitigation and adaptation strategies. Those adaptation include no till planting, sustainable farming, contour ploughing and rituals. *No till planting* and *contour ploughing* strategies enabled the farmers to control or manage erosion/flood in their farms while sustainable farming in the form of shifting cultivation ensured that soil nutrients are replenished before the land can be cultivated again. When considered approppprately, it can be said that MSFs possesss a vast knowledge of climate change adapatation (solutions to climate change) and hence these knowledge forms should be accorded a space in contemprorly adapatation policies and programmes.

CHAPTER SIX

PRELIMINARY STUDY

EXPLORING IN-SERVCE EXTENSION PRACTITIONERS' KNOWLEDGE AND LEVEL OF PREPAREDNESS TO DELIVER EXTENSION SERVICES RELATED TO CLIMATE CHANGE TO END-USERS

INTRODUCTION

The previous chapter presented the analysis based on awareness, knowledge and effect of climate change on Msinga smallholder farmers. The data was generated by means of questionnaires and three focus group interviews in line with the tradition of mixed method. The analysis was guided by Sustainable Livelihood Approaches (SLA). This chapter presents a detailed analysis of the data generated based on the knowledge and level of preparedness of extension practitioners to offer extension services related to climate change in rural context. The data analysis was guided by the following question:

- *Are in-service agricultural extension practitioners in rural contexts adequately trained to offers extension services related to climate change adaptation to smallholder farmers?*
  - i. *What is the level of education and training of extension practitioners?*
  - ii. *Does their education and training expose these extension practitioners to knowledge of climate change?*
  - iii. *How do the extension practitioners rate their competency level in disseminating climate change information?*

A total of 17 agricultural extension practitioner in Msinga Local Municipality completed the closed-ended questionnaires. The analysis is presented below, starting with the biographical statistics of the participants.

6. 1 BIOGRAPHICAL STATISTICS

The following section presents the biographical statistics of the participants.

6.1.1 Gender of respondents

A total of ten out of the 17 participants that completed the questionnaires are males. This represents 58.8% of the sampled population. On the other hand, 7 participants out of the 17 participants are females. This makes up 41.2% of the total population. This information is represented in the table and graph below.

Table 21 Gender of participants

Gender	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Male	10	58.8	58.8	58.8
Female	7	41.2	41.2	100.0
Total	17	100.0	100.0	

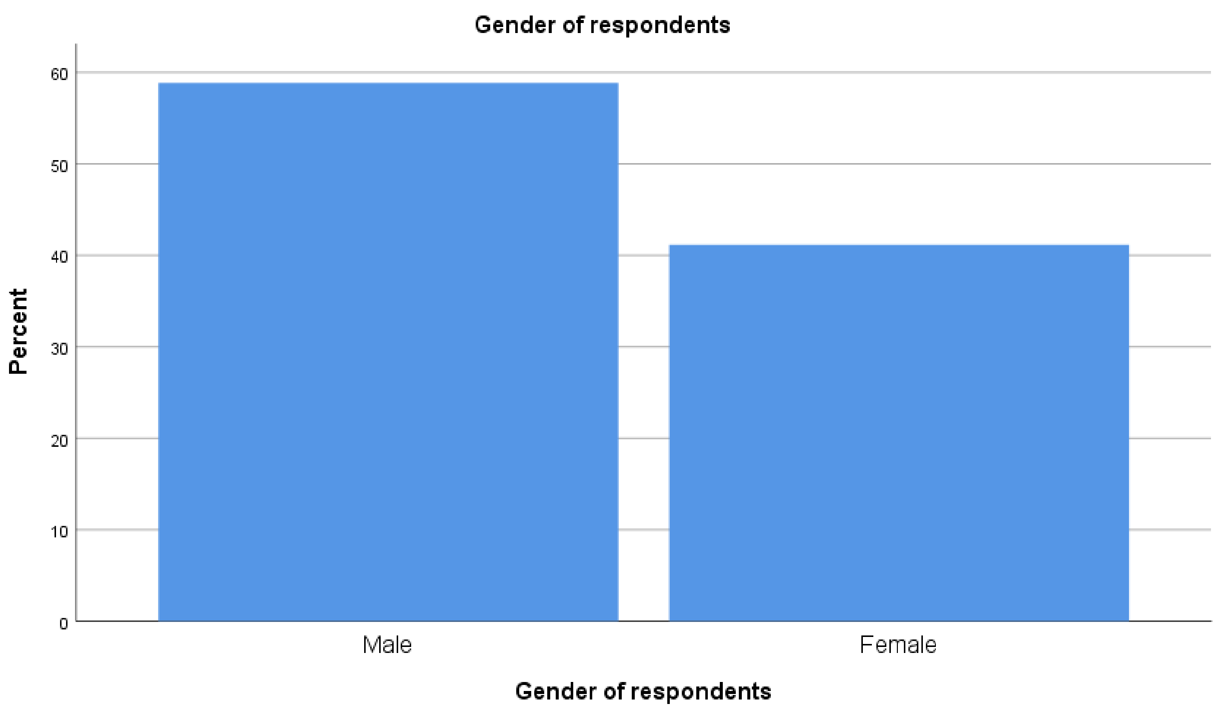

Figure 13: **Gender of participants**

6.1.2 Age of respondents

The participants were grouped into four age groups, namely, 31-40 years, 41-50 years, 51-60 years and 51-60 years. The result shows that all the participants' age falls under these age bracket, that is, 31-60 years. This is shown in the table below.

Table 22: Age of participants

Age Group	Frequency	Percent	Valid Percent	Cumulative Percent
31-40	7	41.2	41.2	41.2
41-50	5	29.4	29.4	70.6
51-60	5	29.4	29.4	100.0
Total	17	100.0	100.0	

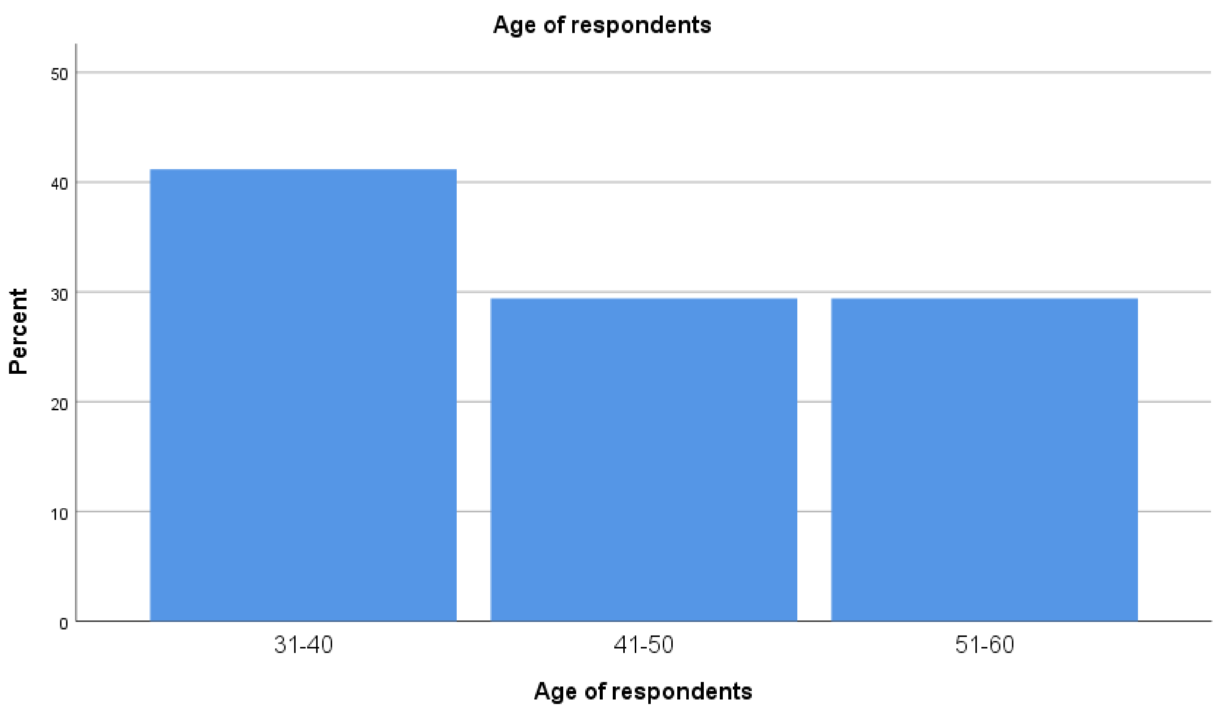

Figure 14: Age of participants

6.1.3 Education level of participants

The level of education of the respondents is presented in table 7.3 below. According to the data, seven out of the 17 participants studied to the level of diploma. This figure represents 41.2% of the total population. 17.6% of the sampled population have degrees. Equally, 17.6% of the participants have matric as their highest level of qualification. 11.8% of the participants have a higher certificate while 5.9% (one of 17 participants) have a postgraduate certificate. 5.9% (one of the 17 participants) of the population did not make any selection with respect to the level of education. Evidently, a diploma is the most frequent qualification of the participants. This was followed by degree and matric. Both qualifications have equal number of participants as their highest qualification. Only one of the participants possesses a postgraduate degree certificate. The analysis is presented in the table and graph below.

Table 23: Level of education of participants

Level of Qualification	Frequency	Percent	Valid Percent	Cumulative Percent
No selection	1	5.9	5.9	5.9
Matric	3	17.6	17.6	23.5
Higher Certificate	2	11.8	11.8	64.7
National Diploma	7	41.2	41.2	76.5
Degree	3	17.6	17.6	94.1
Postgraduate Degree	1	5.9	5.9	100.0
Total	17	100.0	100.0	

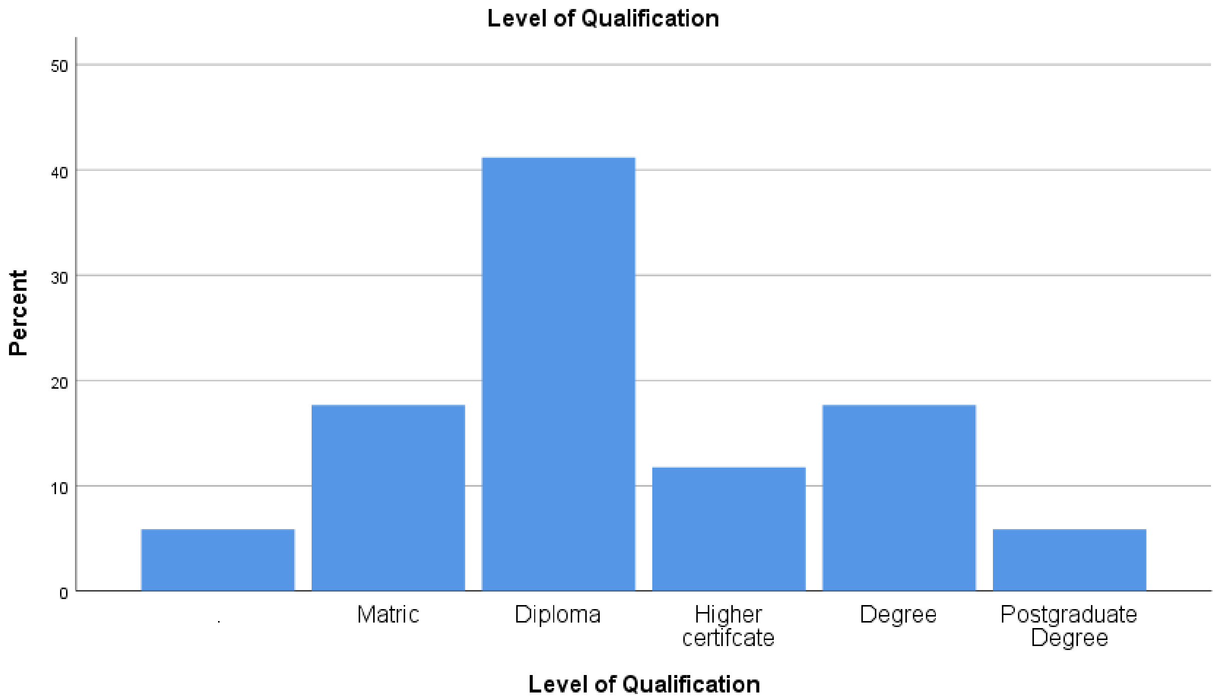

Figure 15: **Level of education of participants**

6.1.3 Area of specialisation of participants

It was assumed that all the participants specialised in agricultural extension, given that they are practising as extension advisors. However, the data revealed that some of the participants did not specialise in agricultural extension, though the majority did. The analysis revealed that 88.2% (1five out of 17) of the participants specialised in agricultural extension. 5.9% of the sample (one of 17) specialised in livestock production while 5.9% (one of 17) specialised in animal science.

Table 24: Area of specialisation of participants

Area of Specialisation	Frequency	Percent	Valid Percent	Cumulative Percent
Agricultural extension	15	88.2	88.2	88.2
Livestock production	1	5.9	5.9	94.1
Animal science	1	5.9	5.9	100.0
Total	17	100.0	100.0	

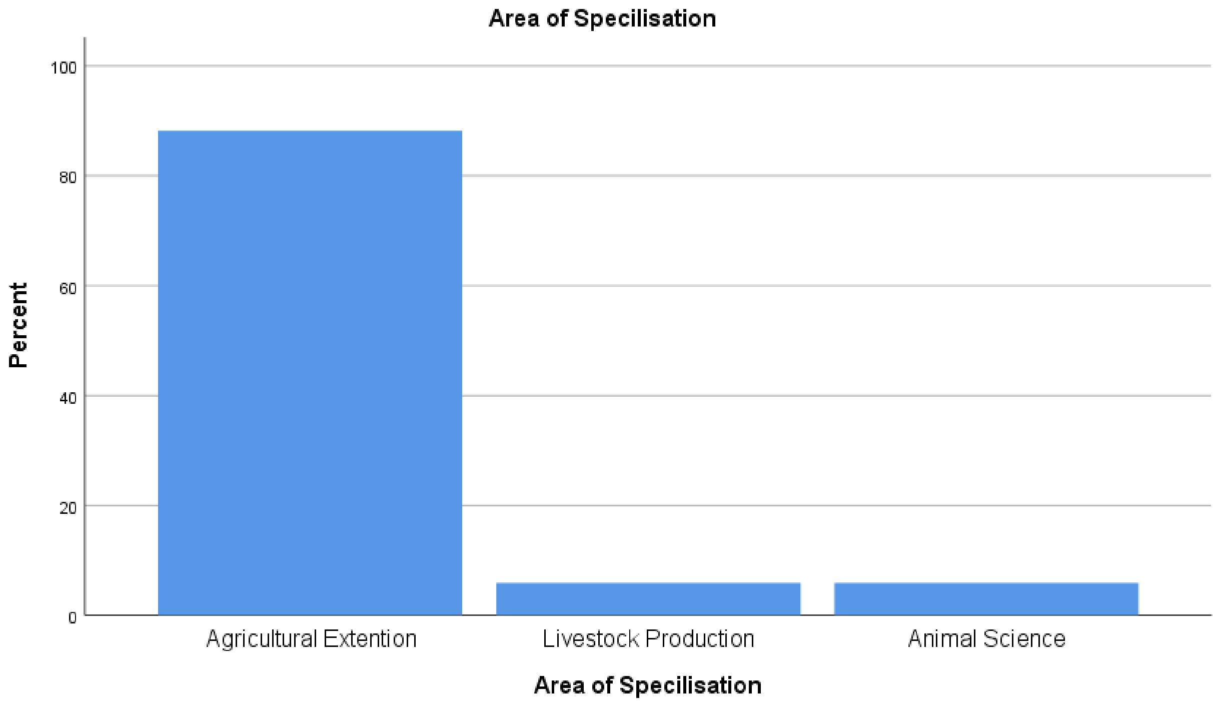

Figure 16: Area of specialisation of participants

6.1.4 Years of work experience of participants

The number of years of experiences were grouped into six categories, namely, 1-5 years, 6-10 years, 11-15 years, 15-20 years, 21-25 years, 25-30 years and > 30 years (30 years and beyond). The analysis shows that 17.6% (three out of 17) of the participants have between 1 to 5 years of experience in extension. Similarly, 17.6% (three out of 17) have 6-10 years' work experience. The same percentage 17.6% (three out of 17) were obtained for participants with 16-20 as well as those with 21-25 years of experiences. 11.8% (two out of 17) of the sampled population possess 26-30 years of experience in extension services. Equally, 11.8% (two out of 17) of the sampled population have >30 years (more than 30) work experience. The participants with 11-15 years of experience are much fewer. Only 5.9% (one of 17) of the population have 11-15 years of experience in extension as shown below.

Table 25: Years of experience in extension

Years of Experience	Frequency	Percent	Valid Percent	Cumulative Percent
1-5	3	17.6	17.6	17.6
6-10	3	17.6	17.6	35.3
11-15	1	5.9	5.9	41.2
16-20	3	17.6	17.6	58.8
21-25	3	17.6	17.6	76.5
26-30	2	11.8	11.8	88.2
>30	2	11.8	11.8	100.0
Total	17	100.0	100.0	

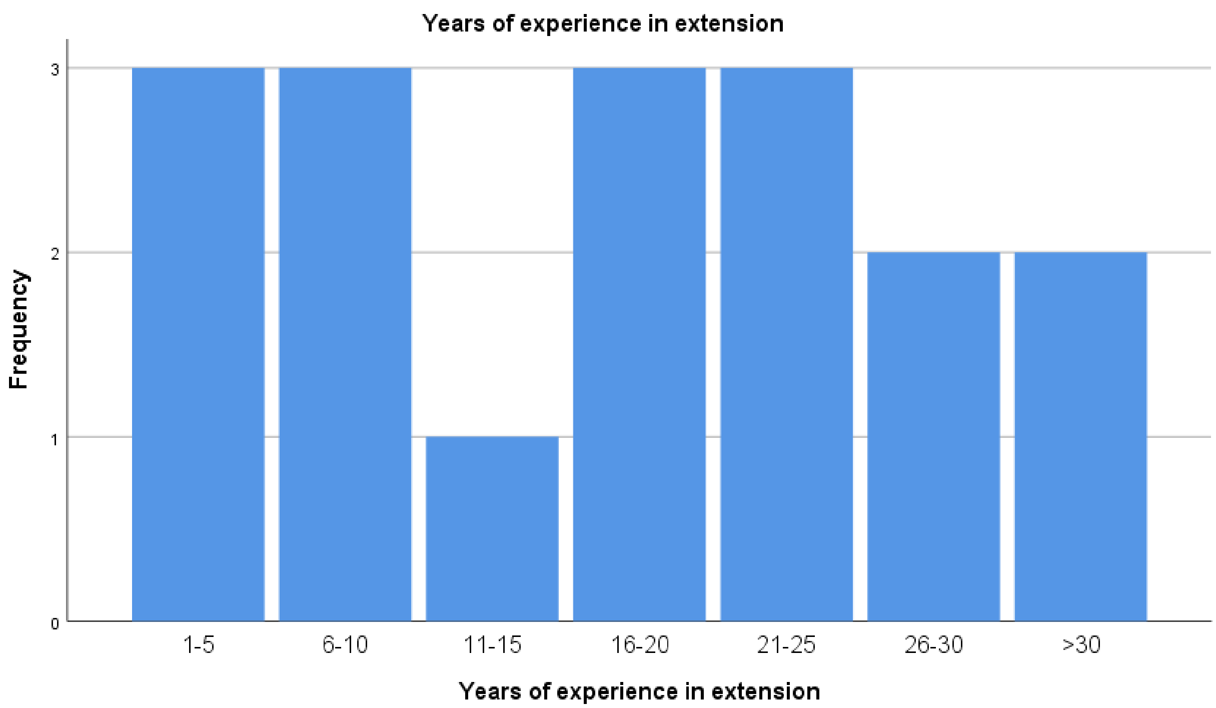

Figure 17 Years of experience in extension

6.1.5 Agricultural audience serviced by extension practitioners

With respect to the agricultural audience serviced by the extension practitioners, 70.6% (1two out of 17) of the sampled population stated that their services are rendered to smallholder farmers. On the other hand, 11.8% of the sample agreed that they service commercial farmers, while 17.6% did not address the question.

Table 26: Which agricultural audience/group do you service?

Clientele	Frequency	Percent	Valid Percent	Cumulative Percent
No Selection	3	17.6	17.6	17.6
Smallholder Farmers	12	70.6	70.6	88.2
Commercial Farmers	2	11.8	11.8	100.0
Total	17	100.0	100.0	

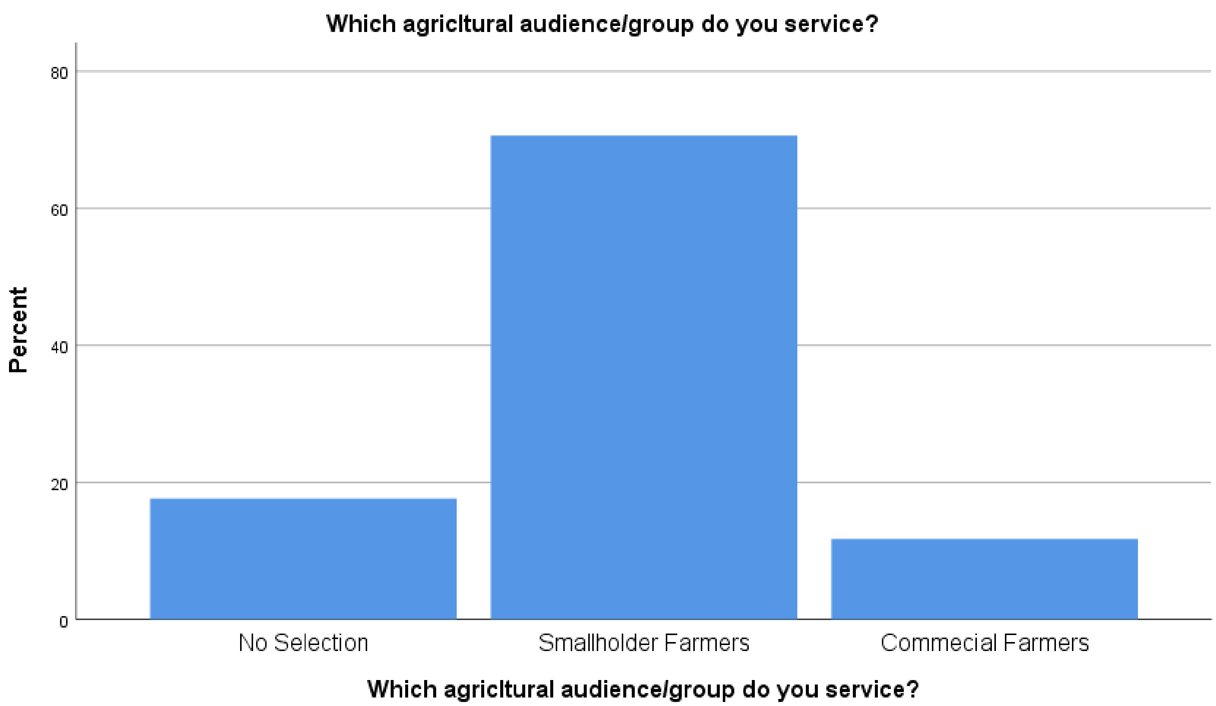

Figure 18: Clientele of the participants

6.2 CLIMATE CHANGE EVENTS AND EFFECTS ON AGRICULTURE

The following section presents the result of quantitative questions that were designed to ascertain the participants' views and experiences of climatic events such as floods, temperature increase, drought and hailstorm in Msinga. Also, the questionnaire sought to explore the effects of such events on agricultural activities/livelihoods of Msinga smallholder farmers.

6.2.1 Participants' views on temperature in their area of work

The majority of the participants indicated that there has been an increase in temperature in their area of work, which in this case is Msinga Local Municipality. A total of 1one of the 17 participants indicated that there has been an increase in temperature in Msinga area. This figure represents 64.7% of the entire population. 5.9% (one of 17) indicated that the temperature in the area has decreased while 29.4% (five out of 17) stated that they were unsure if the temperature has increased or decreased. Looking at this data, it is clear that most of the participants (agricultural extension practitioners) believe that there has been an increase in temperature in their area of work. This confirms the assertion of the smallholder farmers in Chapter 6 of this study. The farmers suggested that there has been an increase in temperature in their locality.

Table 27: Participants' views on temperature in their area

views on Temperature	Frequency	Percent	Valid Percent	Cumulative Percent
Increased	11	64.7	64.7	64.7
Decreased	1	5.9	5.9	70.6
Unsure	5	29.4	29.4	100.0
Total	17	100.0	100.0	

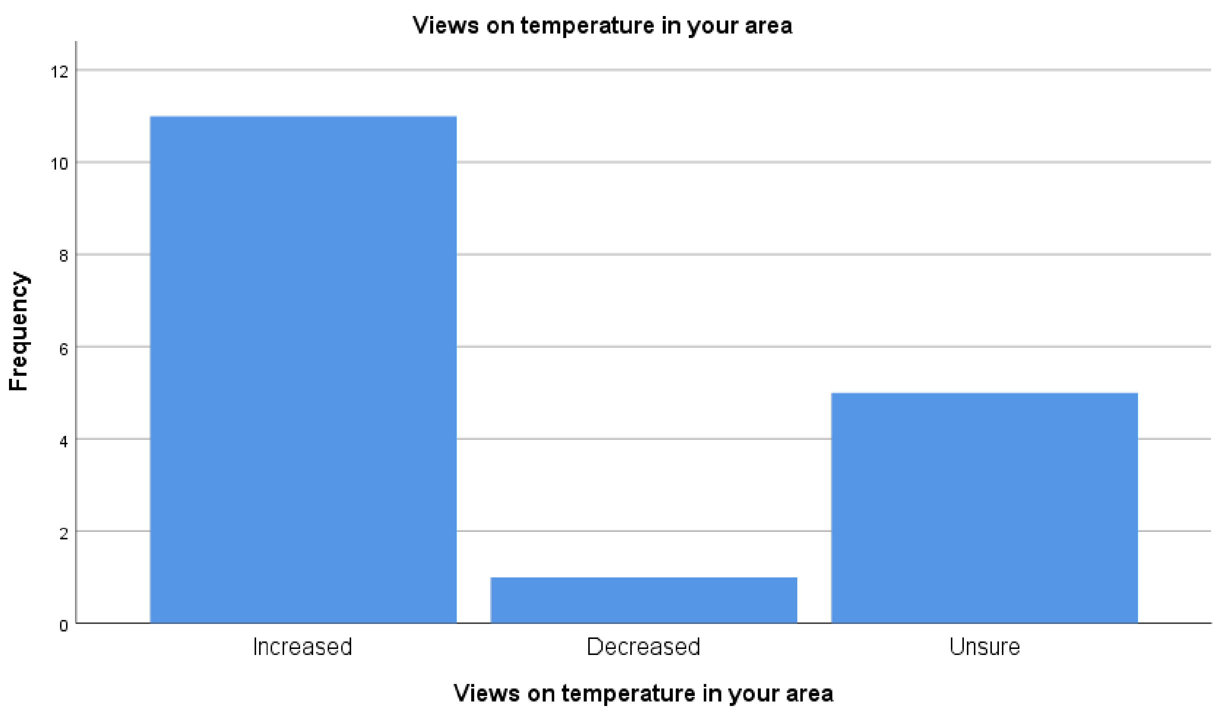

Figure 19: Participants' views on temperature in their area of work

6.2.2 Participants' views on the severity of drought in their area of work

The analysis shows that 58.8% (ten out of 17) of the sampled population confirmed that the severity of drought in their area is on the increase. 11.8% (two out of 17) of the participants were of the view that the severity of drought has decreased while another 11.8% (two out of 7) suggested that drought severity is constant. On the other hand, 17.6% (three out of 17) of the participants indicated that they are unsure of the status of drought in their area of work.

Table 28: Severity of drought in your area

Severity of drought in your area				
Severity of drought	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Increased	10	58.8	58.8	58.8
Constant	2	11.8	11.8	70.6
Decreased	2	11.8	11.8	82.4
Unsure	3	17.6	17.6	100.0
Total	17	100.0	100.0	

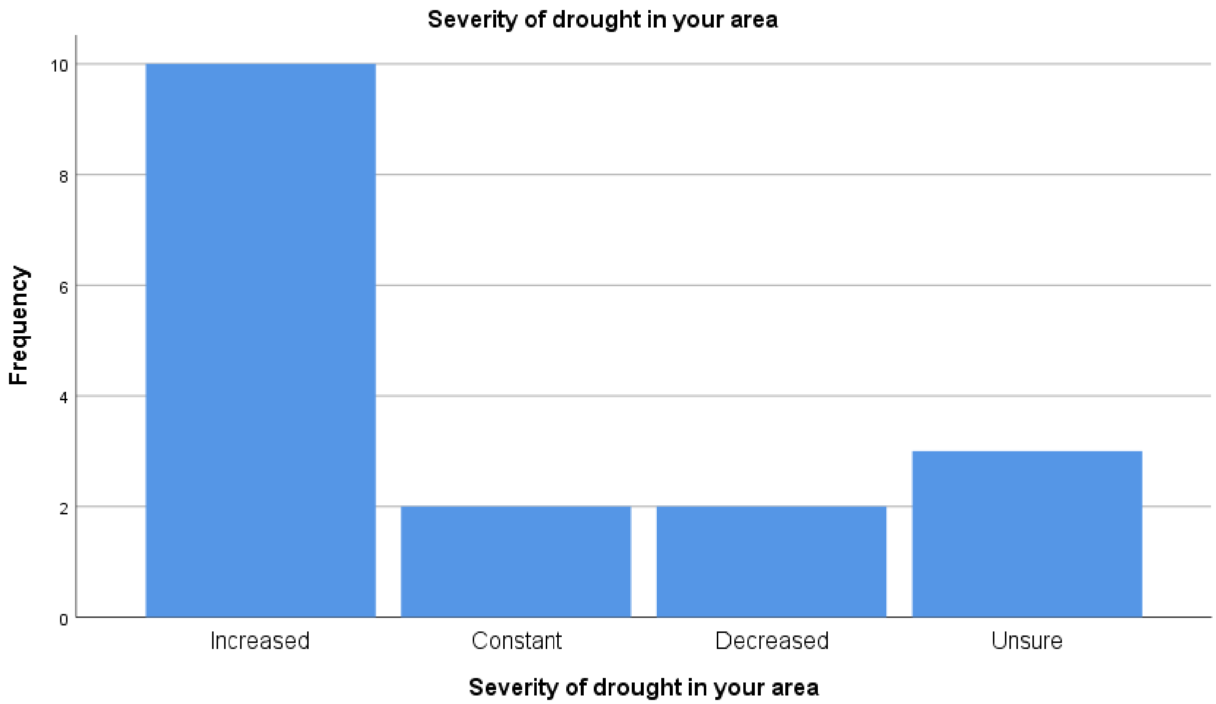

Figure 20: Severity of drought in their area of work

6.2.3 Participants' views on the severity of flood in their area of work

With respect to flood severity, 29.4% (five out of 17) of the sampled population indicated that the incidence of flood has increased in their place of work, that is, the Msinga Local Municipality. However, 35% (six out of 17) suggested that the severity of drought in Msinga is constant. This however does not mean that there is no more incidence of flood in the area. In contrast, 11.8% of the sampled population indicated that the severity of flood has reduced in their area. Lastly, 23.5% (four out of 17) stated that they were unsure of the status of drought in their area of work.

Table 29: Severity of flood in your area

Severity of Flood	Frequency	Percent	Valid Percent	Cumulative Percent
Increased	5	29.4	29.4	29.4
Constant	6	35.3	35.3	64.7
Decreased	2	11.8	11.8	76.5
Unsure	4	23.5	23.5	100.0
Total	17	100.0	100.0	

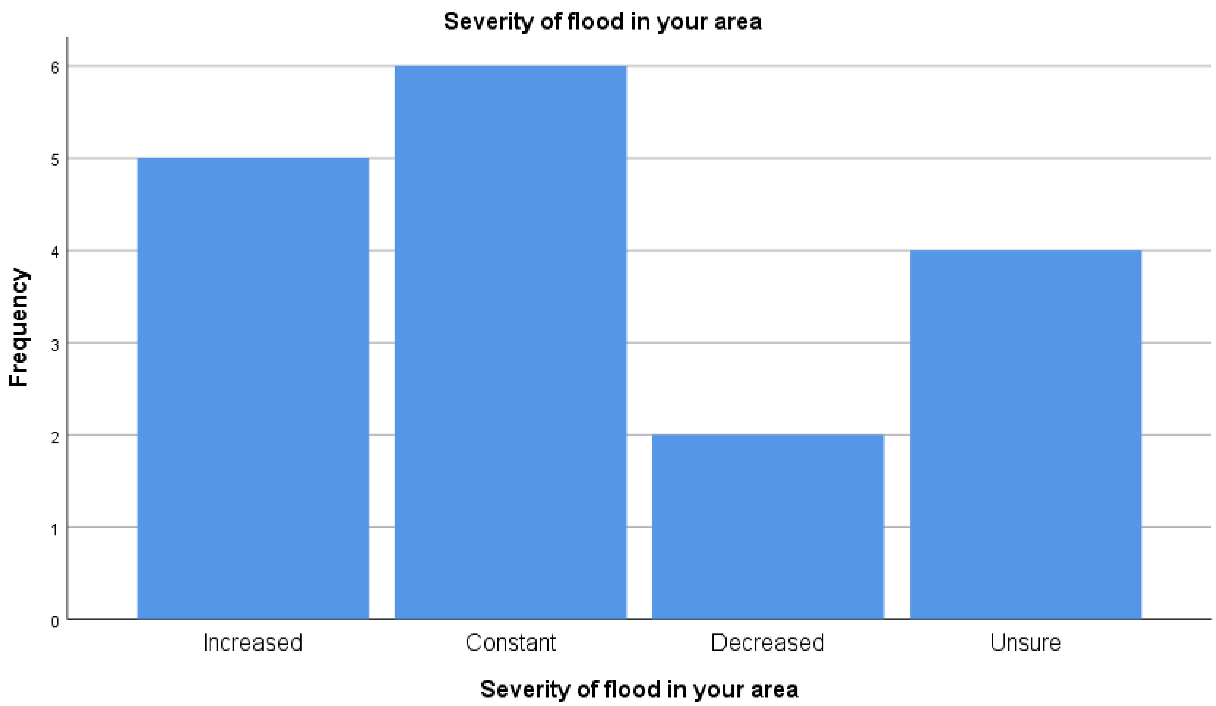

Figure 21: Severity of flood in the area of work

6.2.4 Participants' views on the severity of hailstorms in their area of work

A total of 29.4% (five out of 17) of the sampled population are of the view that harshness of hailstorm in Msinga Local Municipality has risen. 41.2% (seven out of 17) of the participants suggest that the incidence of hailstorms is constant while 23.5% (four out of 17) stated that the harshness of hailstorms is decreasing. 5.9% (one of 17) indicated that they were unsure if the severity of hailstorm is increasing, constant or decreasing.

Table 30: Severity of hailstorm in your area

Severity of Hailstorm	Frequency	Percent	Valid Percent	Cumulative Percent
Increased	5	29.4	29.4	29.4
Constant	7	41.2	41.2	70.6
Decreased	4	23.5	23.5	94.1
Unsure	1	5.9	5.9	100.0
Total	17	100.0	100.0	

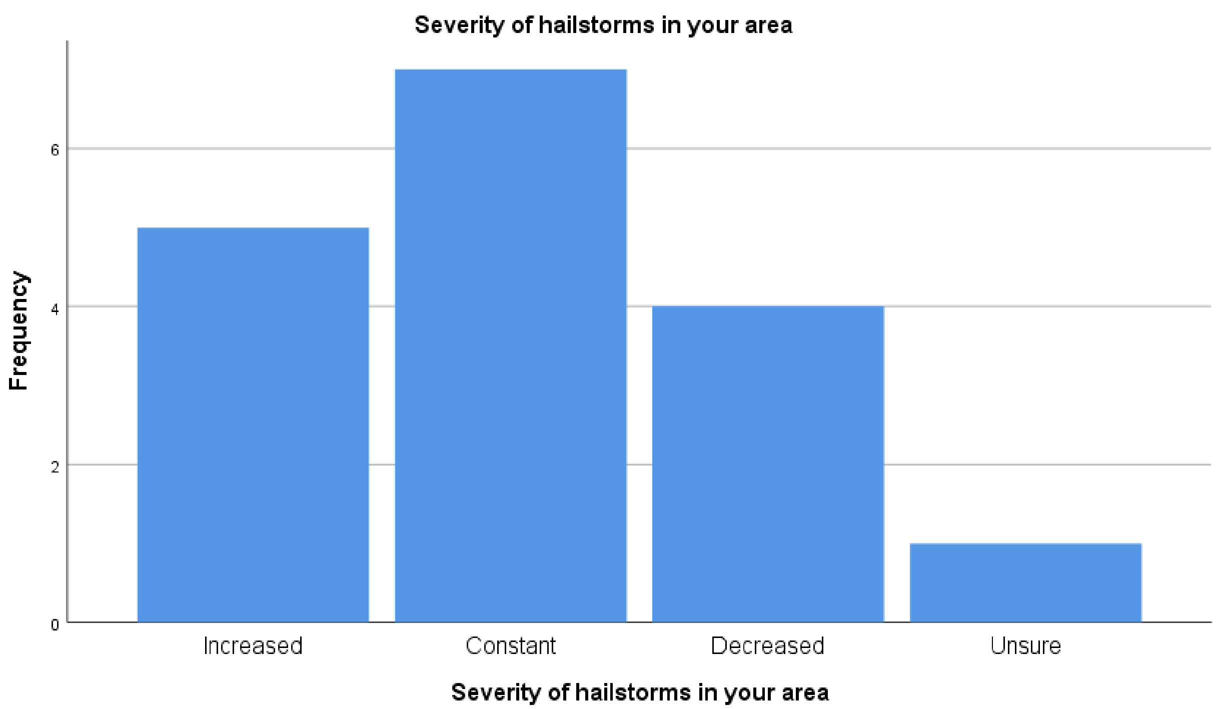

Figure 22: Severity of hailstorms in the area

6.2.5 Participants' views on livestock diseases in their area of work

Given the climate events such as drought, etc. are rampant in Msinga Local Municipality, this aspect of the questionnaire sought to understand (from the perspective of extension practitioners) the effect of such climate events on the agricultural activities and livelihoods of smallholder farmers. The analysis shows that 58.8% (ten out of 17) of the sample believe that livestock diseases has increased in Msinga. 11.8% (two out of 17) of the sample indicated that livestock disease in the past five to 10 years is constant while 23.5% (four out of 17) suggested that livestock diseases have decreased. 5.9% (5) of the sample indicated that they are unsure if livestock diseases have increased or not.

Clearly, the number of participants that suggested that livestock diseases are on the increase are higher (slightly more than half of the population) than those that think otherwise.

Table 31: Livestock diseases in the area over the last 5-10 years

Livestock Disease	Frequency	Percent	Valid Percent	Cumulative Percent
Increased	10	58.8	58.8	58.8
Constant	2	11.8	11.8	70.6
Decreased	4	23.5	23.5	94.1
Unsure	1	5.9	5.9	100.0
Total	17	100.0	100.0	

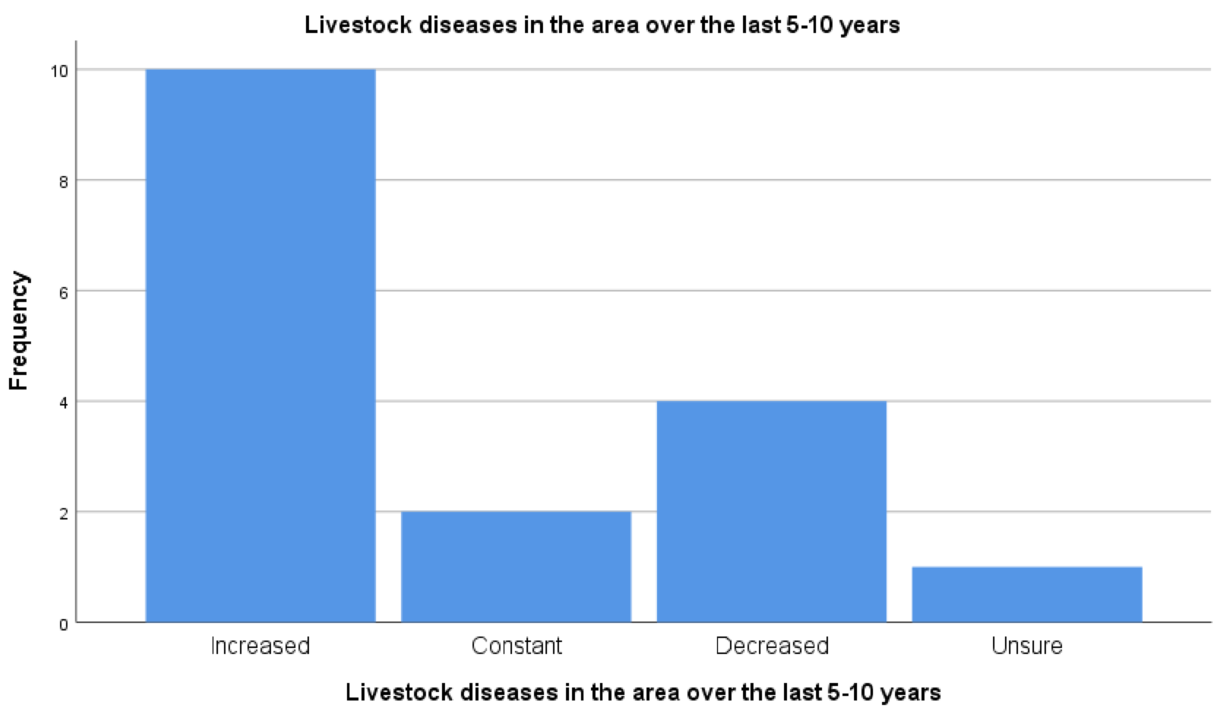

Figure 23: Livestock diseases in area of work over the last 5-10 years

6.2.6 Participants' views on crop failure in the area of work

A total of 47.1% (eight out of 17) of the population indicated that there has been an increase in crop failure. On the other hand, 23.5% (four out of 17) of the population are of the view that crop failures are decreasing. 11.8% suggests that crop failure is constant while 17.6% stated that they are unsure if crop failure has increased or decreased. The views of the participants are represented in the table and chart below

Table 32: Crop failure in the area over the last 5-10 years

Crop failure	Frequency	Percent	Valid Percent	Cumulative Percent
Increased	8	47.1	47.1	47.1
Constant	2	11.8	11.8	58.8
Decreased	4	23.5	23.5	82.4
Unsure	3	17.6	17.6	100.0
Total	17	100.0	100.0	

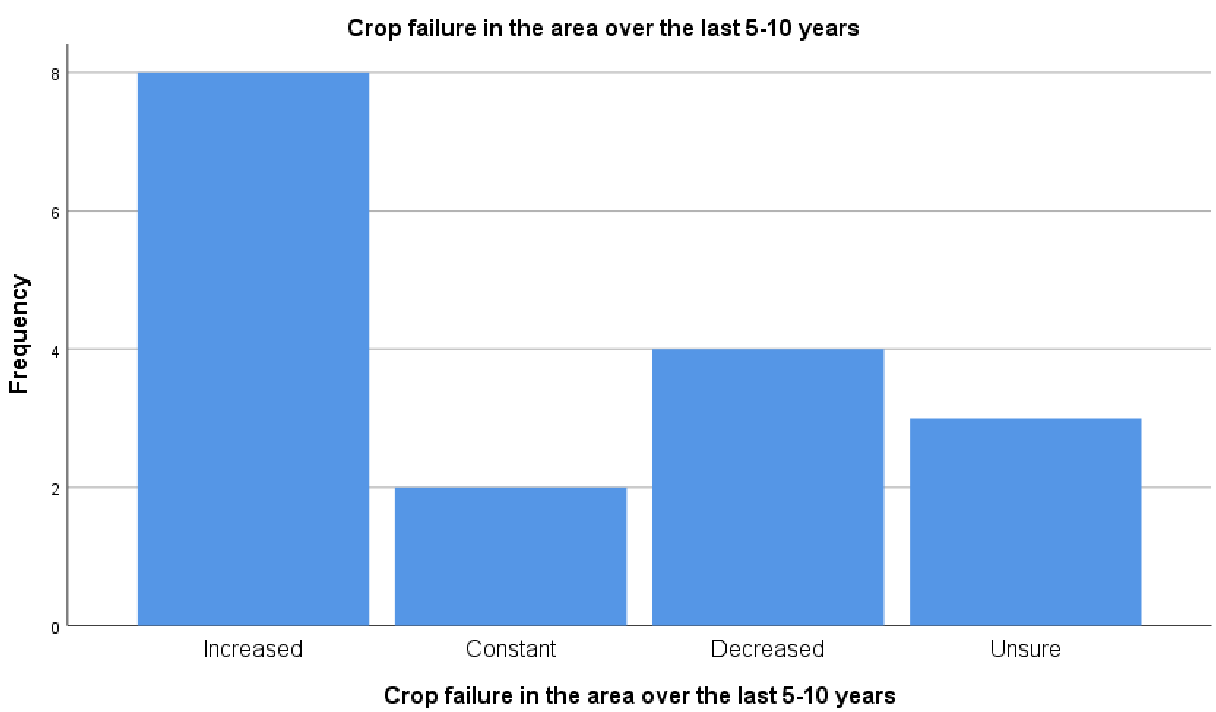

Figure 24: Crop failure in area of work over the last 5-10 years

6.2.7 Participants' views on incidents of hunger reported in their area of work over the last 5-10 years

A high proportion of the sampled population confirmed that incidents of hunger reported in their area of work is on the increase. A total of 64.7% (eleven of 17) of the population indicated that reports of hunger in their areas in the last five to 10 years has risen. This is in line with the views expressed by smallholder farmers and reported in Chapter six of this study. In contrast, 11.8% (two out of 17) suggested that incidents of hunger and disease is decreasing. Furthermore, 11. 8% (two out of 17) of the participants suggested that incidents of hunger and diseases reported in Msinga area in the last five to 10 years is constant. Equally, 11.8% of the population indicated that they are unsure whether the incident of hunger and disease in Msinga is on the increase, constant or reducing.

Table 33: Incidence of hunger and diseases reported in the area of over the last 5-10 years

Incidents of Hunger	Frequency	Percent	Valid Percent	Cumulative Percent
Increased	11	64.7	64.7	64.7
Constant	2	11.8	11.8	76.5
Decreased	2	11.8	11.8	88.2
Unsure	2	11.8	11.8	100.0
Total	17	100.0	100.0	

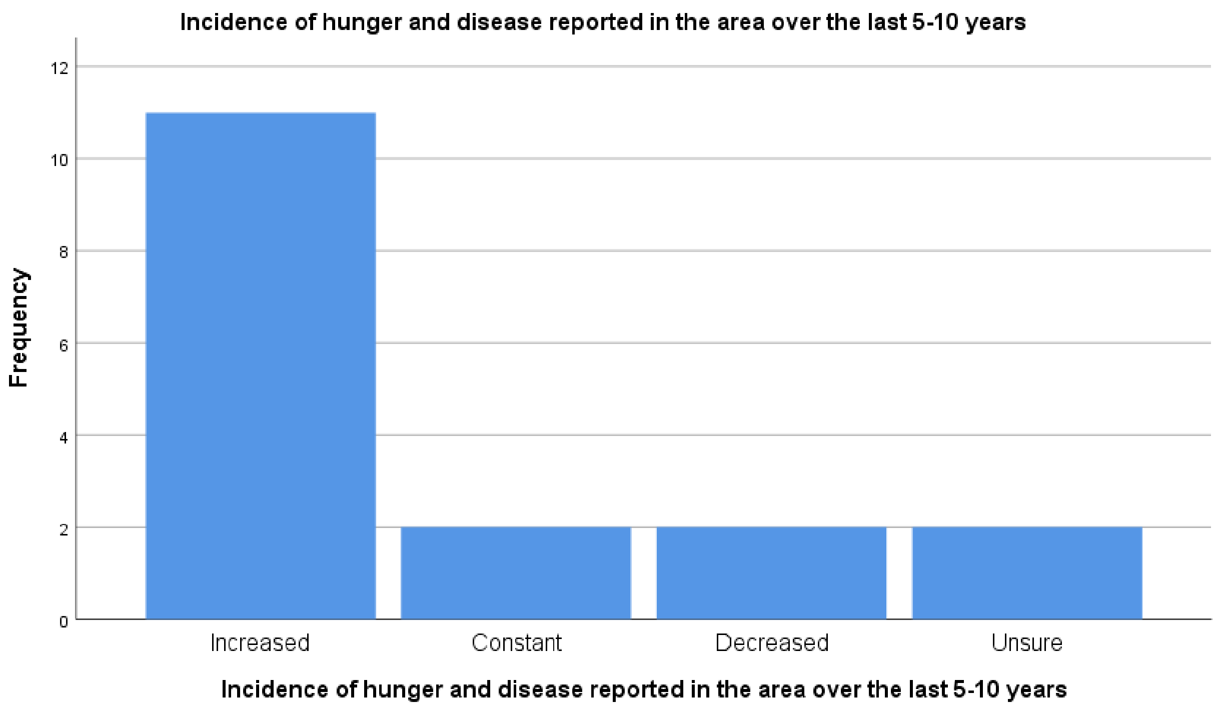

Figure 25: Incidence of hunger and disease reported in the area of work over the last 5-10 years

6.3 EXTENSION PRACTITIONERS' LEVEL OF PREPAREDNESS TO OFFER EXTENSION SERVICES RELATED TO CLIMATE CHANGE ADAPTATION TO SMALLHOLDER FARMERS

In this section, the results of quantitative questions which were designed to determine the level of preparedness of in-service extension practitioners to offer extension services related to climate change to end-users, in this case Msinga smallholder farmers. The questions asked in this section centred on the pre-service and in-service trainings received by the extension practitioners and level of competencies to deliver extension services. The analysis is guided by the following questions:

- *Are in-service agricultural extension practitioners in rural contexts adequately trained to offer extension services related to climate change adaptation to smallholder farmers?*
    i. *Does their education and training expose these extension practitioners to knowledge of climate change?*
    ii. *How do the extension practitioners rate their competency level in disseminating climate change information?*

6.3.1 Agricultural extension practitioners' knowledge/understanding on climate change

As shown in the table 7.14 below, only 5.9% (one out 17) of the sample indicated that their knowledge and understanding of climate change is excellent. 17.6% of the sample said their current knowledge or understanding of climate change is good. However, 58.8% (ten out of 17) of the sample agreed that their current knowledge/understanding of climate change is average. This figure represent more than half of the poulation. Lastly, 17.6% of the population acknowledged that their knowledge/undersatnding of climate change is poor. Interestingly, this finding concurs with some other studies on the knowledge of extension advisors about climate change, For example, a study piloted by Mberego and Sanga-Ngoie (2014) in Zimbabwe found that only one of the 20 extension advisors engaged in his study showed some level of knowledge about the climate change events such El-Niño and its relationship to drought.

Table 34: Current knowledge/understanding on climate change

Current knowledge	Frequency	Percent	Valid Percent	Cumulative Percent
Excellent	1	5.9	5.9	5.9
Good	3	17.6	17.6	23.5
Average	10	58.8	58.8	82.4
Poor	3	17.6	17.6	100.0
Total	17	100.0	100.0	

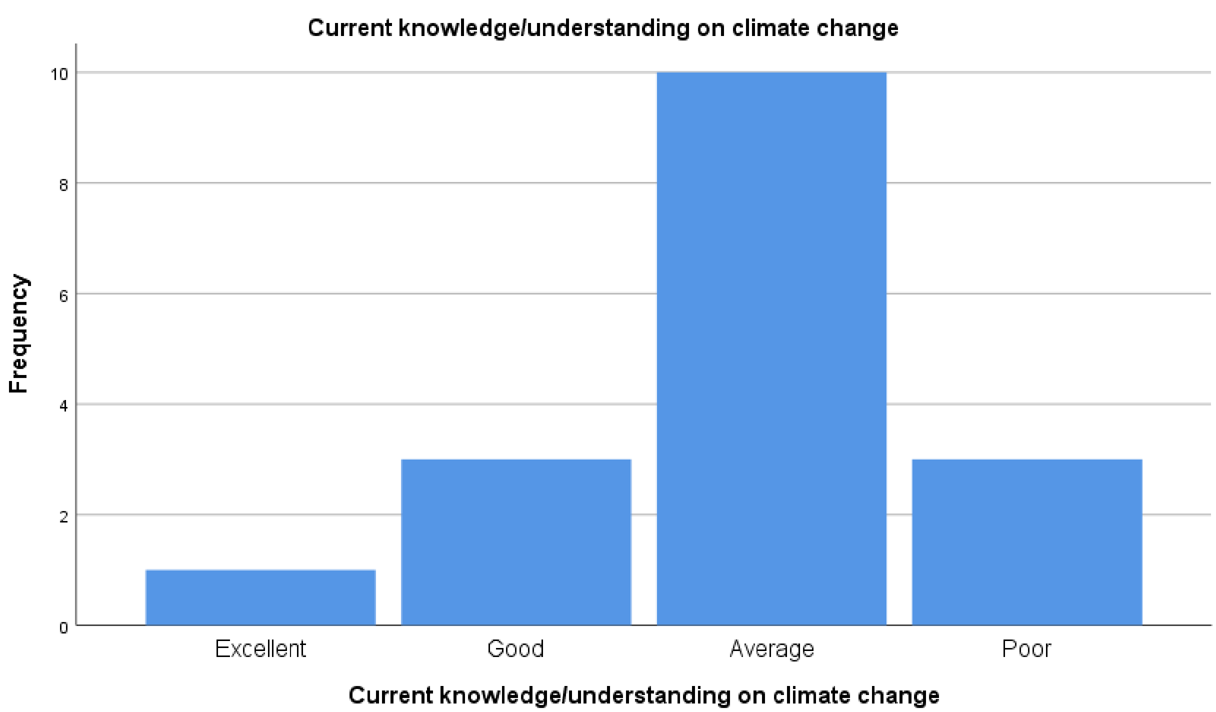

Figure 26: Current knowledge/understanding on climate change

6.3.2 Inclusion of climate change in the agricultural extension curriculum and training

Given the revelation that there are gaps in the curriculum and training of extension practitioners (Zikhali, 2016) in South Africa, this section sought to understand if climate change was included in the curriculum of the participants during their training. By implication, this section aimed to establish if the education and training received by these extension practitioners exposed them to knowledge of climate change.

The analysis shows that 58.8% (ten out of 17) indicated that climate change was not included in their curriculum. On the other hand, 29.4% agreed that climate change was covered or included in their curriculum during their training. 11.8% of the sample did not make any selection with respect to the above question. The number of participants that indicated that climate change was not included in their curriculum was much higher than those that acknowledged that climate change was included in their curriculum. This position was later confirmed by lecturers in the Agricultural Extension and Rural Development Department during the focus group. Hence, it can be argued that the education and training of many participants (58.8%) did not expose them to knowledge of climate change.

Table 35: Was climate change included/covered in your extension curriculum/training?

Extension Curriculum/Training	Frequency	Percent	Valid Percent	Cumulative Percent
No Selection	2	11.8	11.8	11.8
Yes	5	29.4	29.4	41.2
No	10	58.8	58.8	100.0
Total	17	100.0	100.0	

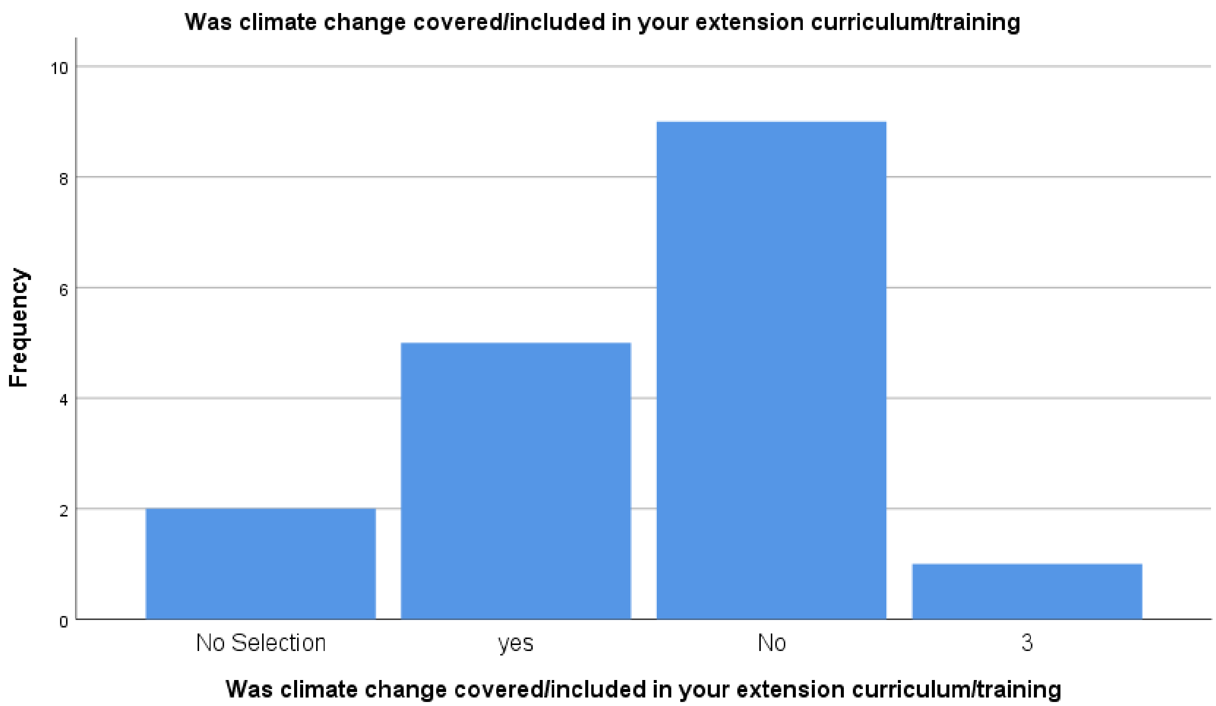

Figure 27: Exposure to climate change content

6.3.3 In-service training on climate change by KZN Department of Agriculture

Given that more than half of the participant were not exposed to knowledge of climate change during training, it was important to explore if they have received any form of in-service training with respect to climate change. The analysis with respect to in-service training on climate change shows that 58.8% of the sample have not received in-service training on climate change by the KZN Department of Agriculture. This number equals the number that indicated that climate change was not included in their curriculum during their training. In contrast, 41.2% agreed that they have received in-service training on climate change by the provincial Department of Agriculture. The breakdown is presented below.

Table 36: Have you received any in-service climate change training from KZN Department of Agriculture?

In-service climate change training	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	7	41.2	41.2	41.2
No	10	58.8	58.8	100.0
Total	17	100.0	100.0	

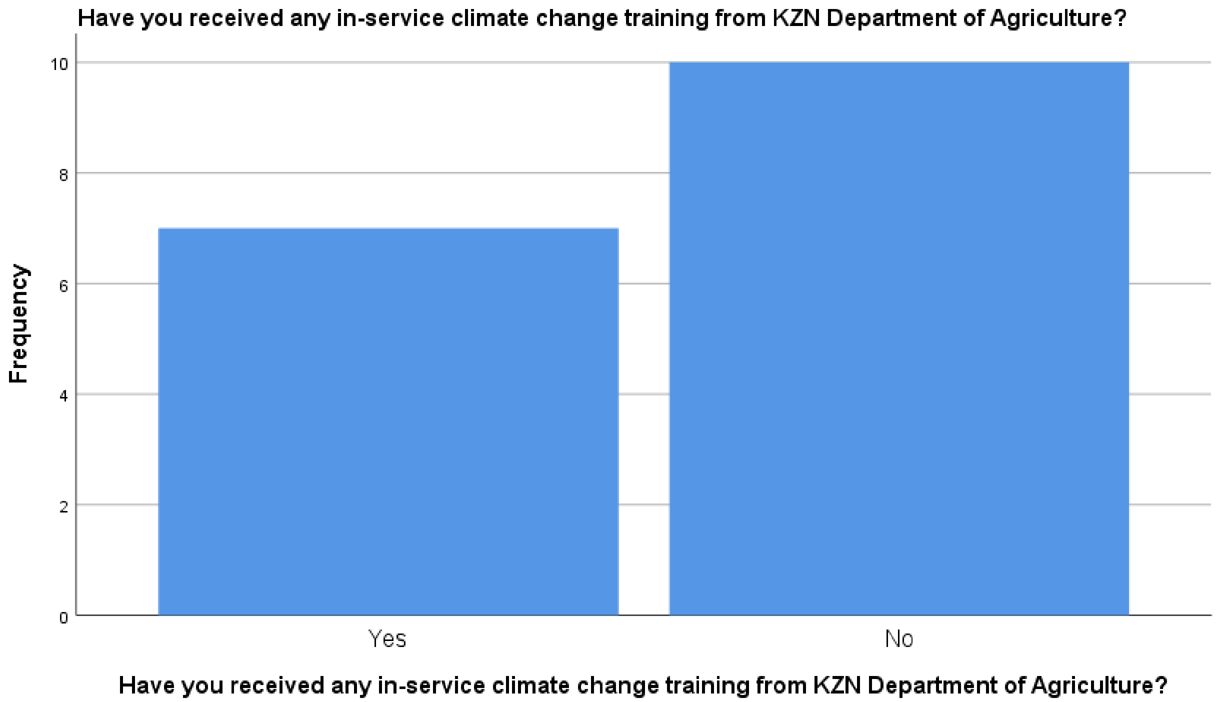

Figure 28: In-service training on climate change

6.3.4 Level of competency in disseminating climate change information to end-users

The participants were asked to respond to this Likert-type statement that rates how competent they were in disseminating information about climate change to farmers. Competency is represented by a mean score on a 4-point scale, where 4 (excellent) represents the maximum score of the scale and 1 (poor) represents the minimum score. A dot indicates no selection. 5.9% of the sample indicated that their competency level was excellent, while 17.6% indicated that their level of competency is good. 47.1% stated that their level of competency is average while 17.6% acknowledged that their competency level in disseminating climate change information is poor. 11.8% of the sample did not make any selection with respect to their level of competency in disseminating information on climate change. This result shows that number of participants on average is higher than those that are at the level of "good" and "excellent" as well as those that are "poor". The table and chart are presented below.

Table 37: What is your level of competency in disseminating climate change information to farmers?

Level of competency	Frequency	Percent	Valid Percent	Cumulative Percent
No selection	2	11.8	11.8	11.8
Excellent	1	5.9	5.9	17.6
Good	3	17.6	17.6	35.3
Average	8	47.1	47.1	82.4
Poor	3	17.6	17.6	100.0
Total	17	100.0	100.0	

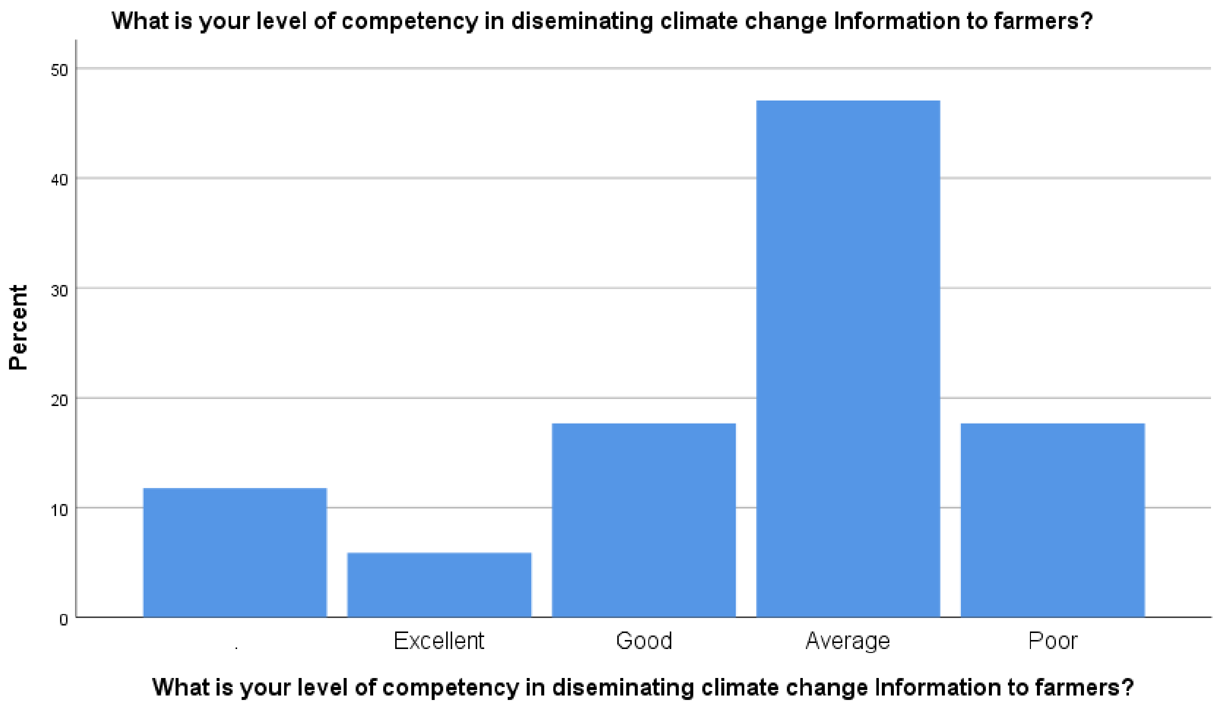

Figure 29: Level of competency in disseminating climate change information to farmers

6.4 CONCLUSION

This chapter has presented the analysis of the quantitative interviews held with in-service agricultural extension practitioners operating in the municipality where this study was conducted. The analysis was done in three parts or sections, namely, 7.1, 7.2 and 7.3. Section 7.1 focused on the biographical statistics of the participants. The second part (7.2) analysed the participants' views on climate change events and its effect on agriculture. The last section explored the level of preparedness of agricultural extension practitioners to offer extension services related to climate change adaptation to smallholder farmers. In order to establish that, the participants were asked to rate their level of competency in disseminating information relating to climate change to end-users. A total of 17 participants completed the questionnaire. The results were discussed and represented in tables and charts. The next chapter presents the analysis of interview held with lecturers involved in the teaching of Agricultural Extension and Rural Development in one of the leading universities located in the province where the study was conducted.

CHAPTER SEVEN

PRELIMINARY STUDY

UNDERSTANDING THE LEVEL OF INCLUSION OF CLIMATE CHANGE AND CLIMATE CHANGE ADAPTATION IN PRE-SERVICE AGRICULTURAL EXTENSION PRACTITIONERS' PROGRAMME

INTRODUCTION

According to the National Department of Agriculture (DoA, 1998), agricultural extension in South Africa should be revamped to address the poor training/qualification of agricultural extension practitioners in rural contexts. Correspondingly, the studies conducted by scholars such as Worth (2008) and Zikhali (2016) suggest that the higher education agricultural extension curricula in South Africa should be revised to address the gaps therein. According to Worth (2008), the failure to re-articulate the agricultural extension curricula to ensure that extension officers and other agricultural development practitioners are equipped to offer appropriate support to farmers has hampered agricultural development in South Africa. A study by Worth (2008), which sought to understand the appropriateness of agricultural extension education in South Africa, found that the then curricula did not adequately equip public sector agricultural extension practitioners to deliver on the agenda of contemporary South African agricultural policy. Hence, Worth (2008) recommends that an extensive revision of curricula in terms of both the quantity and quality of extension training is needed, otherwise, the country's public sector agricultural extension service will not be able to attain the anticipated transformation in agriculture.

Arguing from the angle of climate change adaptation, the study by Zikhali (2016) suggests that the poor delivery of extension services in South African rural context is linked to gaps in the education and training of the extension advisors. Zikhali (2016) points out in her study that a high proportion of agricultural advisors engaged in her study had not received formal climate change training in their curricula at the tertiary education level. This is despite the recommended inclusion of climate change into all educational processes to enable both subsistence and commercial farmers adapt to the challenges of climate change (Department of Environmental Affairs, 2011).

Against the above background, the previous chapter (Chapter 6) sought to understand the extent to which the in-service agricultural extension practitioners possess the knowledge and skills needed to offer effective extension service in relation to climate change in smallholding farming communities such as Msinga. In order to achieve this, I used an open-ended questionnaire to understand whether the required climate change content and concepts were included or accommodated in their curriculum during their higher education training. Also, the questionnaire inquired if the extension officers engaged in this study have received on the job training on climate change after completing their qualification. The result of this investigation shows that 58.8% (10 out of 17) of the participants indicated that climate change and its adaptation were not included in their curriculum during training (see Chapter 6), while 29.4% (5) of the participants indicated that climate change was included in their curriculum. 11.8% (two out of 17) made no selection with respect to the inclusion climate change in the curriculum. When asked about their level of competence in disseminating climate change information to smallholder farmers, 47.1% (8) stated that they are of average competence. 17.6% (3) indicated that they are at poor level while 17.6% said they were good. 11. 8% (2) did not respond to the question (see Chapter 6). This means that the number of extension officers that are professionally competent in delivering extension services as it relates to climate change in the context of this study are much fewer in number than those that are incompetent. Therefore, the result of this engagement shows that the in-service agricultural extension officers in the context where the study is located do not have the competencies needed to effectively deliver services relating to climate change to the end-users (Msinga smallholder farmers).

As a result of the above findings, it was necessary to critically analyse the agricultural extension programme in one of the leading universities situated in the province where this study is located. Therefore, the aim of this preliminary chapter is to ascertain the extent to which the agricultural extension programme equips pre-service agricultural extension practitioners to facilitate adaptation to climate change in smallholder farming communities. A combination of document analysis of the Bachelor of Agriculture programme template and focus group discussion with the Agricultural Extension and Natural Resources lecturers were used to generate data in response to the following questions:

Is climate change and climate change adaptation being accommodated in the Agricultural Extension and Rural Development programme of higher education institutions?

a. ***If yes, to what extent?***

b. If not, what areas are foregrounded?

c. Why are those areas foregrounded?

Against the above background, this chapter is divided into four broad sections (7.1 to 7.4) in line with the questions asked and the sets of data that were generated. Section 7.1 presents the analysis of the Bachelor of Agriculture programme template (BAPT, 2009) in response to the research questions. Sections 7.2 and section 7.3 will analyse the data generated from the focus group interviews held with the Agricultural Extension and Rural Development lecturers. The last section is 7.4, which serves as a conclusion to the chapter. The analysis of the BAPT (2009) of the selected university is presented. This will be followed by the analysis of the focus group interview with the lecturers.

7.1 DOCUMENT ANALYSIS

The question and sub-questions, which guided the document analysis, are as follows:

Preliminary research question 3: **Are climate change and climate change adaptation being accommodated in the Agricultural Extension and Rural Development programme?**

a) If yes, to what extent?

b) If not, what areas are foregrounded?

c) Why are those areas foregrounded?

The document analysis presented in this section is done by using Jansen and Reddy's (1994) document analytical tool. The tool foregrounds four critical factors to be considered when analysing policy documents. These are:

Context: This refers to the sources of the document, and the context in which it was produced. In other words, it considers the historical background of the document and the purpose behind its production.

Recommendations: This addresses the rationale behind the recommendations made, also the conception of the recommendations according to the policy.

Skills, knowledge, values and attitude (SKAV): This relates to the outcomes in the form of knowledge, skills, attitudes and values that should be achieved through the policy recommendations. It considers how the recommendations will be achieved practically (Jansen & Reddy, 1994).

Implementation: This looks at measures to be taken to ensure successful implementation of the recommendations made.

For the purpose of this study, only the third factor, which relates to the skills, knowledge, attitudes and values (SKVA), was used in the analysis. This aspect was foregrounded because it outlines a broad synthesis of abilities (knowledge, skills, values and attitudes) that the pre-service extension practitioners will be able to demonstrate at the completion of their programme. The analysis sought to understand the extent to which the programme equips agricultural extension practitioners to facilitate adaptation to climate change amongst smallholder farming communities.

7.1.1 Are climate change and climate change adaptation being accommodated in the Agricultural Extension and Rural Development programme?

Bachelor of Agriculture programme template (BAPT, 2009) document Analysis

The title of the programme analysed is Agricultural Extension and Resource Management. The programme is offered at one of the colleges of agriculture in KwaZulu-Natal in conjunction with one of the universities in KwaZulu-Natal. Students are awarded a Bachelor of Agriculture (B. Agric) at the completion of the programme. The BAPT (2009) being analysed here is the document that outlines what is covered in the Agricultural Extension and Resource Management programme. The programme has 384 credits and is capped at National Qualification Framework (NQF) level 7. The programme aims to train and equip agricultural extension practitioners with the SKVA needed to:

- Build the capacity of farmers and farming communities;
- Engage in market-orientated sustainable agricultural production, diversification of products and value adding,
- Improve their household livelihood and to contribute to strengthening the rural economy (BATP, 2009, p.2).

Hence, the Agricultural Extension and Resource Management programme was designed to capacitate the agricultural extension practitioner to work in agricultural and rural development in the NGO sector, for government departments, for agribusiness and for other private sector companies involved with farmers and rural communities (BAPT, p. 2). To this end, students are expected to demonstrate the following skills, knowledge, values and attitudes:

i. Implement a communication strategy by applying the principles of communication, leadership skills and group dynamics in extension for the benefit of the target group.
ii. Apply the principles and philosophy of extension in practice to implement policies and strategies related to extension and advisory services in agriculture.
iii. Facilitate learning, innovation and, where appropriate, adoption, for impact on local economic development through the production of food, fibre, fuel and value-added products, the improvement of household livelihood and food security and access to mainstream agriculture.
iv. Design and implement an integrated development/extension project that improves and sustains agricultural production and the livelihoods of clients.
v. Implement an integrated, sustainable agri-business management plan by applying business principles through utilising agricultural, financial, marketing and production-conversion information.
vi. Implement an integrated, sustainable farming systems plan by applying natural resource management principles.
vii. Apply animal production practices to ensure the quality of livestock on a farm.
viii. Apply production practices to plant systems to ensure the quality of the yield on a farm (BATP, 2009, p. 3).

From the above-outlined programme outcomes, the programme intends to develop extension practitioners in a holistic manner. In this regard, knowledge and skills in critical aspects of agriculture and rural development, such as financing and marketing, agri-business, animal and plant production, sustainable farming, communication and leadership are clearly articulated in the outcomes.

It is, however, significant to note that SKAV related to climate change or climate change adaptation **are not** included/accommodated in the outlined outcomes. This implies that climate change and climate change adaptation are not accommodated in the Agricultural Extension and Rural Development programme (curriculum).

Given the case that climate change and climate change adaptation are not being accommodated, the study sought to ascertain the areas that are foregrounded in the programme.

7.1.2 If not, what areas are foregrounded and why are those areas foregrounded?

Table 38 and Figure 34 below show that five keys streams or content areas are foregrounded in the programme, namely:

(i) Extension;

(ii) Agricultural production;

(iii) Farm business management;

(iv) Resource management and

(v) Farm engineering (BAPT, 2009).

As shown in Table 38, different modules are covered under each of the stream. For example, Extension covers seven modules over a three-year period. The agricultural production stream covers six modules over the three years while the farm management stream cover three modules within the three-year period.

Table 38: Agricultural Extension and Rural Development content coverage

		Extension	Agricultural Production		Farm Business Management	Resource Management	Farm Engineering
YEAR 1	S1	Rural Wealth Creation NQF 6 (16)	Farming Systems NQF 5 (16)			Natural Resources Identification NQF 5 (16)	Farm Infrastructure NQF 5 (16)
	S2	Rural Economic Systems NQF 6 (16)	Agricultural Production NQF5 (16)		Production Economics and Marketing NQF 5 (16)	Impact on Natural Resources NQF 5 (16)	
YEAR 2	S1	Extension Methods NQF 6 (16)	Vegetable Production NQF 6 (16)	Field Crop Production NQF 6 (16)	Farm Business Management NQF 6 (8)		Infrastructure and Machinery Development NQF 6 (8)
	S2	Extension Practice NQF 6 (16)	Beef Production NQF 6 (16)	Forage Management NQF 6 (16)		Farm Development NQF 6 (16)	
YEAR 3	S1	Designing Extension Projects NQF 7 (16)			Farm Finance NQF 7 (32)	Land Use Planning NQF 7 (16)	
		Participatory Extension NQF 7 (16)					
	S2	Extension Placement NQF 7 (32)					

(Adapted from BAPT, 2009)

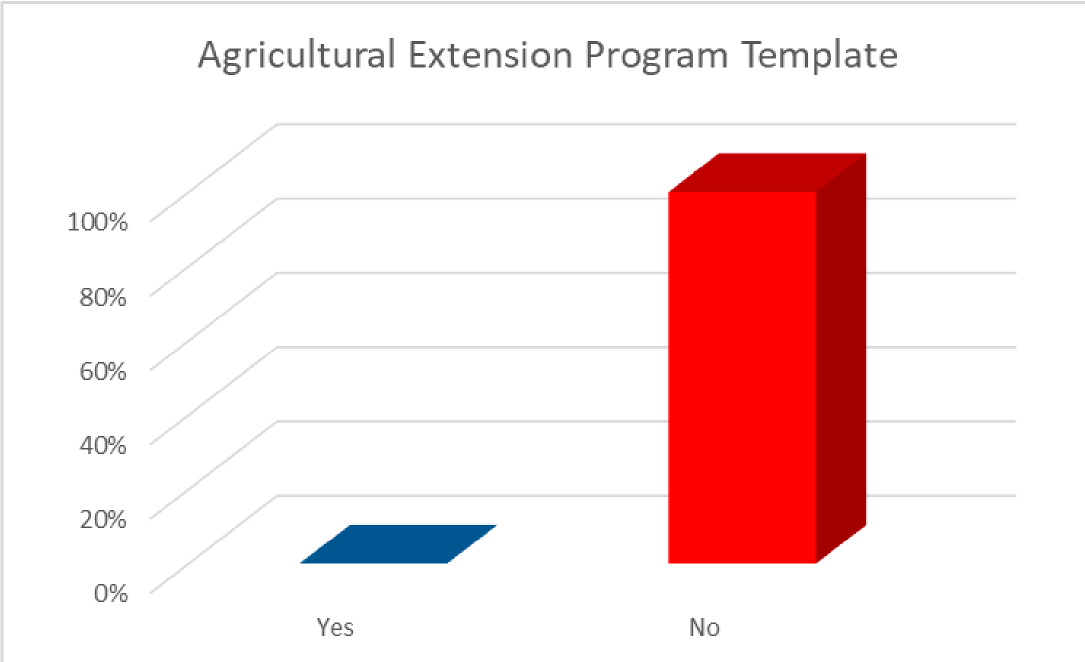

Figure 30: Chart on the inclusion of climate change and climate change adaptation in the Agricultural Extension programme template

Despite the fact that climate change affects and influences every aspect of agriculture today, climate change content or topics were not accommodated or considered in any of the five streams and their associated modules. Rather only specialised content areas/streams and modules were foregrounded in the programme.

To interrogate this significant finding further, a focus group interview was held with the members of the academic staff teaching on this programme. In the next section, analysis of the focus group interview with the agricultural extension lecturers will be presented, starting with the demographics of the participants.

7.2 ANALYSIS OF FOCUS GROUP INTERVIEWS

7.2.1 Are climate change and climate change adaptation being accommodated in the Agricultural Extension and Rural Development Programme?

Three out of seven academic staff members who lecture in the Agricultural Extension and Rural Development programme offered at the higher education institution engaged in this study took part in the focus group interview. As shown in Table 39 below, all participants are females with 16-20- and 1-5-years' experience, respectively.

Table 39: Demographic statistics of participants

Name	Gender	Age range	Year of Experience
P1	Female	50-60	16-20
P2	Female	40-50	16-20
P3	Female	20-40	1-5

The focus group interview enquired about whether climate change and climate change adaptation are being accommodated in the Agricultural Extension and Rural Development programme? This question was followed up with the sub-questions:

a) ***If yes, to what extent?***

b) ***If not, what areas are foregrounded?***

c) ***Why are these areas foregrounded?***

Table 41 below shows that two out of three participants agreed that climate change and climate change adaptation are accommodated in the Agricultural Extension and Rural Development programme.

Table 40: Inclusion of climate change & climate change adaptation in the programme

Are climate change and climate change adaptation being accommodated in the Agricultural Extension and Rural Development programme?	
YES	**2**
NO	**1**

The qualification of the inclusion of climate change and climate change adaptation are accommodated within the Agricultural Extension and Rural Development programme pointed to some very interesting results.

7.2.2 If yes, to what extent?

Table 41: Inclusion of climate change & climate change adaptation in the programme

Are climate change and climate change adaptation being accommodated?	If yes, to what extent?
Not explicitly, but implicitly	Integrated into modules

As shown in Table 41 above, the analysis reveals that the Agricultural Extension and Rural Development Programme does not focus on climate change and climate change adaptation explicitly, but does so implicitly. According to the two participants that opted for a "yes", climate change and climate change adaptation are integrated into other modules or topics (such as conservation agriculture and cattle innovation), as seen in the following two excerpts:

> *"**Well, yes, but we don't teach it as a module but it's integrated into** their natural resources content, it's integrated into the soil facility content as a conservation agricultural content, it's integrated into uhm **it cuts across all the different modules**, uh even the breeding of the cows that they choose*" (P1).

> *"Yeah, also I teach a section called innovation, cattle innovation. So that's how, okay this is what's happening out there, so what can you do in order to address that? There's a shortage out there, what are the innovation that are out there, what can people do with what they have to address it. **So we do address climate change but we don't say okay now we are teaching climate change**, this is climate change da da da da, but **we address the effect of climate change rather than the topic itself**, if that makes sense"* (P2).

With respect to "the extent" to which climate change and climate change adaptation are accommodated, the analysis confirms that it is accommodated in an integrated manner. "It's integrated into their natural resources content, it's integrated into the soil facility content as a conservation agricultural content, it's integrated, it cuts across all the different modules". Therefore, it is clear that climate change and climate change adaptation are accommodated in an "integrated manner" in the agricultural extension and natural resources management modules. Furthermore, the analysis highlights that "climate change is not necessary a topic to be taught", rather is a set of values and attitudes to be learnt. These views are reflected below:

*Well, technically, the school has **historically produced graduated who understood how to adapt to the climates**, so if you guys aren't teaching it now, it's something we've lost, because it's not a, **it's not a topic that you teach, it's a set of behaviours and attitudes**, so **being able to respond to adapt to climate change is an attitude and behaviour of innovation.** P1*

"Is integrated into different modules" (P1 & P2).

"*… it's not because we don't need it, we integrate it… we understand the need for it but we integrate it"* (P1).

"So there's no need to have it as a stand-alone, yeah" (P2).

The participants affirmed their earlier position about integrating climate change concepts in other modules instead of teaching it as a stand-alone module. They acknowledged that students need to know about climate change, but the best way for them to know about it is by teaching it in an integrated manner, hence "there is no need to have it as a stand-alone module. Also, it is more appropriate methodologically and philosophically" to teach climate change in an integrated manner.

"Yeah, it will be more philosophically and methodologically appropriate to integrate it, than create another module" (P1).

It is significant to note that the third participant (P3) differed from the position of the other two participants. According to P3, climate change is not "***built in their programme outcomes***" and they needed to pay attention to it.

It's something that we haven't mmm, we have conversations about it, but… I don't think that it's really built in our outcomes. It's something that we really need to pay attention to. You know, it's just, you know climate is an important aspect of agriculture, so if the climate changes then all your parameters change. But in terms of actually equipping them to uhm to really, to really adapt to, I don't know, if that's our main focus" (P3).

Analysis of the above vignette shows that the participants have not really considered the inclusion of climate change in their programme. Perhaps, this is because it was "not built in their module outcomes or because "I don't know, if that's our main focus." As highlighted, climate change and climate change adaptation may not have been considered as the focus of the

Agricultural Extension and Rural Development programme, hence it was not built into the programme outcomes. The analysis further shows that the programme may not "actually equipping them to uhm to really, to really adapt to". It is significant to point out this curriculum gap especially because "climate is an important aspect of agriculture" and "if the climate changes then all your parameters change".

However, upon reflection, P3 seems to agree with the others about the inclusion of climate change in an integrated manner. This interesting twist is shown below.

> *"We use this sort of module of sustainable agriculture, so we look at social sustainability, environmental sustainability and economic sustainability and climate change will affect any of those. So, when we talk about it, you know we have to address all of those. So, I think, as she said, we don't do it as a stand-alone module, but it definitely gets covered in all the modules"*. (P3).

As can be seen above, climate change is not taught "as a stand-alone module, but it definitely gets covered in all the modules" given that their modules are geared towards "sustainable agriculture". So, climate change is accommodated when they look at topics such as "social sustainability, environmental sustainable and economic sustainability"

Going by the views expressed above, it is clear that climate change and climate change adaptation is implicitly accommodated in different content areas and modules in the agricultural extension and natural resource programme. Even though, P3 had differed initially stating that it not built in their module outcomes. However, upon reflection, she acknowledged that it definitely gets covered in all the modules. Drawing from the above views, it suffices to say that climate change is implicitly accommodates in the programmes. The participants felt it was more appropriate to accommodate it in an integrated manner instead of teaching it as a standalone module.

7.2.3 If not, what areas are being foregrounded?

In line with the programme template, Table 42 below shows that five main streams are according to the participants being foregrounded in the programme, each with their own focus and modules. The "Engineering" stream focuses on *infrastructure of farming.* The "Economics" stream focuses on *farm related business management planning.* The "Production" focuses on i*ntroductory* *animal & plant production* while the “Resource management” focuses on *environment.* Lastly, the “Extension” component focuses on *wealth creation.*

Table 42: The focus of the agricultural extension programme

What is foregrounded
Engineering Infrastructure of farming
Economics Farm related business management planning
Production Introductory animal & plant production
Resource Management Environment
Extension Wealth Creation

The participants highlighted the theoretical underpinning and anticipated outcomes of their programme. They stated that their programme is guided by the SLA and that students are expected to demonstrate knowledge and skills in communication, learning, project management and project design at the completion of their degree. By definition, SLA is a framework used to analyse the dimensions of poverty and well-being, by exploring types of resources that poor households and rural communities deploy to sustain and maintain their livelihoods under changing living conditions (Norton & Foster, 2001). The excerpts from the interview are provided below:

> *“We have five streams for the degree programme, we have an **engineering** which looks at farm development uh land use planning, so it looks at the infrastructure of farming then you have another stream which is **economics** and that looks at farm related business management planning, and then we have a third stream which is **production** and they d,o uhm, introductory animal and plant production, so they do production sciences, then the fourth stream is the engineering, no, okay is **resource management**. Resource management is environmental stream. So you’ve got these four streams, on top of that, the **extension** students do wealth creation in terms of **the development of communities as people centred and asset based**”.* (P1*)*

*"...so **it's asset based development using sustainable livelihood as a framework**, as a theoretical framework. And the main theories uh we use are **system thinking, sustainable livelihood framework**, **those are our main theories**. So, what they do is **they come out of the programme in extension theme with several competences**: Communication, learning, project management, project design etc..."* (P1)

As indicated above, the Agricultural Extension and Rural Development foregrounds five broad streams or content areas. Theoretically, the programme is underpinned by sustainable livelihood and system thinking theory. Specifically, it is *asset-based development using sustainable livelihood as a framework.* It is anticipated that the pre-service extension students will acquire *"several competences in the extension theme*" at the completion of their programme.

Furthermore, three areas within the Agricultural Extension and Rural Development programme were identified by the participants as critical. These areas are shown in Table 43 below.

Table 43: Three areas foregrounded within the extension programme as crucial from the perspective of the lecturers

What is being foregrounded in the programme?
• ***Conservation agriculture*** • ***Natural resources*** • ***Facilitation – facilitators for development***

7.2.3.1 Conservation agriculture

The analysis shows that areas such as conservation agriculture are foregrounded in the agriculture and resource management programme. This means that they prioritised conservation agriculture and hence it was explicitly taught to students.

We don't have in our programme we don't have formal climate change as a module okay? To begin with, but I will say to you that the concept of conservation agriculture is far more important than teaching students about climate change, because conservation agriculture is the response to climate change. So, for us our priority will be to teach conservation agriculture" (P1)

As indicated in the above excerpt, climate change is not explicitly included as a module in their programme/curriculum. The participants suggested that there are other important contents or concepts like "conservation agriculture" that should be covered. It was indicated that teaching concepts like "conservation agriculture" automatically addresses climate change "because conservation is a response to climate change". This affirms their earlier position that climate change is accommodated in an implicit/integrated manner.

7.2.3.2 Natural resources

With respect to the above category of description, the analysis shows that natural resources are one of the key aspects that are foregrounded in their programme. According to P3, knowledge about climate change is equally embedded in the teaching of natural resources.

> *I think, also because we don't really think as this is something I deliberately need to teach, but in all of our modules uh we teach from basic principles. So, even now with the first years, we're learning that you know to grow crops successfully, you have to rift to genetics, your, uh,m your nutrition, water, soil properties, climate etc,. and so your selection of your crops and your management is based on all those conditions, the biggest of them being climate, because you can't change climate to suit you, you have to change yourself to suit the climate so... So I think that actually is the truth that runs the whole way through, you know when they get to second year, they do a lot more about the assessment of natural resources and then when they get to third year they actually do a farm plan where they go to, they actually have to go and physically assess the natural resources which includes climates..."* (P3)

As seen in the excerpt above, climate change and climate change adaptation are covered in modules/topics on natural resources. In second year, the students are exposed to a lot more about the assessment of natural resources. Equally, in their third year, the students "actually do a farm plan where they go to, they actually have to go and physically assess the natural resources which includes climates".

7.2.3.3 Facilitation - Facilitators for development

The analysis shows that the train extension officers are trained to become facilitators for development. According to the participants, the anticipated role of an extension practitioner or advisor should be to facilitate and guide farmers to excel in what they are doing "using what they have". The participants maintain that the extension officer is trained to use what is available in the community or what the farmers are currently doing to facilitate development.

> *"So theoretically the extension officer goes into the field with a development perspective not an adoption perspective. And their key role in the community with small scale farmers and we do talk to small scale farmers in deep rural areas, their role is as a* ***facilitator for development****, starting with* ***what people have****."* (P1)

> *Yeah that's the basic development, so you don't come with your knowledge, you have to use what they have first and then they can have access to….*" (P2)

P1 went on to explain that the extension officer facilitates development by "raising consciousness". He helps the farmers find solutions to their problems from the farmer's perspective and not from a technical perspective. This implies that extension practitioner encourages the farmers to find solution to their problems from within, perhaps using their indigenous/local knowledge. This view is articulated in the vignette below:

> *"They play a facilitator's role, there's an intermediary role, and because they should know about technology, so what technology does the farmer have? So he helps farmer access the technology that's available so, maybe a farmer doesn't know, so the first step to development will be raising consciousness with the farmer uhm and then, uh, looking for what's available and then using that to address the need, but it's from a farmer's perspective, not from the technical perspective or the research laboratory perspective"* (P1).

> *"… we are teaching them to be facilitators. And the only thing you can teach a student in her three years at university is what they are going to know in the first day of their first job when they graduate"* (P1).

Explaining further, P1 made the following comment*:*

> *"Okay so, our extension officer is not going to tell them what to plant, our extension officer is going to say, do you know that this is the climate that you have? Okay? And this is where we find information about the climate, this is where we find information about when it's going to rain next and what the trends are. And they will help the farmer learn that there are databases and predictions for weather trends, and they will work with the farmer, if the farmer doesn't know that already, and then they will say okay now these are the kind*

of plants according to the different databases that are available that can grow under these conditions, this is what you are already growing and this might be options maybe we could experiment with some, you make the decisions. Not I'm gonna teach you now to grow this variety of cabbages because the research laboratory has decided with their climate change research, this is going to be the best one for you, but you can say to them, this is an option, let us go and get it and experiment. But then the farm makes the decision, not the extension officer" (P1).

As can be seen from the foregoing, the pre-service extension practitioners are trained to be ***"****facilitators"* of knowledge. As facilitators, they use what is available within community to facilitate knowledge.

7.3 WHY ARE THOSE AREAS BEING FOREGROUNDED?

With regard to the "**why**" question, five categories of description were brought to the fore, as shown in Table 44 below. These categories were derived from the participants' reference to specific issues/reasons, such as what extension work entails, and from their responses to the explicit question relating to climate change and climate change adaptation in their programme.

Table 44: Categories of description of what informed what was foregrounded

Why are these areas foregrounded?
• *Conception of extension work* • *Conceptions of climate change* • *Farmers are knowledgeable* • *Process of accreditation of programme and module credits* • *The shift from technical extension to process extension*

7.3.1 Conception of extension work

This category of description was derived from the participants' recurrent reference to what extension work entails or in the words of the participants, "what an extension officer should do" when they are in the field. In responding to the question as to "**why**" they focus on areas such as conservation, natural resource , etc., the participants indicated that their extension programme is different based on what extension work entail. They explained that their extension programme is "not an aid based extension, rather is a developmental extension". This means that their programme equips students to help farmers to gain a clearer insight into their problems and find solution to these problems themselves instead of offering them solutions to these problems on a platter of gold. This explains why their programme **is** regarded as being “emancipatory. “It is designed to have farmers direct their own futures”. In other words, their conception of extension work determined what they teach and how they teach.

> *“Is a different kind of extension, the course is different in a way that the students know how, you don’t go there with a preconceived idea of what an extension officer should do, like you are there to give them the seeds and there to give them a tractor and there to give them, but it’s in such a way that they, they can find within the community what they can do and then move from.”* (P2).

> *“So it’s not an aid based extension but it’s more developmental, it’s more participatory, it’s more system based. So you don’t look the problem, but it’s the system, where is the problem within the bigger system. So you don’t just go there to solve a problem, but hey, where is the problem coming from? Who are the actors within the problem, then how can we prove it?”* (P2).

The above view was corroborated by P1 as follows:

> *“It is emancipatory. It is designed to have farmers direct their own futures”.* (P1)

Furthermore, the participants stated that their programme is not designed to teach students the core contents of climate change. Again, the analysis shows that extension students are not going to graduate from their program with the knowledge of what “percentage of methane and gas are gonna change the temperature” because they “really don’t have to know that content*”*. However, they need to know “how to adapt to the temperature change” in their farming. This implies that the details or in-depth scientific knowledge about climate change and its causes may not be necessary for extension practitioners. Rather, what is required is teaching them how to adapt farming practices to the changes in line with the duties of an extension practitioner. Perhaps, this is why climate change is taught an integrated or implicit manner.

> *“Also, they’re not gonna come out of here saying that so much percentage of methane and gas are gonna change the temperature of such and such because they don’t know that content, but they don’t need to know that. What they need to know is, I have to adapt my farming because my rain, I’m dependent on rain and my rain is coming at one month*

intervals, it's coming in a down-pour and it used to start in July and now start in September so how do I adjust?" (P1)

Drawing from the aforementioned, it can be seen that the conception of the duties of an extension practitioner (developmental and emancipatory) is the reason why certain areas are foregrounded in the programme and why others are not.

7.3.2 Conceptions of climate change

This category was derived from participants' responses to the explicit question on their conception/understanding of climate change. The participants understanding of climate change is linked to "natural cycles". The participants explained that climate change "happens, thousands and millions of years" and "understanding which part of that cycle we are in is important" in order to adapt. Still, the participants linked climate change to "change in weather patterns". The excerpts are shown below.

> *"I don't know about the others but for me it's a **natural cycle**, okay? Some of it has been documented and some of it hasn't been documented. What I understand is **we're going, getting to the end of the cooling period** and we are **moving into the warming period**, and the perspective of farmers, the need to adapt is uh faster than they know how to do. So climate, climate change is not like an, it's not like this eh"* (P1).

> *"It's something that happens, **thousands and millions of years** it's been happening uhm, understanding which part of that cycle we're in is important uhm and how do we adapt to that cycle, uhm how long do we predict which is gonna happen and what needs to happen in response to that in terms of agriculture*" (P1).

> "*I could describe it as the **change in weather patterns** from what we are used to…"* (P2)

> *"... and it's more sudden. Sudden in a way that the change is just abrupt, it's **harder rain, it's no longer softer for a long period of time**, but it's in a **high intensity for a short period of time**. Therefore it's **more disruptive than it used to**. So, it's for me climate change is an **immediate difference in a change of how the weather used to before**. Before meaning maybe **50 years but not like 100**. It's like in our life span basically, yeah because it's like compared to generations before ours"* (P1).

It is interesting to note that the participants have different conceptions of climate change. While one participant conceived it as changes in "natural cycles*"* such as "cooling periods*"* and “warming periods”, the other one described it as change in “weather patterns”. The participants made reference to the “intensity” of rain being “harder” for a longer period of time and “softer” for a shorter period. When put together, these conceptions of climate change can be “change of how the weather used to before”. Whether these conceptions of climate change were correct or not, one can argue that it will have a significant impact on what and how the participants (lecturers) teach contents and concepts related to climate change and climate change adaptation to pre-service extension practitioners.

The analysis further shows that climate change is believed to be “more disruptive” today than it used to be in the past. This revelation concurs with the findings made in Chapter 6 of the study on the effects of climate change. The participants (smallholder farmers) engaged in Chapter 6 confirmed that climate change has a very disruptive effect on their livelihood. This means that there is a similarity in the way both stakeholder groups have experienced climate change. in consideration of the foregoing, it can be said that the participants’ views on what climate change is “change of how the weather used to before” influenced what was foregrounded in their programme. Perhaps, not having a clear-cut conception of climate change made them to accommodate it in an integrated manner.

7.3.3 Process of accreditation of programme and module credits

This category of description was derived from the participants’ recurrent reference to the processes of getting approvals for programmes and the amount of credit students are allowed to take during their programme. The analysis highlights that issues such as the process of getting approvals for programmes, as well as the number of module credits allowed, influenced what was foregrounded in the programme. The participants described the accreditation process as “horrendous” and also stated that their programmes is controlled (in terms of enrolment and credits) significantly.

> *“Well, when you design or develop a programme, it has to be accepted by higher education, so all of our templates are pre, it takes two or three years to get accredited,* ***so if you change that programme, it takes another 2 or 3 years to get accredited again****, uhm I’m not quite sure if that’s accurate in terms of time frames or whatever but* ***it’s a horrendous process that we’re going through. So why would you add climate change when the best way to teach something is to integrated it****? Because climate change integrates, affects every part of, so yeah why would you in a small programme like we have,*

we have a lot more control, we have a lot more flexibility in Cedara and the extension programme. We take in 60 students a year, so we have uh total of what? A hundred and twenty (120) students on campus at any one time, plus or minus. Yeah 170. And so, you got a small intimate group of students that you can be very flexible with, so we can integrate uhm and so… "(P1)

"It's easier to do that than to change the whole curriculum". (P2)

*"Well it's also there's so much they have to learn, how do you**, why would you add something that takes more credit hours, that students already don't have**".* (P2)

As can be seen from above responses, climate change is not explicitly accommodated as a module or topic for two reasons. First, the horrendous process of getting approval for new programmes makes it difficult for restructuring or redesigning the programmes. Second, students do not have enough credit hours, so this makes it difficult to add new programmes. Therefore, these two limitations influenced their decision to focus on knowledge areas such as conservation and, in the words of the participants earlier, "conservation agriculture is the response to climate change".

7.3.4 Farmers are knowledgeable

This category of description was derived from the participants' recurrent comments on the farmers' skills and knowledge of agriculture. In justifying what was foregrounded in their programme, the participants accentuated that farmers (especially smallholder farmers) are knowledgeable about farming and farming decision making, using their indigenous knowledge. However, what they need is someone to explain "why" certain changes occur and then they can change their "what" to adapt to new conditions.

*"Most important thing is **farmers know what to do**, okay? They don't have any problem with production. Farmers **know what to do**, but when climate change is affecting them, and as they lose knowledge uhm and **as the knowledge that they their traditional or indigenous knowledge fails them then they need to know why, and once they know "why" then they are able to take decisions about "what"**. So, so they grow up knowing what to do…"* (P1).

*"**But when you raise consciousness and explain and people develop their own new knowledge and understanding of "why", then they are able to change the "what"**. Uhm,*

and that is actually the fundamental, because then when the next chaos comes along, they are able to make those decisions themselves" (P2).

Again, P1 highlighted that farmers are knowledge and do not have to be treated like empty vessels.

*"….. and we **don't assume that farmers don't have skills,** and this is the problem with technology adoption, is that everybody assumes that farmers don't know anything and so they go and teach them how to plant and they do it over and over again and they don't understand why the farmers get grumpy with them and don't cooperate because the farmers actually know how to plant the plant"* (P1).

*"**What the farmer doesn't know how to do, is source this or that or connect to a market because he doesn't have an English skills** or he **doesn't have understanding of how the market works or he can't believe that the market would work that way**. Okay? So those are the kind of things that.eh, they are the soft skills and they are more important than the technology. Technology is important but….* (P1).

As can be seen from the excerpt above, the decision to teach pre-service extension practitioners certain contents and leave out others is influenced by the fact that smallholder farmers are knowledgeable about agriculture/farming decision making. The participants believe that most farmers have advanced knowledge of agricultural practices, therefore, their students are not required to teach them about farming when they qualify. Rather, they are preparing the students to raise consciousness amongst the farmers in the light of current climate conditions. Perhaps, raising consciousness will help them understand how the markets work and why it works in a particular way. When considered appropriately, it can be said the decision to foreground some specific areas in the programme was influenced by the belief that farmers are knowledgeable. So, the areas foregrounded are, perhaps, the areas in which they assume farmers lack knowledge of, for example, "how the markets works".

7.3.5 The shift from technical extension to process extension

This category of description was derived from the participants' recurrent emphasis on process extension versus technical extension. The analysis revealed that their programme has shifted from teaching the "content of technical extension" to "process extension". Technical extension can be likened to traditional extension approaches. According to Agriculture for Impact

(2019), traditional extension approaches focus on increasing agricultural productivity using a top-down approach. This approach emphasises transfer of technology (Agricultural Impact, 2019). The analysis shows that process extension teaches the process of learning and perhaps this differs from technical extension or traditional extension**,** which according to P1 involves *"giving a basket full of solutions and technologies"*. So, the participants are teaching their students the "*process of learning and adapting*" to climate change with the anticipation that the students will pass it on to the farmers.

> *"I think what you are seeing is that we uhm* ***we have stopped teaching the content of technical extension*** *and we are* ***teaching them the process****. The* ***process of learning, the process of change, of adapting to change*** *and because that is core and* ***fundamental to what we do****, it doesn't matter what the change is, it doesn't matter what the learning need to be"* (P1).

> *"..we are* ***teaching them how to learn****, we are* ***teaching the students to teach the farmers how to learn,*** *and we* ***are teaching our students how to adapt to change, so they can then pass that,*** *so* ***that's what they are passing on to the farmers, not a range of technologies, not a basket full of solutions*** *which is what the. What the last sort of* ***modernist period was teaching****. So,* ***the postmodern approach, post structural approach is to look at the process****. And so we want our students to come out of, as a graduate with the processor they can facilitate that process in community"* (P1).

As explicitly indicated in the excerpt above, the participants are no longer teaching "*technical extension*" which is a top down approach. Rather, they are now teaching "***process extension***", which can be described as being bottom-up and places extension practitioners in a position of being *"facilitators"* of learning. P1 provided more insight on the difference between their agricultural extension programme, which was regarded as *"process extension"* and the traditional agricultural extension programme as follows:

> *"You see the fundamental difference is that uh traditional extension uhm* ***traditional extension officer is focused on the technology****, okay?* ***That's the trainer is focused on the technology that they are going to use to advice with****. Our extension officer,* ***our extension facilitator is focused on building capacity*** *in the people who need to use technology and engage with the environment around them.* ***That is your fundamental difference****."* (P1).

*"So we call it SKAV. For us, **building competency is about skills, knowledge, attitudes, and behaviours** all the time, okay? And behaviours are linked to our values, we do what we value, so when **we look at building competency with the farmers**, **we look at all those things, not just the technology**…."* (P1).

*"… is more on how to **capacitate farmers** to have their own command in whatever decisions that they want to make. If they want to grow in this way, how do they ensure that they do things the way they want to, but then **the extension officer facilitates it in such a way that is sustainable** or in a way that is, **informed decision making**. They are not, it's not like a group of kids who you just let them play and make any decision and stuffer the consequences. Your role, part of your role is to help them make informed decisions, help them learn how to make informed decisions.* (P 1)

These findings, with respect to the fundamental difference between the traditional or technical extension and the type of extension practitioners in the programme concur with the views of Agricultural Impact (2019) on types of extension services or models. According to Agricultural Impact (2019), technical extension services or technology transfer uses the traditional model of the transfer of advice, knowledge and information in a linear manner. On the other hand, the extension facilitation model aims to help farmers to define their own problems and develop their own solutions. So, while one approach is linear and top-down (*modernist*), the other approach is interactive and perhaps bottom-up (*post-modernist/ post-structural*).

Based on the foregoing comments, it can be concluded that the agricultural extension students (in the institution where this study is located) are being trained to become extension facilitators because their programme have shifted from technical extension to process extension. Perhaps, this shift is in line with their programme outcomes which was identified as building competency in relation to skills, knowledge, attitudes, and behaviours (SKVA). However, the participants acknowledge that "technical expertise" is still needed. They emphasised that there is still need for "people who knows everything there is to know about cows and animals". This implies that knowledge of technical extension is still relevant but a post-modernist or post-structuralist approach to extension is more suitable. Hence, the participants maintained that their extension programme equips extension practitioners to apply the "information" about cows and animals.

*"**But you still have extension, and you still need technical expertise**, you still need it, you still need people who, who know everything there is to know about cow and everything there is to know about a crop, you still need those people, **but our extension facilitators are trained to do, what do I do with this information about the cow in relation with the people who own the cow?**" (P1)*

*"**No, they do get introduced to that and the basic science of animals**, animal science and crop science and soil fertility, **all of that technical uh now the foundation is laid**, obviously they can't learn everything. **So, they have to build on that knowledge in an applied way**, uhm they can go on and learn it in a much more, uhm... But because we've taught them how to learn, they can move from there, into more uhm depth, deep understanding of a particular thing"* (P1).

*"So **they have a very solid foundation on crop production** but they are not specialists in maize production or vegetable production".* (P3).

Summarily, the justification **(why)** for what is foregrounded in extension programme can be linked to the shift from technical extension to process extension. From the views expressed above, process extension equips students to facilitate informed decision making amongst smallholder farmers.

7.4 CONCLUSION

This chapter offered insight into the space accorded to climate change and climate change adaptation in the university's agricultural extension programmes. The analysis was guided by the following question:

Is climate change and climate change adaptation being accommodated in the Agricultural Extension and Rural Development programme?

- ***If yes, to what extent?***
- ***If not, what areas are foregrounded***
- ***Why are those areas foregrounded?***

In line with these questions, the purpose of this chapter was to understand (through document analysis and focus group interviews with lecturers) the extent to which the agricultural extension programme prepares extension practitioners to facilitate adaptation to climate change in smallholder farming contexts. To this end, the chapter was divided into five broad sections in line with the two sets of data that were generated. The first section, 7.1, presented the analysis of the Bachelor of Agriculture programme template in response to the research questions. Sections two (7.2) and three (7.3) used the focus group interviews held with the Agricultural Extension and Rural Development lecturers to address the research questions. The last section (7.4) concluded the chapter. The analysis for the Bachelor of Agriculture Programme Template was guided by Jansen and Reddy's (1994) document analysis tool, while the focus group interview was analysed through content analysis. The summary of the results is presented in Table 45 below.

Table 45: Summary of the results/findings

Research Question	Data Source 1: Bachelor of Agriculture programme template (2009)	Data Source 2: Focus Group interviews with agricultural extension lecturers (academia)
Is climate change and climate change adaptation being accommodated in the Agricultural Extension and Rural Development programme	**NO** - Not accommodated	**YES (Implicitly) -** 2 **NO** - 1
If yes, to what extent? *If not, what areas are being foregrounded?*	• Extension; • Agricultural production; • Farm business management; • Resource management and • Farm engineering (BAPT, 2009	**Integrated into modules** • Engineering • Economics • Production • Resource management • Extension **Three knowledge areas foregrounded crucial areas:** • Conservation agriculture • Natural resources • Facilitation – facilitators for development
Why are these areas foregrounded?		- Conception of extension work - Conceptions of climate change - Farmers are knowledgeable - Process of accreditation of programme and module credits - The shift from technical extension to process extension

As presented in table 45 above, climate change and climate change adaptation are not explicitly included/accommodated in the programme template of the Bachelor of Agriculture. This result was affirmed by one participant during the focus group interviews. However, the result of the engagement with the academic staff members showed that climate change and climate change adaptation was accommodated implicitly, in different modules of the programme. Given that climate change and climate change adaptation was not explicitly accommodated as a stream/content area in the programme, the analysis probed for the streams that were covered in the programme. Interestingly, the result from both data sources confirmed that five streams or content areas are foregrounded in the Bachelor of Agriculture in Extension and Resource Management of the sampled university. Furthermore, the programme outcomes, as outlined in the programme template and confirmed by the lecturers, are same. From both data sources, students are expected to show aptitude in communication, leadership, project design/ management , etc. as shown below.

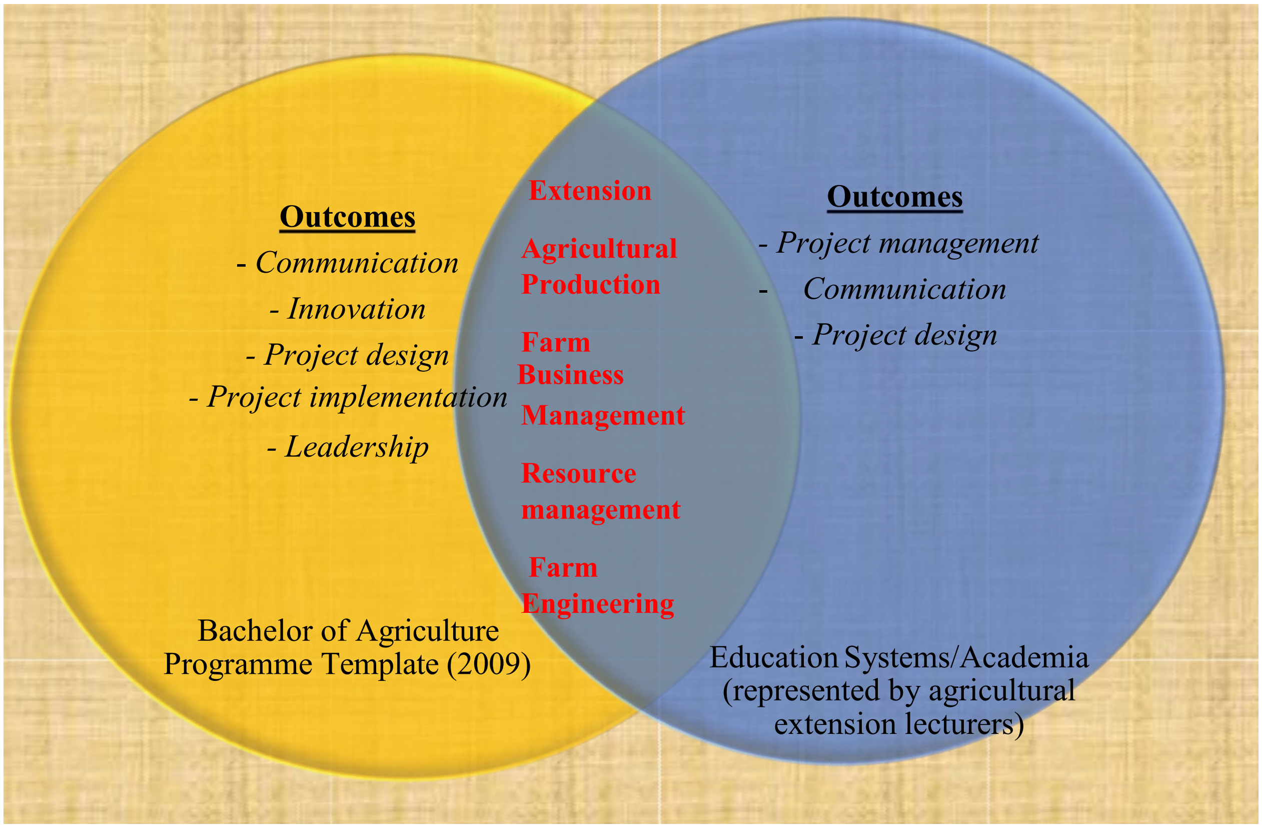

Figure 31: The focus of the agricultural extension and resource management, as confirmed by the two data sources

Besides foregrounding five streams and teaching about climate change in an integrated manner, the analysis further uncovered three other knowledge areas or topics that are foregrounded as crucial areas by the lecturers (see Table 42 and Table 43). With respect to why these areas were foregrounded, the analysis points to five reasons, as disclosed in Table 44. The next chapter will present the analysis for research question one in the main study.

CHAPTER 8

MAIN STUDY

EXISTENCE OR NON-EXISTENCE OF PARTNERSHIPS BETWEEN GOVERNMENT, UNIVERSITY AND SMALLHOLDER FARMERS WITH RESPECT TO CLIMATE CHANGE

INTRODUCTION

The previous chapters, namely, Chapter 4, Chapter 5, Chapter 6 and Chapter 7 presented the preliminary phase of the study. This chapter presents the results of the second phase of the study, namely Phase 1 of the main study. It explores the existence or non-existence of partnerships amongst the three stakeholders with respect to changing weather and climate and its impact on agriculture. The stakeholders engaged in this study include academia (represented by agricultural extension lecturers in the university), the government (represented by agricultural extension practitioners from the Department of Agriculture) and media and culture-based public/end-users (represented by smallholder farmers from the Msinga community).

The chapter is guided by the following research question:

1. Do partnerships exist amongst universities, government and small-holding communities?

(a) If so, what type of partnership exists amongst these actors with respect to changing weather and climate patterns and its impact on agriculture in South Africa?

(b) If not, what exists? What is its nature?

To answer the questions above, data was generated by a semi-structured questionnaire for the existence and types of partnerships. The analysis in this chapter is guided by the Quintuple Helix Innovation Model (QHIM). According to Carayannis et al. (2012), QHIM is an innovative institutional alignment or configuration comprising of five helices (stakeholders), namely, education system, the economic system, the natural environment, the media- and culture based public (end-users) and the political system. Carayannis and Campbell (2010) reason that the QHIM is a framework for interdisciplinary analysis and transdisciplinary problem-solving in relation to sustainable development. The authors maintain that QHIM emphasises the need for knowledge production and use, as well as innovation, to be set in context or they must be contextualized by the natural environment of society. In this regard, the QHIM is an analytical frame that aligns or links knowledge and innovation with the natural environment (Carayannis & Campbell, 2010). In other words, QHIM incorporates features of social ecology (Ibid.). However, it is important to note that the natural environment is not an actual stakeholder (helix); rather it is the driver of novelties in response to environmental challenges (Grundel & Dahlström, 2016). In other words, the natural environment offers the other helices the platform (natural capital) that drives innovation. This implies that the desire for a sustainable environment is the main motivation for partnership arrangements between different stakeholders. It is important to note that QHIM consists of the earlier Triple Helix Model (THM) of Academia, Industry and Government as well as the Quadruple Helix Innovation Model (QHIM) of Academia, Industry, Government and Civil Society/End-users (Grundel & Dahlström, 2016).

This chapter is divided into five main sections in line with the questions posed above, namely, sections 8.1 to 8.4. These four sections present the analysis of whether partnerships do indeed exist, and, if so, what type of partnership exists amongst the three stakeholders. Where there is no partnership in existence, the chapter sought to understand the nature of what exists between the three stakeholders or other stakeholders.

8.1 PRESENTATION AND ANALYSIS OF THE EXISTENCE AND TYPE OF PARTNERSHIP AMONGST UNIVERSITIES, GOVERNMENT AND SMALL-HOLDING COMMUNITIES

Waddock (1991) reasons that partnerships are a voluntary collaborative effort of stakeholders from two or more sectors in a forum in which they cooperatively endeavour to solve a problem of mutual concern to them and to the society at large. Similarly, Van Huijstee et al. (2007) conceive partnerships as collaborative arrangements in which stakeholders from different sectors of the society (state, market, civil society, etc.) are involved in a non-hierarchical process, and through which these actors strive for a sustainability goal. With respect to sustainable development, multi-stakeholder partnership was recognised as an important implementation framework for sustainable development at the Rio de Janeiro conference (Warner & Sullivan, 2017). In concurring with the foregoing perspective, Pinkse and Kolk (2012) assert that "global partnerships" were enlisted as one of sustainable development goals because of the relevance of partnerships in addressing sustainable development challenges. This means that partnership is a very important factor in the attainment of sustainable development. However, Pinkse and Kolk (2012) suggest that there is lack of discussion and action amongst developing countries on partnerships with respect to sustainable development. Thus, the purpose of this chapter is to unravel whether partnerships exist amongst the three stakeholders engaged in the study with respect to changing weather and climate and its adaptation.

This section presents the analysis on the existence and types of partnership amongst academia (represented by university lecturers), government (as represented by agricultural extension advisors) and public/end-user (represented by Msinga smallholder farming community) with respect to climate change and its impact on agricultural practices. Firstly, I will present the analysis based on the responses from the participants in the university.

8.2 ANALYSIS OF PARTNERSHIPS IN EXISTENCE BETWEEN UNIVERSITY LECTURERS AND OTHER STAKEHOLDERS

As indicated earlier in Chapter 1, the first objective of this study is to understand if a partnership exists amongst university, government and small holding communities with respect to changing climate patterns and adaptation to these changes. To this end, participants were drawn from university, government and the Msinga smallholding community. Three participants who are lecturers in the Agricultural Extension and Rural Development programme participated in this main study. The three participants equally took part in the preliminary study.

In the following section, I will present the analysis of the data with respect to partnerships in existence, from the perspective of the university lecturers. Three lecturers who teach in the Agricultural Extension and Rural Development programme of the university were selected through a process of linear snowballing sample. The biographic data of the participants, such as age, gender and number of years of working experience, was presented earlier in Chapter 8. So, with respect to the question on existence of partnership amongst the university lecturers and other actors, the following data emerged.

Table 46: Partnerships involvement between university lecturers, MSF and government

Do you partner with Msinga smallholder farmers on climate change adaptation

Partnership involvement with MSF	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	2	66.7	66.7	66.7
No	1	33.3	33.3	33.3

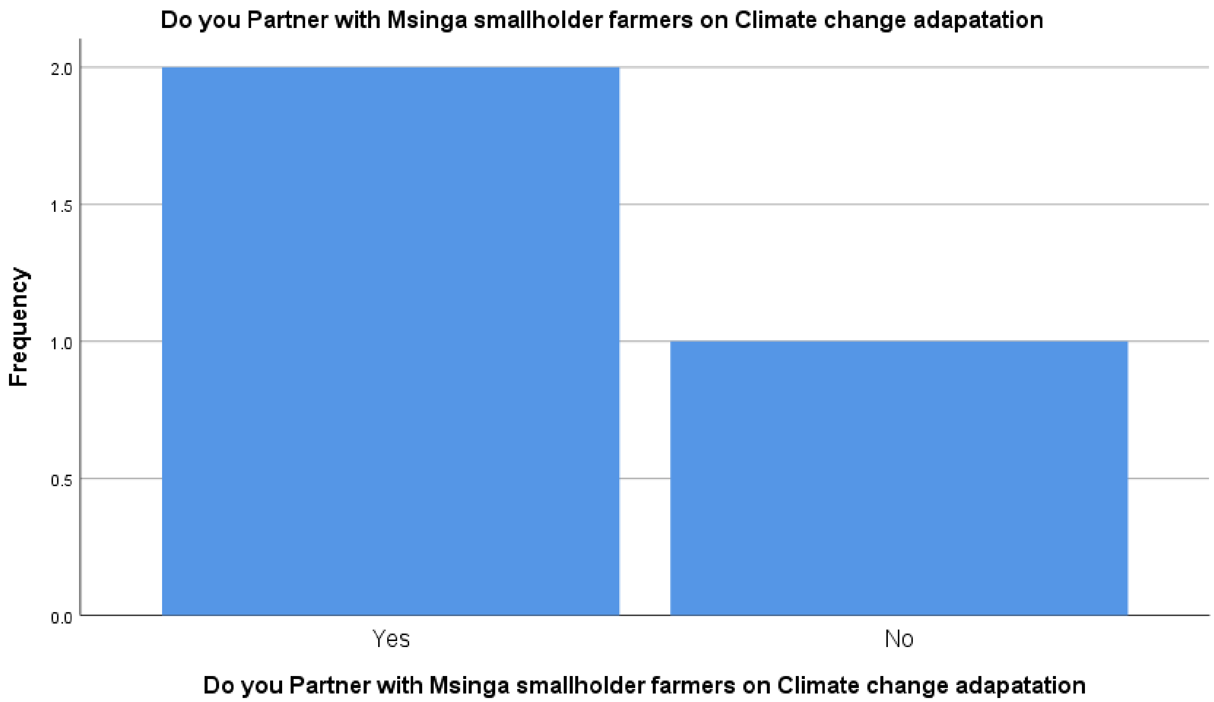

Figure 32: Partnership involvement between university lecturers, MSF and government

As illustrated in the table and chart above, two out of the three participants indicated that they are in partnerships with other stakeholders, specifically, smallholder farmers. This figure represents 66.7% of the sampled population from the university. On the other hand, the participants that indicated that they are not in partnership represent 33.3% (one of 3) of the sampled population. Therefore, it can be concluded that the participants from the education systems/academia (represented by university lecturers) do partner with end-users/public (as represented by Msinga smallholder farmers).

With respect to research question 1a: ***If not what exists? What is its nature?*** The analysis shows that nothing exists between the participant(s) that does not relate to the partnership with end-users (smallholder farmers/farming communities) and the government.

1a. If so, what type of partnership exists amongst these actors with respect to changing weather and climate patterns and its impact on Agriculture in South Africa?

With respect to the above research question (1a), the data analysis shows that the participants from the education systems or academia, as represented by the university lecturers, are in in a two-legged *indirect/representative partnership* with the other stakeholder engaged in this study. Literally, "indirect partnership" means that they partner with the other stakeholders in an indirect or representative manner; that is by proxy. Though a two-legged type of partnership was elicited from the data, the helix of natural environment was added to this partnership. Given that this study centres on adaptation to climate change, which is an environmental challenge, the helix of natural environment automatically becomes a partner (though implicitly) in the identified partnership between different stakeholders in this study. Thus, with reference to the above question, the following category of description was elicited:

Table 47: The type of partnership that exists between education system/academia, government and end-users

S/N	Name of Institution/Actor	Partnership Involvement with MSFs & Government?	Type of Partnerships
			University - End-user (farming community - Natural Environment
P1	University Lecturers	Yes	- *Indirect/Representative Partnership*
P2	University Lecturers	Yes	- *Indirect/Representative Partnership*
P3	University Lecturers	No	-

As can be seen from the table 47 above, a two-legged indirect/representative partnership exists between the university and the farming community. This was captured in the comments made below.

> *"I am not directly involved in a formal partnership with a smallholder farming community in KZN. However, our students do go on internships around KZN for one of their modules. Another relation we have is with the fieldtrips that students do every year, visiting all kinds of farms from subsistence to commercial farms from across the country"* (P2).

As evident in the above comments, the stakeholders from the education systems/academia (university lecturers) are not directly involved with the stakeholders from the other institutions such as end-users (community) and government (agricultural extension practitioners). Nonetheless, an "indirect/representative" type of partnership was established between them and the end-users. In this partnership (indirect/representative partnership), the education system or academia (university lecturers) is represented by the students by way of students' engagement such as *internships* and *fieldtrips*. The data clearly shows that the relationship that exists between the university and farming communities requires them to send their students out for internship and field trips to different farms across the country. The internship is in fulfilment of the 32 credit "Extension Placement" module offered in the final year of the Bachelor of Agriculture and Rural Extension programme (Bachelor of Agriculture programme template, 2009). The participants emphasised that their students go out to observe different agricultural practices, as can be seen below:

> *"Our students do go out and see a variety of environments, a variety of agricultural practices, a variety of agricultural management approaches during…. So, our programme is field experiential. Other programmes are becoming more and more classroom based and more theoretical and that's not connected to the real world. So, these students have a real connection to the real world as much as they can"* (P1).

Again, the above excerpt shows that the university students are exposed to different agricultural audiences and practices, given that their programme is experiential in nature. According to the participants, the students have a "real connection to the real world as much as they can". So, even though it appears like the university lecturers are not directly involved with the other stakeholders, such as the farmers, in reality, they are "indirectly" involved with the farming communities through the students and the natural environment. The above perspective in terms of an "indirect/representative" partnership was echoed in the excerpts below.

> *"I am involved in teaching Diploma and B. Agric students who will work in the extension field in the future"* (P1).

Again, the above comment shows that the university lecturers are involved in the training of future government employees (future extension workers). This means that the indirect partnership placed them in a position to provide/offer skills and innovation to other stakeholders.

> *"Not directly involved, main role is in the form of advising, consulting on learning interventions and in providing future training officers with practical farm skills*" (P1).

Going by the above views, it can be seen that the university partners are in an "indirect/representative" partnership with other stakeholders such as end-users/public (smallholder farming communities) and the natural environment, which is implicitly involved in all forms of partnerships in line with tenets of QHIM. This indirect partnership requires them to send students out for internship and field trips to different farming communities and to provide education and training for future employees or workforce in the agricultural sector.

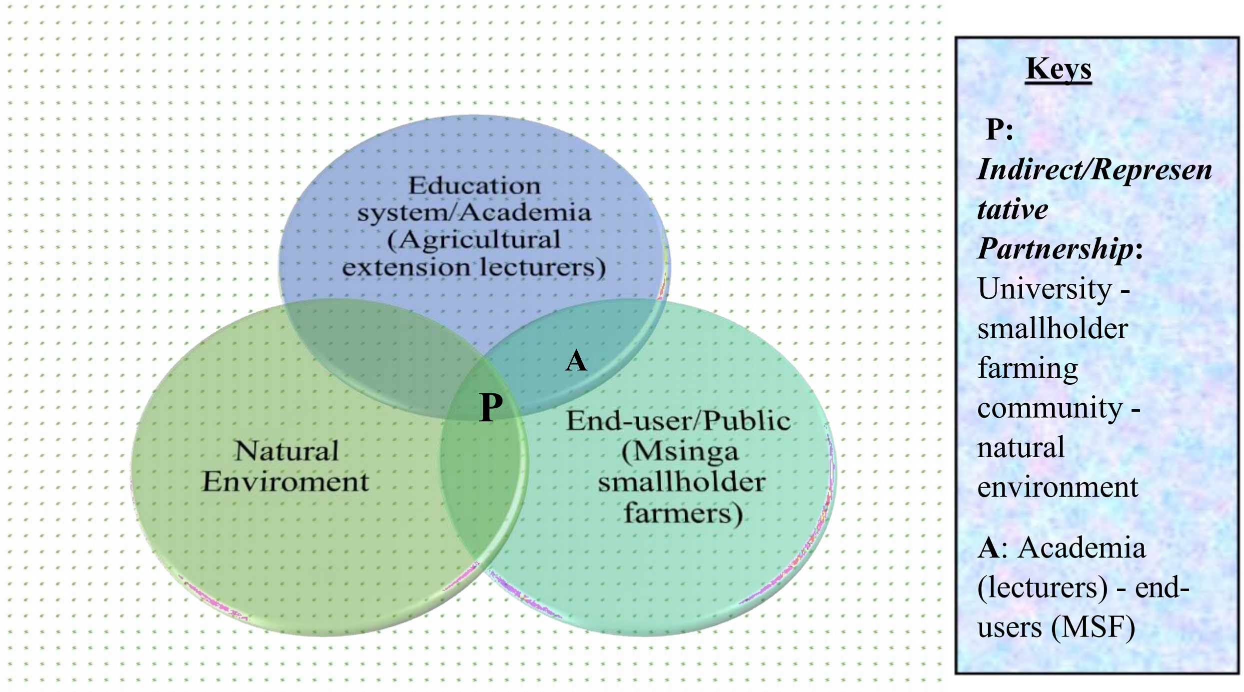

Figure 33: Partnerships in existence between academia, end-users and natural environment

Beyond the established indirect or representative partnership that exists between education systems/academia, end-users and the natural environment (which is an implicit partner), the data shows that 66.7% (2 out of 3) participants indicated that they are in partnership with other stakeholders with respect to climate change adaptation. Still, 33.3% (1 out of 3) maintained that they are not involved in any form of partnership with other stakeholders with respect to climate change adaptation. It is therefore evident that another type or level of partnership exists between the academia (university lecturers) and other stakeholders. The analysis is presented in the Table 48 and chart below.

Table 48: Partnerships involvement between university lecturers and other stakeholders

Are you in any multi-stakeholder partnership w.r.t climate change adaptation?

Partnership involvement	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	2	66.7	66.7	66.7
No	1	33.3	33.3	100.0
Total	3	100.0	100.0	

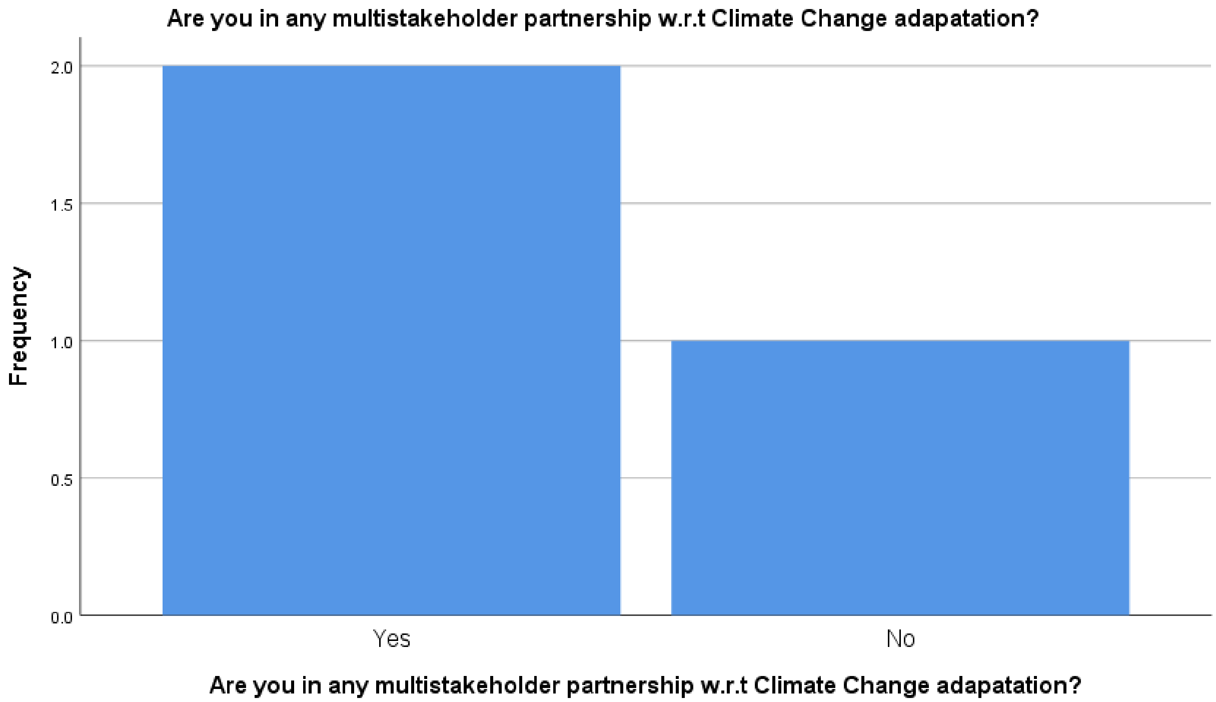

Figure 34: Partnerships involvement between university lecturers and other stakeholders

As can be seen from the data presented above, two out of the 3 (66.7%) participants acknowledge that they are in partnership with other stakeholders with respect to climate change adaptation. In the light of this revelation, the researcher sought to understand the type of partnership that exists between them and other stakeholders. The following responses were offered by the participants.

Table 49: Type of partnerships between the university and other stakeholders

	Name of Institution/Actor	Partnership Involvement with other stakeholders?	Type of Partnerships
			University - NGO - Natural Environment
P1	University Lecturers	Yes	University - NGO
P2	University Lecturers	Yes	University - NGO
P3	University Lecturers	No	-

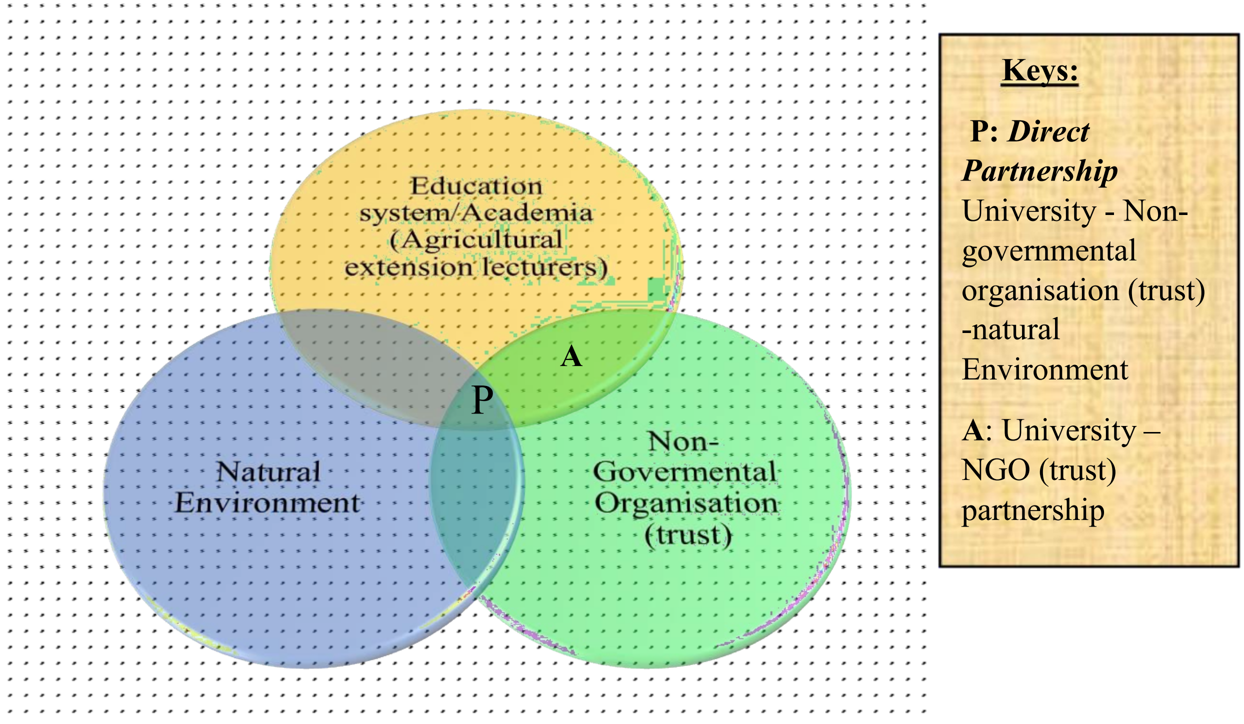

Figure 35: Partnerships in existence, between university, end-users and the natural environment

As indicated in the above chart and table, the participants from the university stated that they are in a two-legged type of partnership with non-governmental organizations (NGOs – Trust). Conclusively, it can be said that the participants from the university are in two different types of partnerships with two different stakeholders. The roles of the university in these partnerships will be discussed in the next chapter. Next, the response from the participants representing the Government is presented.

8.3 ANALYSIS OF PARTNERSHIPS IN EXISTENCE BETWEEN GOVERNMENT (AS REPRESENTED BY AGRICULTURAL EXTENSION PRACTITIONERS) AND OTHER STAKEHOLDERS

A total of 13 agricultural extension practitioners employed by the Department of Agriculture and Rural Development (13 out of the 17 that took part in the preliminary study) participated in the main study. Though the questionnaire for the main study was administered to all 17, only 13 participants responded to the questions. So, 13 participants responded to the question on the partnership existence between them (government as presented by extension practitioners) and the other two stakeholders engaged in this study that is end-users (Msinga smallholder farmers) and the academia (University lecturers). The analysis of the result is shown in the Table 50 and Figure 36 below.

Table 50: Partnership involvement between government (agricultural extension advisors), university lecturers and MSF

Partnership Involvement with Msinga smallholder farmers on Climate Change Adaptation				
Extension - Farmers partnership	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Yes	11	84.6	84.6	84.6
No	2	15.4	15.4	100.0
Total	13	100.0	100.0	

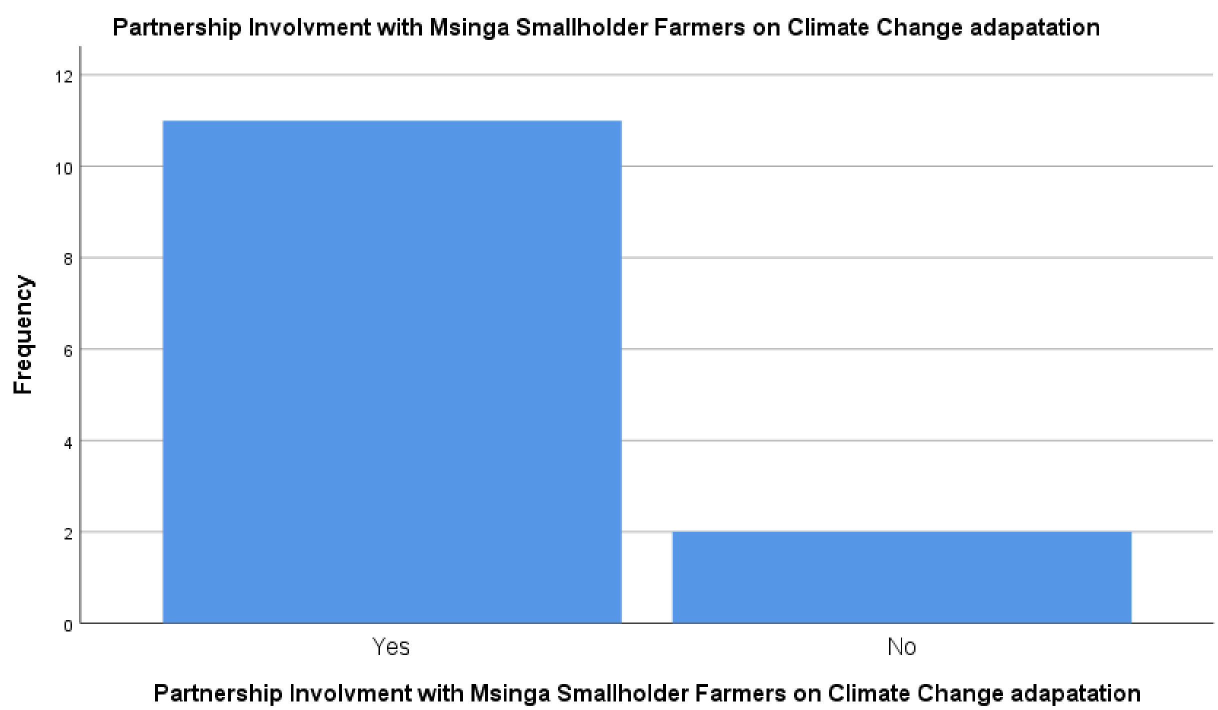

Figure 36: Partnership involvement between government (agricultural extension advisors) university lecturers and MSF

From the data presented above, it is clear that 84.6% (11 of 13) of the participants are in partnership with Msinga smallholder farmers. On the other hand, 15.4% (2 out of 13) of the participants indicated that they are not in partnership with Msinga smallholder farmers. This means that the number of extension practitioners that are in partnership with MSF are higher in number than those that are not in partnership with MSF. With respect to research question 1a:

> ***If so, what type of partnership exists amongst these actors with respect to changing weather and climate patterns and its impact on agriculture in South Africa?***

The result shows that the type of partnerships that exists between the extension practitioners and the other partners are mostly two-legged partnerships. That is, a partnership between agricultural extension and community/smallholder farmers. However, two participants (P4 & P13) indicated that they are in a three-legged (trilateral) partnership. These partnerships appear to be "direct" or formal in nature and are mostly in line with the demands of their jobs. In line with research question 1a, the table below outlines the type of partnerships that exists between the agricultural extension practitioners, Msinga smallholder farmers and the university.

Table 51: Type of partnerships between the government (as represented by agricultural extension advisors), MSF & university

S/N	Name of Institution/Actor	Partnership Involvement?	Type of Partnerships
			Government, University, End-user & Natural Environment
P1	Department of Agriculture & Rural Development	Yes	Extension – Community (MSF)
P2	Department of Agriculture & Rural Development	Yes	Extension – Community (MSF)
P3	Department of Agriculture & Rural Development	Yes	Extension – Community (MSF)
P4	Department of Agriculture & Rural Development	Yes	Extension - Community – Higher Education Extension – Community; Extension – Agricultural Research Council (ARC)
P5	Department of Agriculture & Rural Development	Yes	Extension – Community (MSF)
P6	Department of Agriculture & Rural Development	Yes	Extension – Community (MSF)
P7	Department of Agriculture & Rural Development	Yes	Extension – Community (MSF)
P8	Department of Agriculture & Rural Development	Yes	Extension – Community (MSF)
P9	Department of Agriculture & Rural Development	Yes	Extension – Community (MSF)
P10	Department of Agriculture & Rural Development	Yes	Extension – Community (MSF
P13	Department of Agriculture & Rural Development	Yes	Extension – Community – University

With respect to research question 1b: **“*if not, what exists and its nature***, the following results emerged.

Table 52: The nature of what exists between government (as represented by extension advisors), MSF and the university

S/N	Name of Institution/Stakeholder	Partnership Involvement with MSF?	What exists? What is its nature?
P11	Department of Agriculture & Rural Development	No	*Consultation* - *Production planning)*
P12	Department of Agriculture & Rural Development	No	*Consultation* - *Production planning* - *Consolidation of business plan*

The analysis shows that though 15.4% (2 out of 13) of participants indicated that they are not in partnership with MSF. However, they are involved in "production planning and consolidation of business plans" as per their work demands. However, the two participants did not indicate if these services are offered to smallholder farmers, commercial farmers or other stakeholders.

So, in terms of **what exists and its nature**, the following views were elicited:

> "*I am involved in production planning, advice on crop production as well as survey and need identification"* (P11).

In a similar view, participant 12 responded as following:

> *"I am involved in production planning and consolidation of business plans"* (P11).

As indicated earlier, the analysis shows that even though 2 out of the 13 participants stated that they do not partner with Msinga smallholder famers and the university, however, they offer services (extension services) in relation to their job demands.

As evident in the above excerpts, P11 stated that she is involved in production *planning* and also conducts *survey on needs identification.* Similarly, P12 indicated that she is involved in *consolidation of business planning* and "*production planning*". Conclusively, it can be said that the nature of what exists between the agricultural extension practitioners that are not in partnerships is in the form of *consultation*.

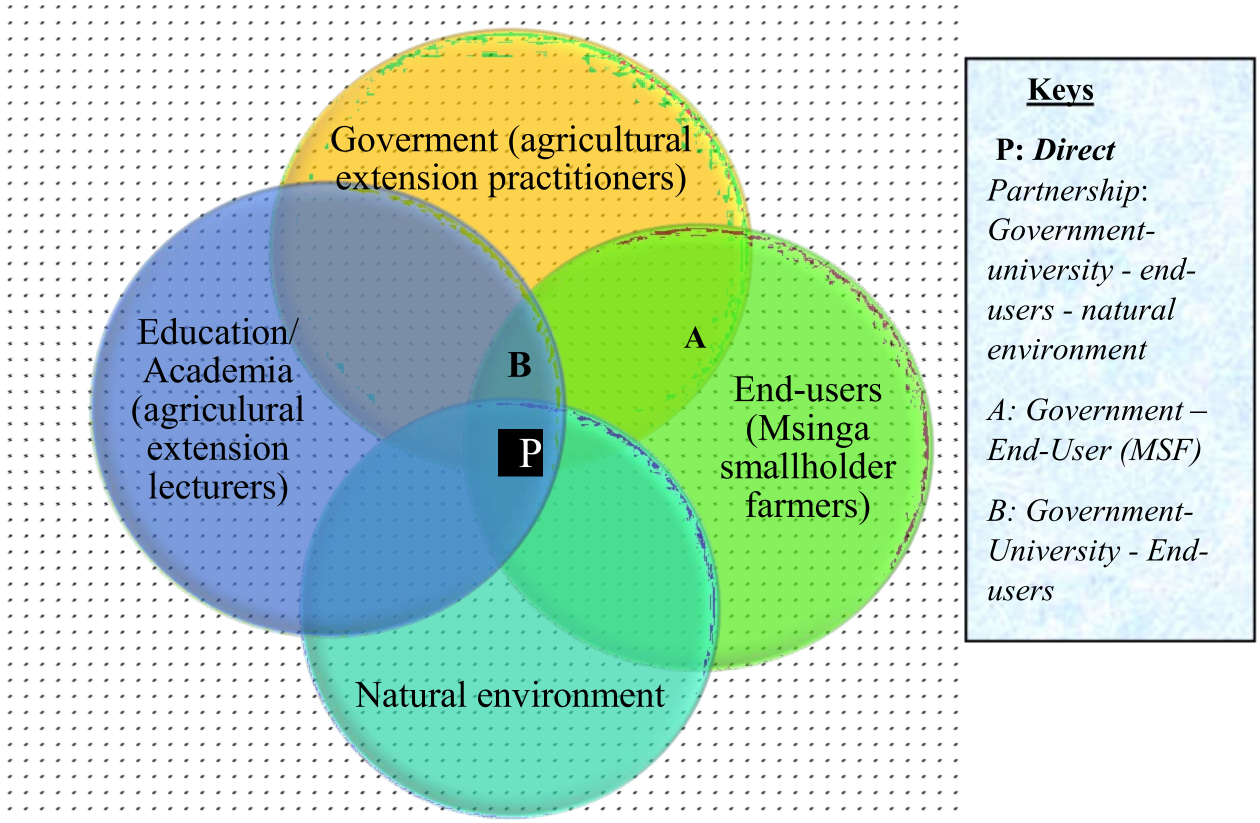

Figure 37 Partnerships in existence between government, university, end-users and natural environment

As can be seen from the Table 51 and Figure 37, 84.6% (11 of 13) of the participants from the government (extension practitioners) indicated that they are in partnership with the end-users/public who in this case are represented by Msinga smallholder farmers, education system/academia (agricultural extension lecturers) and the natural environment, which is an inherent partner in all QHIM configuration. In terms of the type of partnerships that exists, nine participants out of the 11 participants indicated that they are in a two-legged type of partnership. The participants are P1, P2, P3, P5, P6, P7, P8, P9 and P10. On the other hand, two participants (P4 and P13) stated that they are in a trilateral (three-legged) partnership. According to P4 and P13, a partnership exists between them and the other two stakeholders engaged in this study. The two stakeholders are Msinga smallholder farmers (community/end-users) and one higher education institution in KwaZulu-Natal. The role of each actor/stakeholder in these partnerships will be explicated in the next chapter.

8.4 ANALYSIS OF PARTNERSHIPS IN EXISTENCE BETWEEN COMMUNITY/END-USER (AS REPRESENTED BY MSINGA SMALLHOLDER FARMERS) AND OTHER STAKEHOLDERS

Even though 40 participants took part at different levels of the preliminary study, only 15 out of the 40 Msinga smallholder farmers participated in the main study. Amongst them were 11 females and 4 males. The age group of the participants ranged from 21 to 59 years; such biographical data was presented in Chapter 5. With respect to the first research question, which sought to understand if a partnership exists between the farmers and other key actors, such as the government and the university, the following result was generated.

Table 51: Partnership involvement between Msinga smallholder farmers, government and university

Are you involved in any form of partnership with stakeholders such as the government and university on climate change?				
Partnership Involvement	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Yes	11	73.3	73.3	80.0
No	4	26.7	26.7	100.0
Total	15	100.0	100.0	

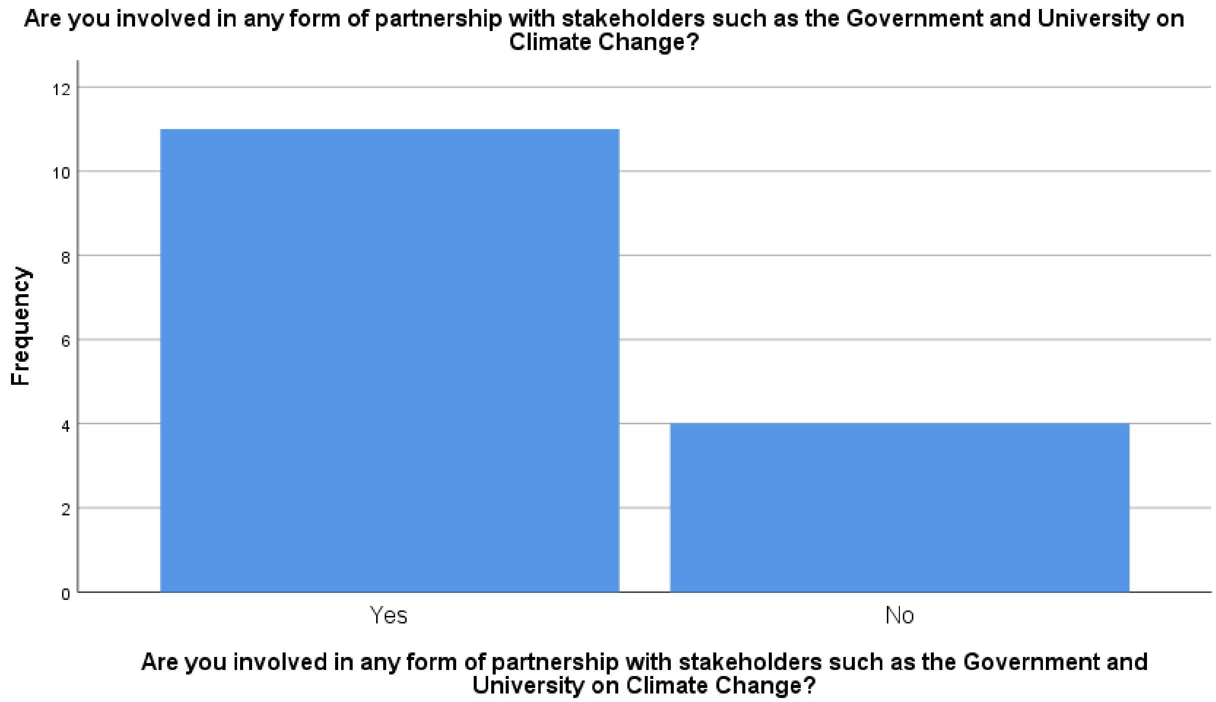

Figure 38*:* Partnership involvement between Msinga smallholder farmers, government and university

As indicated in the above Table 53 and Figure 38 above, 73.3% (11 out of 15) of the participants that took part in the main study stated that they are in **"direct"** partnership with other stakeholders while 26.7% (4 out of 15) of the participants indicated that they are not in partnership with any stakeholder. It is clear that the farmers in partnerships regarding weather and climate change are much higher in number than those that are not.

With respect to research question 1a: ***If so, what type of partnership exists amongst these actors with respect to changing weather and climate patterns and their impact on agriculture in South Africa?***

The analysis reveals 73.3% (11 out of 15) of end-users (as represented by Msinga smallholder farmers) are in partnership with the government and the academia as earlier indicated. The analysis further shows that 7 out of the 11 are in partnership with the government. The participants include P1, P4, P5, P6, P9, P11 and P15. On the other hand, a participant (P 8) stated that they partner with the SETA (Sector Education and Training Authority). Still, the analysis shows that 3 out of the 11 participants did not specify the type of partnership they are involved in. The details with regard to the type of partnership are presented in Table 54 below.

Table 54: Type of Partnerships between MSFs, government and university

S/N	Name of Institution/Actor	Partnership Involvement?	Type of Partnerships
			End-user, Government, University & Natural Environment
P1	Msinga Smallholder Famers	Yes	Community/End-users (MSF) – Government
P2	Msinga Smallholder Famers	Yes	-
P4	Msinga Smallholder Famers	Yes	Community/End-users (MSF) – Government
P5	Msinga Smallholder Famers	Yes	Community/End-users (MSF) – Government
P6	Msinga Smallholder Famers	Yes	Community/End-users (MSF) – Government
P8	Msinga Smallholder Famers	Yes	Community/End-user (MSF) – Higher Education Institution (SETA)
P9	Msinga Smallholder Famers	Yes	Community/End-users (MSF) – Government
P10	Msinga Smallholder Famers	Yes	-
P11	Msinga Smallholder Famers	Yes	Community/End-users (MSF) - Government
P12	Msinga Smallholder Famers	Yes	-
P15	Msinga Smallholder Famers	Yes	Community/End-users (MSF) - Government

With respect to research question 1b**:** ***If not what exists? What is its nature?*** the four participants that do not partner with any stakeholders with respect to changing weather and climate maintained that they ***handle their matter themselves*** without any help or support from anybody. This implies that the four participants are **self-reliant.** The views of the farmers are captured in the excerpts below.

> *"We had advisors long ago; they were not working at the office and working with us in the fields. Today advisors are now working at the office. Where are we supposed to get information when advisors work at the office? We don't get support from anywhere"* (P7).

In the same vein, participant 13 stated that there is no support available to them, even though their plants are getting destroyed. This is captured in the excerpt below.

> *"There is not support available to us. Our plants are getting destroyed, but no support"* (P13).

In concurring with the foregoing perspectives, P14 indicated that they address their agricultural challenges or matters themselves without help from anywhere.

> *"There is no support that we receive from anywhere, we handle matters ourselves"* (P14).

Still on question 1a "What exists? What is its nature?" P3 indicated that they are not in partnership with any of the stakeholders. Her view is captured below:

> *"We are not cooperating with any of the institutions or organizations you have mentioned"* (P3).

In the light of the foregoing, it is evident that four participants are not in partnership with any stakeholder in relation to climate change and its effect on smallholder farming communities such as Msinga. Therefore, the response to question 1a: "If not, what exists? What is its nature?" for these four participants can be summarized as "**self-help/self-reliance**".

Table 55: The nature of what exists between MSFs and government and university

S/N	Name of Institution/Actor		Partnership Involvement with Stakeholders?	RQ1a - What exists? What is its nature?
P3	Msinga Famers	Smallholder	No	-
P7	Msinga Famers	Smallholder	No	- Self-help/Self-reliance
P13	Msinga Famers	Smallholder	No	- Self-help/Self-reliance
P14	Msinga Famers	Smallholder	No	- Self-help/Self-reliance

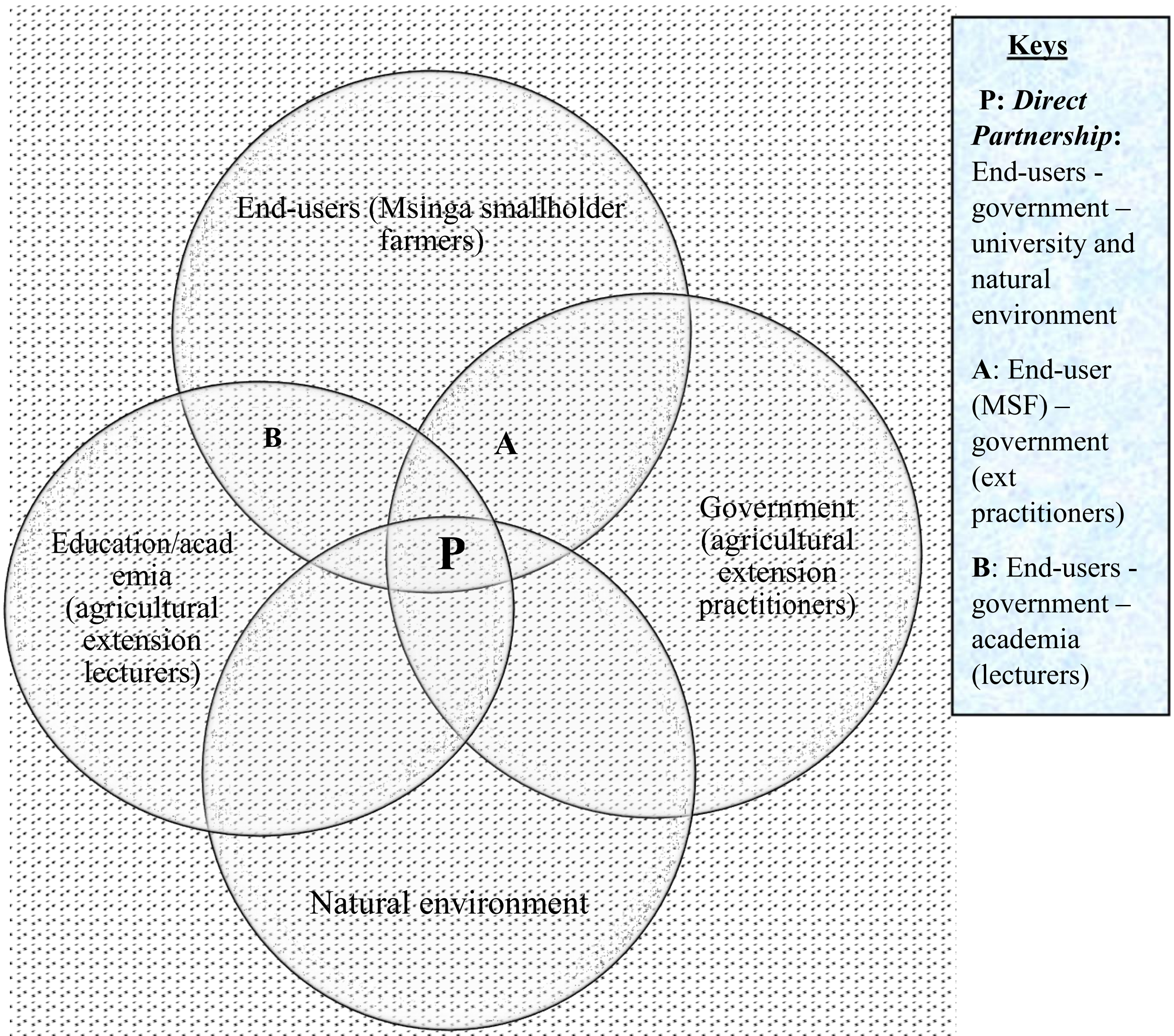

Figure 39: Partnerships in existence between end-users, government, university, and natural environment

As indicated in the Table 54 above, some of the end-users (Msinga smallholder farmers) engaged in this study are in partnership with other stakeholders such as government (agricultural extension practitioners), and the academia (agricultural extension lecturers). Given that the natural environment is implicitly embedded in all knowledge/innovation partnerships, therefore, it can be said that the end-users are in partnership with three sectors, these are the government, the education systems/academia, and the natural environment. The role of each actor/stakeholder in these partnerships will be explicated in the next chapter.

Table 52: Summary of findings for research question one in the main study

S/N	Name of Institution	Partnership Involvement with University, Government & MSF (Community)	If not, What exists? What is its nature?	Type of Partnerships in Existence
1	University (Academia)	Yes – 2 (66.7%) No – 1 (33.3%)	- Nothing	- Education/academia (university lecturers) - End-users (Msinga Smallholder farmers)- Natural environment - Education/academia (university lecturers) – Non-governmental organization (NGO) - Natural environment
2	Government (extension practitioners)	Yes -11 (84.6%) No – 2 (15.4%)	- Consultation	- Government(extension practitioners) – End-users (Msinga smallholder farmers) - Education/academia (university lecturers) - Natural environment
3	MSF (Community/ end-user)	Yes – 11 (73.3%) No – 4 (26.7%)	- Self-reliance	- Community/End-user (MSF) - government - Community/end-user (MSF) - Education (SETA).

8.5 CONCLUSION

This chapter explored the existence of partnerships amongst university, government and Msinga smallholding farming communities (academia, government and end-users). The analysis was guided by the Quintuple Helix Innovation Model (QHIM). QHIM is a five stakeholder innovative configuration, which includes the education system/academia, the political system (government), the economic systems (industry), the natural environment and the media- and culture based public (end-users). In this configuration, the natural environment was identified as the driver or motivation for novelties and not an actual partner. The result of the analysis revealed that there is a high percentage of partnerships in existence amongst the three stakeholders engaged in the study. For instance, 66.7% of participants from the education systems/academia, which are represented by university lecturers, were found to be in partnerships with other stakeholders. On the other hand, 33.3% of the participants were found not to be in any form of partnership with other stakeholders. With regard to the type of partnership that exists between them and other stakeholders, the analysis revealed two forms/types of partnerships. The first type of partnership was categorised as an "indirect/representative" type of partnership. This means that the stakeholders from the education system/academia were not "directly" involved with end-users and the government rather, they are indirectly involved with these stakeholders through student engagement. Under this indirect or representative partnership, the students undertake internships and field trips to different farms with the country. The second type of partnerships a direct form of partnership between the university and non-governmental organization (trust).

Similarly, total of 84.6% (eleven of 13) of the participants from the government indicated that they are in partnership with other stakeholders (education systems/academia, end-users and the natural environment) with respect to climate change. The analysis further shows that the types of partnerships that exists between the government stakeholders and other stakeholders is "direct" or formal in nature. As for the participants that are not in partnership with MSF or the University, the analysis shows that they offer consultation for production planning. However, it was not clear as to which stakeholders they offer their consultation services to. Furthermore, 73.3% (eleven out of 15) of the sampled population from the community (Msinga smallholder farmers) stated that they are in partnership with the government and education systems/academia. Seven participants out of 11 participants indicated that they are in partnership with the Department of Agricultural and Rural Development while one of the 11 participants stated that they are in partnership with a SETA (Sector Education and Training Authority). However, three participants did not indicate the stakeholders they partner with, even though they have earlier indicated that they are in partnership. With respect to the participants that are not in any form of partnership, the analysis shows that they are "self-reliant". In the next chapter, the analysis of Phase 2 of the main study will be presented. The chapter will explore the role of each stakeholder in these partnerships and why they play such roles.

CHAPTER NINE

MAIN STUDY

THE ROLES OF THE STAKEHOLDER GROUPS IN EXISTING PARTNERSHIPS ON CLIMATE CHANGE ADAPTATION MAINSTREAMING

INTRODUCTION

The previous chapter presented the analysis for research question one in the main study. The chapter explored the existence of partnerships amongst the education systems/academia (represented by agricultural extension and lecturers), government (represented by agricultural extension practitioners) and end-users (represented by smallholding farming communities) with respect to climate change and its impact on livelihoods. A summary of the findings is presented in Table 53 below.

Table 53: Summary of Chapter 8 Findings

Stakeholder groups	Partnership Existence	Types of Partnerships
Education/academia (represented by agricultural and natural resources lecturers)	**Yes** - 2 **No** - 1	• *Indirect/representative partnership (university - farmers-natural environment)* • *Direct partnership (university-NGO – natural environment*)
Government/political system (represented by agricultural extension practitioners from the Department of Agriculture	**Yes** - 11 **No** - 2	• *Direct partnership (agricultural extension – university – farmers – natural environment*
End-users/culture-based public (represented by Msinga smallholder farmers	**Yes** - 11 **No** - 4	• *Direct partnership - (farmers - agricultural extension – university – natural environment*)

In this current chapter, I will present the analysis of the second research question in the main study, namely:

- ***What are the roles of each of the actors in these partnerships and why are these roles foregrounded?***

In the light of the above research question, this chapter focuses on establishing the roles of each of the stakeholder groups (partners) in the partnerships identified in chapter nine. The chapter is divided into five broad sections. Section 9.1 presents the roles of academia (as represented by the Agricultural Extension and Rural Development lecturers) in their partnerships with the other stakeholders. Section 9.2 addresses the role of the government (as represented by agricultural extension practitioners from the Department of Agriculture) in their partnerships with other stakeholders. Section 9.3 unearths the role of the end-users (as represented by Msinga smallholder farmers) in their partnerships with other stakeholders. Lastly, section 9.4 is the conclusion to the chapter.

The analysis in this chapter is guided by a combination of Quintuple Helix Innovation Model (QHIM) and Sustainable Livelihood Approaches/Framework (SLA). As explained previously in chapters 3 and 8, the QHIM is an institutional innovative configuration between five stakeholders namely:

- The education system/academia,
- The economic system/industry,
- The political systems/government,
- The media-based and culture-based public/end-users
- The natural environment (Carayannis et al., 2012).

In this configuration, the natural environment is not an actual actor or helix, rather, is the driver of new knowledge and innovation in response to environmental challenges (Grundel & Dahlström, 2016). According to Carayannis et al. (2012), the addition of the natural environment highlights the importance of the relationships between nature and the society and their co-evolution. This implies that the natural environment helix emphasises the importance of sustainability in the evolution of knowledge and innovation in the society. On the other hand, the sustainable livelihood approaches focus on the ability of individuals and groups to cope with and recover from stresses and shocks arising from climate change and other environmental challenges (Scoones, 1998). As a framework, it provides the analytical tool for analysing the dynamic dimensions of poverty and well-being by exploring the types of assets (natural capital, human capital, social capital, physical capital and natural capital) that poor households and rural communities deploy to sustain and maintain their well-being under changing living conditions (Norton & Foster, 2001). Having said that, the combination of components of QHIM and SLA were employed in analysing the data that emerged in this chapter. These two theoretical lenses are applied in identifying and analysing the roles of the stakeholders/helices of academia, government and end-users in their partnerships on climate change adaptation within smallholder farming communities such as Msinga. Bearing the above explanation in mind, the role of the University stakeholder group in its partnership with the other stakeholders engaged in this study is presented and analysed.

9.1 THE ROLES OF THE ACADEMIA IN EXISTING PARTNERSHIPS WITH END-USERS

Ideally, there is a clear differentiation of roles in all partnership arrangements. This is exemplified in partnership arrangements between the education systems/academia, political system/government, economic system/industry, natural environment and end-users under the QHIM. Pinkse and Kolk (2012) explain that each stakeholder involved in a partnership brings something unique to the table to help the group in achieving its common goal. For example, in a trilateral collaboration between the Industry, NGOs and Government, the industry brings specific knowledge and expertise, the NGO provides local embeddedness and capacity building; while the government provides funds (Kolk et al., 2008).

As indicated in Table 53 above, two out of the three participants representing the education system/academia stakeholder group indicated that they are in partnership with other stakeholders. With respect to their roles in these partnerships the following categories of description were elicited.

Table 54: The roles of academia in its partnerships with government and end-users

Stakeholder	Types of partnership	Roles in partnership	Why are these roles foregrounded?
Education System/Academia (represented by university lecturers)	• Indirect/representative partnership: University - End-user - Natural Environment	• Advisory, consultation and skills development	• To provide future officers with practical farming skills
	• Direct partnership: University - NGO - Natural Environment	▪ Liaison ▪ Researcher	To upgrade their teaching programme To address food insecurity

9.2.2 Analysis of the roles of academia in the indirect/representative partnerships

As indicated in Tables 53 and 54 above, the stakeholders from the academia are in two categories of partnership with end-users and NGOs (Trust). These partnerships were categorised as "indirect or representative" and "direct partnership". In the *indirect partnership*, the analysis shows that the participants (academia) play the *advisory, consultative and skills development role*. The analysis of the above role is presented below.

9.2.2.1 Advisory, consultative and skills development role

This category of description was derived from the participants' responses to the explicit question on their roles in the partnerships with other stakeholders. The participants explained that their role is in the form of **advising and consulting on learning interventions** and in providing future officers with practical farming skills.

> *"Not directly involved, main role is in the form of advising and consulting on learning interventions and in providing future officers with practical farming skills"* (P1).

The above category of description is consistent with the roles of the education system/academia in development of knowledge and innovation under the QHIM (Carayannis et al., 2012). The role of education system in the QHIM configuration is to develop the '**human capita**l' such as students, teachers, scientists/ researchers, academic, entrepreneurs, etc of the nation/state (Carayannis et al., 2012, p. 6). Significantly, the **human capital** is a very vital capital within the **sustainable livelihood approaches**. According to Morse and McNamara, (2013, p. 19), **access to human capital,** such as skills, knowledge, abilities, etc., are critical for the successful pursuit and sustenance of livelihoods. In contrast, **lack of access** to or failure to develop livelihood capitals or resources such as "human capital" is a major barrier to mitigation and adaptation to climate change, especially in rural contexts (Gbetibouo, 2009b; Obayelu, Adepoju & idowu, 2014). This shows that **QHIM** and **SLA** are interdependent, given that the innovation arising from **QHIM** is necessary for achieving livelihood outcomes under the **SLA** as seen above. Therefore, application of both theories in this study will assist in the generation/development and dissemination of knowledge with respect to mainstreaming climate smart technology adaptation in smallholder communities such as Msinga.

Furthermore, Odora Hoppers (2001, p. 79) and Stephens et al. (2008) reason that higher education institutions as citadels of learning play a leading role in skills development, knowledge production, validation and dissemination. Stephens et al. (2008) go on to explain that universities play a leading role as change agents in society's transition towards sustainability. In this regard, Bangay and Blum (2010) and Mochizuki and Bryan (2015) suggest that the role of education is indispensable in responding to the threats of climate change. When considered in the context of this study*, the advisory, consultative and skills development* role of academia is critical in the development of *human capital* for the sustainability of livelihoods of the *end-users/culture-based public* as well as their *natural environment*. With respect to "**Why"** the above role was foregrounded the analysis shows that the desire to provide *practical farming skills* (which is linked to human capital in SLA) for a future agricultural workforce was their rationale for playing the above roles.

9.2.3 Analysis of roles of academia in the direct partnerships

As stated earlier, stakeholder from academia are in two types of partnerships, namely, indirect/representative and direct partnerships. Their roles in the indirect partnership were analysed in 9.2.2 above. With respect to their **role**s within the *direct partnership*, the analysis pointed to the following: *liaison role*, and *researcher role***.** The analyses of the two categories of description is presented below.

9.2.3.1 Liaison role

This category of description was derived from the participants' responses to the explicit question on their roles in the partnerships with other stakeholders. With respect to the above category of description, the analysis shows that the participants from academia plays a "**liaison role**". According to the Oxford South African Concise Dictionary (2006), the term "**liaison**" means communication or cooperation between people or organisations.

> "*Wildlands Trust. Liaison regarding latest developments with respect to climate change observations and policies with a view to updating our teaching programme"* (P1).

As shown in the above quote, the university stakeholder group partners or **liaises** with an NGO known as the "*Wildlands Trust regarding latest developments with respect to climate change*". Liaising or cooperating with other stakeholders with respect to climate change is considered necessary, given that the problems associated with climate change cannot be addressed by a single sector (Sullivan, Mwamakamba, Mumba, Hachigonta, & Majele Sibanda, 2012). Sullivan, et al. (2012) further reason that climate related problems in sub-Saharan Africa require novel approaches, partnership and opportunities to assemble people with multiple perspectives, roles and responsibilities (Ibid.). With respect to "**why**" these roles were foregrounded, the analysis shows that the participants intend "*to upgrade their teaching programme*". By implication, liaising with other stakeholders with respect to climate change will enable them to develop and share relevant knowledge and innovation (cross-fertilisation of ideas) on climate change adaptation. Analysis of academia's role as **researchers** is presented next.

9.2.3.2 Researchers' role

This category of description was derived from the participants' responses to the explicit question on their roles in the partnerships with other stakeholders. The analysis reveals that academia/the education systems stakeholders (university lecturers) play the role of researchers in their partnership with the NGO. This is captured in the excerpt below.

> *"Welcome Trust/Sustainable Healthy Food Systems (SHEFS). I am one of the researchers under the research group, and we are looking at community food security and nutrition"* (P2).

It is clear from the above vignette that the education/academic stakeholder group (represented by agricultural extension lecturers) plays the "*role of researcher"* in their existing partnerships with other stakeholders. The analysis further reveals that the research interest in this partnership is on *"community food security and nutrition".* Hence, it can be argued that the justification (**Why**) for assuming the role of researcher is to contribute to the "*attainment of food security*" in communities. Research centred on "*community food security and nutrition*" is quite significant especially because food insecurity remains a major problem in sub-Saharan Africa (Lipper et al., 2014). According to United Nations Economic Commission for Africa (UNECA) (2016) report, 46% of the people living in hunger and extreme poverty today are in Africa.

In South Africa, Mugambiwa and Tirivangasi (2017) found that food security has been highly compromised as a result of decrease in crop production arising from climate change. Therefore, partnership arrangements geared towards food security, such as those identified above, is necessary, given that achievement of food security is a key livelihood outcome and a major sustainable development goal. It is anticipated that the novelties developed from the existing partnership between academia/the education system and the other stakeholders in this study will contribute to achieving *community food security and nutrition* in rural contexts such as Msinga.

9.3 THE ROLE OF THE GOVERNMENT IN EXISTING PARTNERSHIPS WITH END-USERS AND ACADEMIA

With respect to the participants (government stakeholder group) that responded affirmatively, the analysis of their responses pointed to the following two broad categories of description:

Table 55: The roles of government in its partnerships with academia and end-users

Stakeholder	Types of partnership	Roles in partnership	Why are these roles foregrounded?
Political system/government (represented by agricultural extension practitioners)	• Direct partnership: Government - End-user - Natural environment	• ***Advisory and conscientisation***	• *To fulfil their duties of the extension officer*
	• Direct partnership: Government Academia - End-user - Natural environment	• ***Meditation Role***	

In the sections that follows, each category of description with respect to the roles of the government in existing partnerships will be presented and analysed.

9.3.1 Advisory and conscientisation role

This category of description was derived from the participants' responses to the explicit question on their roles in the existing partnerships and from their recurrent reference to what they advise farmers on. With respect to the above category of description, the analysis shows that the agricultural extension practitioners (government stakeholder group) play an *"advisory and conscientisation role*" in the partnership that exists between them and Msinga smallholder farmers (end-users/culture-based public). Furthermore, the analysis reveals the areas or agricultural issues the participants advise the end-users on. For instance, the participants stated that they *"advise farmers"* on the following issues:

- Animal production and environmental management
- Agricultural decision making according to climatic condition
- Crop production
- Irrigation and planting techniques
- Drought and pest Control

9.3.1.1 Advisory and conscientisation role: Animal production and environmental management

With respect to the above category of description, the analysis shows that the agricultural extension practitioners play an *advisory and conscientising role* in their interaction with Msinga smallholder farmers. In addition, the analysis shows that the participants offer advice on *animal production and environmental management.*

> *"Doing **advisory** to farmers"* (P10).

> *I advise farmers especially **on animal production** side not to use **chemicals that can affect the environment** and climatic conditions like dip, bury dead carcasses instead of burning them**,** also ploughing back animal litter/manure to cropping fields instead of throwing it around which affect the environment & climate with gases"* (P1).

As evident in the above vignettes, the roles of the agricultural extension practitioners are advisory and conscientisation in nature. This role was confirmed in the except presented below.

> *"…as the extension officer, one of my duties is to **help the farmers to be aware** of what can be **harmful to their lives and to the environment** as well as to **livestock** and produce that will make decrease in their production leading to loss and get poor quality that will not be suitable for market"* (P6).

Interestingly, the above analysis not only revealed the roles of the extension practitioners, but it also highlighted the stakeholder group they are in partnership with and the areas or issues they offer advice on. The participants explicitly mentioned that they *"advise farmers*" on "*animal production not to use chemicals that can affect the environment***.** They emphasise that they *make farmers aware (conscientise farmers)* of what can be **"**harmful" to their lives and to **"**the environment as well as to livestock". This means that they advise or conscientise farmers on what actions to take in their farming activities, given that their choices will either impact positively or negatively on animal production and the environment.

9.3.1.2 Advisory and conscientisation role: Agricultural decision making according to climatic condition

Again, the analysis affirmed that the role of the government stakeholder group is advisory in nature. Furthermore, the analysis showed that they advise farmers on how to make appropriate farming decisions in relation to the climate condition of their community. The excerpt is presented below.

> *"**I am involved in advising** them to **plant vegetables according to the climatic conditions** of the area. **I encourage** them to **consider climate** when planting since **weather** has huge **impact on agricultural production**"* (P7).

As explicitly presented above, the extension practitioners are involved in advising farmers. With respect to what they advise farmers on, the analysis shows that they advise farmers to plant vegetables according to the climatic conditions of the area. The role of the extension practitioners and what they advise farmers on was echoed below:

> *"**My role** is to **advise** them on recommended ways to deal **with climate change complications** in order to adapt to changes"* (P13).

The foregoing views was again echoed in the vignette below.

> *"As an agricultural advisor, I spent most of my time with farmers **observing** what they did **correct and wrong.** If I see someone doing what is wrong and which is harmful in our environment, **I will raise awareness**"* (P3).

It is therefore clear that one of the roles of the extension practitioners in their partnership with smallholder farmers is to advise and conscientise (raising awareness) on their practices. Should the farmer's farming activities become harmful to the environment, the extension practitioners will *conscientise* (raise awareness) them**.** The advice offered to farmers is related to agricultural decision making in line with climatic conditions.

9.3.1.3 Advisory and conscientisation role: Irrigation and planting techniques

Again, the analysis revealed that the role of the government stakeholder group is in this partnership is **advisory** in nature. The participants repeatedly mentioned that they "*advise them*" on the need to *irrigate*, to *harvest* and *save water*.

> *"I do **advise** irrigation farmers **to irrigate when the plant,** and they also to **save water because plants need water to grow**. **I advise** them on **planting times** as the season **planting dates changed** because of climate change. I advise farmers on **no till planting to prevent dust and fossil air coming out from tractors**. I advise farmers to prevent burning of plant residues to protect the environment and also use of inorganic farming"* (P3).

> *"**I did capacitate them on aware of climate change** by trying to look at cultivars that are drought tolerant and making them know that since we are facing the drought, whenever they do planting, they need to **save water, not misusing** it. If there **are water available, they should have to harvest water and store water on drums**"* (P5).

As seen above, the extension practitioners *conscientise* (capacitate) farmers on climate change. With respect to what the extension practitioners advise farmers on, the analysis shows that they advise them on issues related to irrigation/water management and planting techniques adaptable to current climate**.** Some of the techniques include changing the planting dates.

In the words of the participants, they do "advise irrigation farmers to irrigate when they plant**,** and also to save water because plants need water grow". "Whenever they do planting, they need to save water, not misusing it". It is clear that farmers are providing advice on irrigation and water management etc.

9.3.1.4 Advisory and conscientisation role: Crop production

With respect to the above category of description, the analysis shows that farmers are "advised agriculturally" on what types of crops and vegetables should be planted.

> *"They are agriculturally **advised** on **vegetables and agronomic crops** specifications which include, inter alia, **crops and vegetables adapted** to or tolerant to specific climatic and soil conditions, control of related diseases and pests, just to mention a few"* (P4).

Again, the participants confirmed that they advise and conscientise the farmers on crop production and ways of adapting to climate change.

> *"I provide extension or **advisory** services **on crop production** to subsistence farmers for food security"* (P9).

As evident in the above excerpts, the role of the government stakeholder group, as represented by the agricultural extension practitioners in this study, is "advisory and conscientisation in nature**.** On what they advise farmers on**,** the analysis shows that they offer advice on crop production" to subsistence farmers for food security.

9.3.1.5 Advisory and conscientisation role: Drought and pest control

Still on the roles of the extension practitioners, the analysis shows that they conscientise the farmers (creating awareness).

> *"I am involved in **creation of awareness** to the farmers when they are facing **the problem of drought** and also when there is outbreak of **unknown diseases and pests** that are unusual in the area of work. Farmers should avoid burning of field and plant residues that can make smoke that will cause air pollution that can be the effect on weather and climate change"* (P6).

As indicated in the excerpt above, the extension practitioners are involved in creating awareness (conscientisation). Their conscientisation and advice is centred on *drought* and control of *unusual disease and pests.*

Based on the foregoing analysis, it is clear that the role of government stakeholder group in their partnership with MSF is in the form of advisory and conscientisation (creating awareness). Their advice to the farmers is related to animal production and crop production (agricultural decision making) in line with climatic conditions of the area. Again, farmers are advised on irrigation, drought and pest control. In addition, they raise awareness when farmers engage in activities that could be harmful to the environment. With respect to why they play such roles, the analysis tacitly shows that their job description or duties and responsibilities as agricultural extension practitioners place them in the position to conscientise and advise farmers on issues related to farming. In their words, the participants indicated that the "duties of the extension officer" is to help the farmers to be aware of what can be harmful to their lives and to the environment as well as to livestock. The foregoing roles shows that agricultural extension practitioners are critical stakeholders in agriculture development and the achievement of the sustainable development goal of food security.

The above findings correspond with other studies conducted within and outside the country. For instance, Fosu-Mensah et al. (2012) found that agricultural extension "advisors educate farmers on the best farming practices", hence increase the adoption levels of technologies. Again, Sulaiman and Van den Ban (2003) in their study of situation and functions of agricultural extension services in India found that the main function of extension advisors is to work as knowledge brokers in facilitating the learning process among different types of farmers. Likewise, the findings of the study by Gbetibouo (2009a) in Limpopo Province of South Africa revealed that farmers that have access to agricultural extension practitioners are likely to perceive changes in the climate because "extension services provide information about climate and weather".

Furthermore, Gbetibouo (2009a) posits that farmers use this information and advice from the extension practitioners to improve their land and resources management strategies, which often result in improved soil fertility and higher agricultural output. This means that access to extension practitioners (services) through partnerships (as obtainable in this study) will improve the human capital (awareness, knowledge and skills) as well as livelihood strategies/pathways of farmers. In the long run, the possibility of *attaining livelihood outcomes such as food security, reduced vulnerability and adaptation to climate change* is enhanced.

As seen in the above analysis, the government stakeholder group did not just indicate their role in these partnerships; they also outline the issues they advise the other stakeholders on. These issues are presented in Table 56 below.

Table 56: The issues the government (agricultural extension practitioners) advise end-users (farmers) on

S/N	Institution	Roles in Partnership	Issues advised on
P1	Government (Department of Agriculture)	Advisory and Conscientization	▪ Effect of chemicals on the environment. ▪ Climate vhange
P2	Government (Department of Agriculture)	Advisory and Conscientization	
P3	Government (Department of Agriculture)	Advisory and Conscientization	▪ Irrigation; Mitigation; ▪ Environmental protection, ▪ Agricultural decision making according to climatic condition ▪ Impact of weather & climate on agricultural productivity
P4	Government (Department of Agriculture)	Advisory and Conscientization	▪ Adaptation to climatic condition; ▪ Pest control
P5	Government (Department of Agriculture)	Advisory and Conscientization	▪ Drought management ▪ Water harvesting
P6	Government (Department of Agriculture)	Advisory and Conscientization	▪ Drought; ▪ Outbreak of disease and; ▪ Pest control
P7	Government (Department of Agriculture)	Advisory and Conscientization	▪ Agricultural decision making to the climatic conditions
P9	Government (Department of Agriculture)	Advisory and Conscientization	▪ Crop production for food security
P3	Government (Department of Agriculture)	Advisory and Conscientization	▪ Adapting to climate change

9.3.2 Mediation role

This category of description was derived from the participants' responses to the explicit question on their roles in these partnerships. With regard to the above category of description, the analysis shows that the government (extension practitioners) plays a **mediation role** between smallholder farmers and the higher education institutions as well as the environment. According to participants, they are required to identify and nominate farmers who will be trained on issues around climate change.

> *"The department staff has twice been requested to identify and nominate climate change workshop attendese (farmers) in Cedara, where in the end those nominees received climate change certificate of attendance…"* (P4).

The participants emphasised that their **role** in this partnership is to "**mediate**" between the three stakeholders engaged in this study, namely, government, academia/the education system and end-users/media-based public.

> *"I mediate between farmers and stakeholders so that they would interact best to support the emerging farmers adapt to changing climate, sharing of knowledge and ideas and provide services such as implements and goods that may assist in the scourge"* (P13).

This shows that the role of the agricultural extension practitioner is interfacing/coordinating the activities and relationships between the higher education institutions and smallholder farmers in Msinga. As the participants clearly stated, they "mediate between farmers and stakeholders" in order to offer support to emerging farmers with respect to climate change. This mediation role facilitates the sharing of knowledge, ideas, implements and services that leads to adaptation to the scourge of climate change. The above views resonate with those of Anderson (2008), who reasons that extension practitioners play an important bridging function between scientists and farmers by disseminating innovations from research to farmers. In the context of this study, knowledge and innovations such as "agricultural decision making according to climatic conditions, irrigation and pest control" and others identified and explicated above were disseminated by the extension practitioners. In addition, Anderson (2008) explained that the extension practitioner helps to articulate for research systems the problems and constraints faced by farmers in rural contexts. When considered appropriately, the position and roles of the agricultural extension practitioners in this study are critical. They are in a position to identify and escalate the problems of smallholder farmers in Msinga (end-users) to other relevant stakeholders.

Still on the mediation role of the extension practitioners, the analysis shows that they partner with the Agricultural Research Council (ARC) to introduce drought tolerant crops to farmers.

> *"I have been involved few years ago with ARC, which is Agricultural Research Council, trying to introduce drought tolerant cultivars of maize to the farmers by introducing some trials of WEMA (Water Efficient Maize in Africa). Those trials worked very well to resist drought since we were experiencing a lot of drought in our area"* (P5).

As shown in the except above, the extension practitioners were involved few years ago *"Agricultural Research Council (ARC) to introduce drought tolerant cultivars of maize to the farmers"*. This implies that the extension practitioners engaged in this study are already helping the farmers to adapt to drought and climate change by extension. This furthermore highlights the importance of their roles/position in the agriculture sector, especially in the wake of climate change and its effects. In the light of the above findings, scholars such as Agrawal (2010, p. 2) reason that local government institutions play an indispensable role in building resilience and reducing vulnerability in poor and marginal areas. According to Agrawal (2010), local institutions/departments (such as the Department of Agriculture) influence adaptation and vulnerability in three key ways:

(a) They structure impacts and vulnerability.
(b) They mediate between individual and collective responses to climate impacts and thus shape outcomes of adaptation.
(c) They oversee the delivery of external resources to facilitate adaptation.

The analysis in this chapter clearly shows that the mediation roles of agricultural extension practitioners in the local municipality where this study was conducted is in line with the position of Agrawal (2010) above. This mediation role is perhaps shaping the outcome of adaptation to climate as P5 stated above.

Additionally, the foregoing findings on the roles of the extension practitioners, concurs with the study by Anderson and Feder (2003). The study found that agricultural extension advisors serve as a direct link between government and the farmers and thus implement government policies and provide feedback from the farmers to higher levels of government. The authors argue that extension advisors also observe emerging innovations in agriculture and educate the farmers accordingly. Based on the findings in this chapter with respect to the role of the extension practitioners, it can be concluded that the agricultural extension practitioners are critical stakeholders (partners) in this research, given that they are in a position to influence the implementation of local government climate change adaptation polices and program. In addition, they are positioned to facilitate the adoption of adaptation strategies at farm level and in return escalate the concerns at farm level to relevant stakeholders, such as the education system/academia, as envisaged in Figure 40 below.

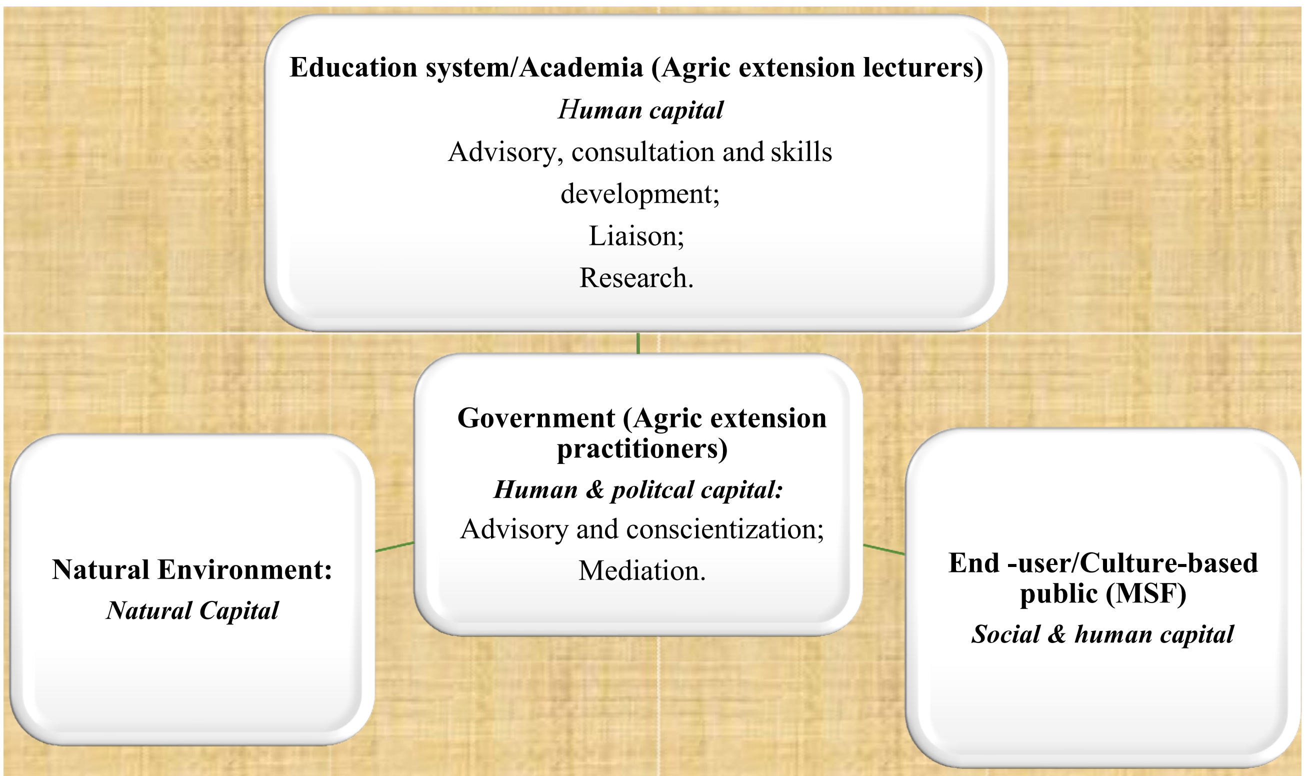

Figure 40: The role of agricultural extension practitioners in the partnerships between government, academia, end-users and natural environment

Figure 40 above captures and summarises the position and roles of the government participants (agricultural extension practitioners) in their partnerships or interactions with academia, end-users and natural environment. First, the participants' role was categorised as "*conscientization and advisory*". Here, they raise awareness and advise farmers on farm-related issues. Second, they play a "*mediation*" or intermediary role between the farmers and higher education institutions. These roles relate to the development of human and social capitals (resources) under the sustainable livelihood approaches.

When considered, these roles are similar to the role and responsibilities of agricultural extension as identified by scholars such as Anderson (2008) as well as Fosu-Mensah et al. (2012). According to these authors, the agricultural extension practitioners are the connecting point between different agricultural stakeholders and they educate farmers on how to tackle farm related challenges. On **why** the extension practitioners in this study plays these roles, the analysis showed that the demands or description of duties/job was the reason why the participants played these roles. Next, the analysis of the roles of the smallholder farmers is presented.

9.4 THE ROLE OF THE END-USERS IN EXISTING PARTNERSHIPS WITH UNIVERSITY AND GOVERNMENT

As indicated in Chapter 8, 7 participants out of the 13 that took part in the main study stated that they were in partnerships, in the form of a "**direct partnership**" with the other two stakeholders. This meant that they interact directly with the government stakeholder group (as represented by agricultural extension practitioners in this study) and the education/academia stakeholder group (as represented in this study by agricultural extension lecturers). With regard to the roles played by these participants in these partnerships, the following categories of description were elicited.

Table 57: Summary of the role of the end-users in existing partnerships with university and government

Stakeholder	Types of partnership	Roles in partnership	Why are these roles foregrounded?
End-user/Culture-based public (as represented by Msinga smallholder farmers)	• Direct partnership: End-user - Government - Natural Environment	• Recipients of information and services	• Not indicated

- **Recipients/end-users of information and services**

This category of description was derived from the participants' recurrent reference to the services they receive from the other stakeholders. The analysis shows that the end-user stakeholder group (Msinga smallholder farmers) does not play any clear roles besides receiving information and services provided by the other stakeholders. Those participants (MSF) who acknowledged that they are in partnership with the other stakeholders did not specify which roles they play in these partnerships. Hence, it was inferred that their role in these partnerships was to receive information and services from the other end-users.

> "*…..they gave us some fertilizer, they gave us cabbage and tomato seedlings"* (P6).

Again, the participants stated that they receive services from the other actors as reflected below.

> *"The university (Sector Education & Training Authority - SETA) has begun to help us in agriculture. We got to plant without having to buy seeds, we harvested and we got money through the crops* (P8).
>
> *"…I received cabbage seedlings and planted and I made money from selling" (*P9).

As can be seen from the above excerpts, the role of the participants in their partnerships with government and higher education institution is to receive and use information and services from the other partners. Hypothetically, one would also assume that the farmers play other roles such as escalating their farming challenges, especially those challenges related to climate change to the government (extension practitioners) and academia (university lecturers). The reason why these roles (recipients/end-users of information and service) were foregrounded was not made explicit.

Table 58: Summary of the roles of the actor/stakeholders in existing partnerships

Institutions	Type of Partnerships	Roles in Partnership	Why are these roles foregrounded?
University (*Lecturers*)	University - End-user- Natural environment	• Advisory, consultation & skills development • Liaison role • Researcher role	- To upgrade academic programme - To contribute to food community security
Government (*Agricultural extension practitioners*)	Government - End-user Academia - Natural environment	• Advisory & eonscientisation • Meditation role	- To meet with job description - To meet with job description - Not indicated
End-users/Culture-based public (*Msinga smallholder farmers*)	End-user - Government Academia - Natural environment -	▪ Recipients/End-users of information and services	

9.5 CONCLUSION

This chapter addressed research question two in the main study, namely: ***What are the roles of each of the actors in these partnerships and why are these roles foregrounded?*** The analysis was grounded on the Quintuple Helix Innovation Model (QHIM) and Sustainable Livelihood approaches. The analysis revealed that the stakeholders play different roles depending on the type and nature of partnerships that exists amongst them and in line with their job description. These findings resonate with studies done by scholars such as (Kolk et al., 2008) on the roles of stakeholders in partnerships. The analysis showed that the stakeholders from academia represented by university lecturers play the following roles, namely, “advisory consultation & skills development”; “liaison” and “researcher”. In these roles, the participants are involved in the development of knowledge and skills of future extension practitioners (government workforce). This implies that academia is involved in development of **human capital** in line with their roles under the QHIM.

With respect to the government stakeholder group as represented by agricultural extension practitioners, the analysis revealed that they play two major roles. These are, “advisory and conscientisation” and ‘mediation”. Under these roles, the extension practitioners create awareness and build capacity amongst the farmers. Furthermore, the analysis revealed that extension practitioners mediate and coordinate the interactions between the farmers and higher education institutions. Still, the analysis showed that the extension practitioners advise farmers on a number of issues such as mitigation, environmental control, drought management, past/disease control, climate change adaptation and many more. Significantly, the analysis highlights that the mediation roles of agricultural extension practitioners in climate change adaptation is very crucial. With respect to the reason or justification (**why**) for playing these roles, the analysis showed (explicitly and implicitly) that most of the actors played these roles in line with their line of **duty** or jobs. The extension officers explicitly indicated that part of their “**duties**” is to help famers to become aware of what can be harmful to their lives and to the environment as well as to livestock. On the side of the community or end-users as represented by Msinga smallholder farmers, the analysis suggests that the farmer play the roles of recipients or end-users of information provided by the other stakeholders. The next chapter addresses research question three in the main study.

CHAPTER 10

MAIN STUDY

TYPES OF CLIMATE SMART ADAPTATION TECHNOLOGIES AND INDIGENOUS KNOWLEDGE SYSTEM PROMOTED IN THE PARTNERSHIPS BETWEEN UNIVERSITY, GOVERNMENT AND MSINGA SMALLHOLDER FARMERS

INTRODUCTION

This chapter presents the analysis of research questions three and four of the main study, namely:

- ***Do these partnerships promote the use of climate smart adaptation strategies in everyday agricultural practices? If so, what CSA practice are promoted?***
- ***Do these partnerships promote the use of indigenous knowledge systems in everyday agricultural practices? If so, what type of IKS practice is promoted?***

The previous chapter discussed the roles of each stakeholder group in their existing partnerships. Therefore, the aim of this chapter is to understand if Climate Smart Adaptation (CSA) technologies and Indigenous Knowledge Systems (IKS) are promoted in the partnerships that exist between the three stakeholder groups (Aca-Govt- Comm: academia, government and end-users), engaged in this study. In line with the above questions, this chapter is divided into two broad sections, namely, section 10.1 and section 10.2. Section 10.1 focus on main research question three, which explores whether these existing partnerships promote climate smart adaptation strategies in the Msinga smallholder farming community. On the other hand, Section 10.2 is focused on main research question 4. This question sought to understand if the existing partnerships amongst the three stakeholder groups promote Indigenous Knowledge Systems (IKS) in the everyday agricultural practices of smallholder farmers in Msinga.

10.1 DO THESE PARTNERSHIPS PROMOTE THE USE OF CLIMATE SMART ADAPTATION STRATEGIES IN EVERYDAY AGRICULTURAL PRACTICES? IF SO, WHAT TYPE OF CSA IS PROMOTED?

According to the Food and Agricultural Organization (2013), the concept of Climate Smart Agriculture (CSA), has been developed to address the following three critical pillars: food security, adaptation and mitigation. The analysis of the data related to research question three, as stated above, highlights that the partnerships identified do indeed promote the use of CSA strategies in everyday agricultural practices of Msinga smallholder farmers. The types of CSA promoted within each partnership are presented in Figure 41 below. As can be seen from the figure, the indirect partnership between academia and end-user shows that one type of CSA practice is promoted, namely conservation agriculture. The direct partnership between the government and academia yielded one type of CSA practice, namely, the planting of drought resilient crop varieties. In addition, the direct partnership between the government and end-users shows that six types of CSA practices are being promoted. These are, the promotion of water management and the use of: sustainable farming approaches, animal traction in place of tractors, environmentally friendly pest control techniques, mulching and information communication technology. The direct partnership between the end-user and the government elicited two types of CSA being promoted, namely, changing in planting dates and the use of fertilizer.

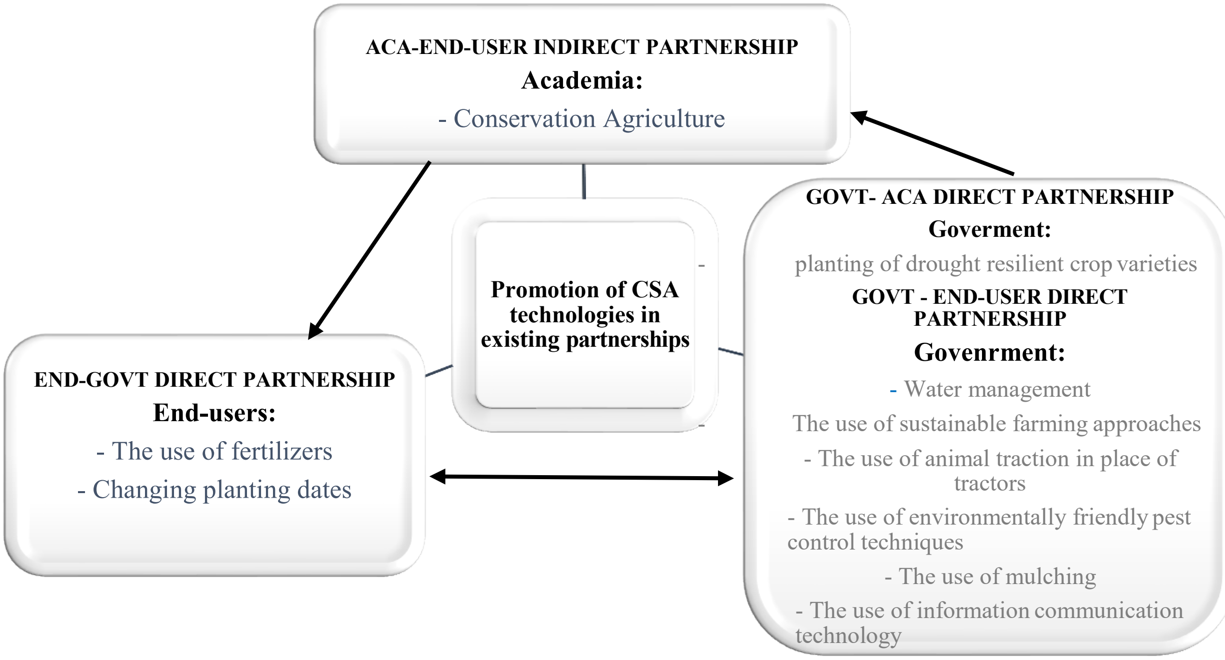

Figure 41: Promotion of CSA technologies in the partnerships between academia, government and end-users

In the sections to follow, the type of CSA strategy identified is described in detail in relation to the partnership that brought it to the fore.

10.1.1 Academia – end-user indirect partnership: Conservation agriculture

As mentioned above, one type of climate smart agricultural practice is promoted in the indirect partnership that exists between academia and end-users (see Table 59 below). As indicated in Chapter 9, academia (agricultural extension lecturers) is involved in an indirect partnership with end-users (Msinga smallholder farmers) through student engagement during internships and field trips.

Table 59: Promotion of CSA in this partnership

Do these partnerships promote climate smart adaptation technology in	Type of Partnership	What type of CSA practice is promoted?

everyday agricultural practices?		
• Yes	Education system/Academia - End-users (indirect partnership)	• Conservation agriculture

According to FOA (2016, p.21), conservation agriculture is a farming system that can prevent losses of arable land while regenerating degraded lands. Conservation agriculture is premised on the following principles: permanent soil cover; minimum soil disturbance, and variation of plant/crop species (Ibid.). As can be seen in the excerpt below, an understanding of conservation agriculture allows the farmers to discern how a simple practice such as "*holding moisture in the soil*" can improve the yield - "*I'm getting 8 tons*" instead of "*only getting 2 tons of maize*".

> *"But they'll be able to say okay, under this rock there's a scorpion and we're gonna do this we're gonna that, and it is coming here because it is attracted to this or that or there is this or that there or because the environment is suitable for it.* ***Because of the conservation agriculture that you don't practise****, it is creating an environment that is conducive for that.* ***And they can say that because of the conservation agricultural practice that you've taught them.*** *So you can teach* ***them that conservation agriculture as a philosophy is important*** *and then they go to conferences and they can do their own reading and find out,* ***oh, this is why uhm you know when everybody else is only getting 2 tons of maize, I'm getting 8 tons, because I'm holding moisture in the soil or I understand the different structures of my soil or whatever****"* (P1).

The promotion of CSA practices through conservation agriculture is significant, especially because of the need to embrace and promote climate smart agriculture in Msinga, where vulnerability is high (Joseph Rudigi Rukema & Simelane, 2013). Furthermore, the notion of treating conservation agriculture as a philosophy implies that conservation agriculture should be seen as a culture that should guide Msinga smallholder farmers' agricultural practices. In other words, the principles of conservation agriculture should engender and permeate their agricultural practices. This place the farmers in a better position to adapt to the effects of climate change through adopting the philosophy and principles of conservation agriculture.

10.1.2 Government – academia direct partnership: Planting of drought resilient crop varieties

As indicated in Table 63 above, one type of climate smart agricultural practice is promoted in the direct partnership that exists between the government and academia. (see Table 59 above). As illustrated in chapter 9, the government (agricultural extension practitioners) is involved in a direct partnership with academia through trainings by the Agricultural Research Council.

Table 60: Promotion of CSA in this partnership

Do these partnerships promote climate smart adaptation technology in everyday agricultural practices?	Type of Partnership	What type of CSA practice is promoted?
• Yes	• Government - Education system/academia	• Planting of drought resilient crop varieties

According to Senyolo, Long, Blok, and Omta (2018), drought is a huge challenge to agricultural production and food security in South Africa. In Msinga Local Municipality, the study by Ngcoya (2017) confirms that drought is a major challenge to smallholder agricultural activities. Therefore, there is need to find means of adapting to drought condition across the country, especially in smallholder farming contexts such as Msinga.

> *"We got some training by the* ***Agricultural Research Council (ARC)*** *on climate change, so the Department is creating our names right now, for* ***the advisors on climate change*** *and also on farmers"* (P1).
>
> *"The research involves a trial where they were training us to* ***promote the varieties of maize that are resilient to drought****. Because there was drought at that time. So we used to promote those trials in the farms.* ***So I have done some trials with the ARC on drought****"* (P5).

As evident in the above excerpt, the government stakeholder group (agricultural extension practitioners) are trained by the Agricultural Research Council "*to promote the varieties of maize that are resilient to drought*". Diverting to drought resilient varieties is a popular climate change adaptation technique highlighted by Lipper et al. (2014). According to the authors, CSA includes practices such as reduced tillage, improving the use of fertilizer, manure management, use of diverse varieties of crops, etc. Similarly, Shisanya (2015) reports that smallholder farmers in uMzinyathi district municipality employ strategies such as growing other crop varieties that are drought resilient to adapt to climate events such as drought.

In the same vein, the study conducted by Senyolo et al. (2018) found that diversification to crop varieties that are drought tolerant and early maturing seems to be the most appropriate climate smart agricultural technology/practice in South Africa. The foregoing shows that diverting to different crop varieties is an adaptable CSA practice in smallholder farming communities. Therefore, it is significant that the government stakeholder group "*promoted the planting of drought resilient crop varieties in the farms*", "*because there was drought at that time*".

10.1.3 Government – End-user direct partnership

As illustrated in Figure 45 above, six types of climate smart agricultural practices are promoted in the direct partnership that exists between the government and end-users (see Table 61 below). As indicated in Chapter 9, the government (agricultural extension practitioners) and end-users (Msinga smallholder farmers) are in a direct partnership and this partnership is anchored on the services offered by the extension practitioners.

Table 61: Promotion of CSA in this partnership

Do these partnerships promote climate smart adaptation technology in everyday agricultural practices?	Type of Partnership	What type of CSA practice is promoted?
• Yes	• Government - End-users/culture-based public	• Water management • The use of sustainable farming approaches • The use of animal traction in place of tractors • The use of environmentally friendly pest control techniques • The use of mulching • The use of information communication technology

In order to survive the effects of climate change such as prolonged dry periods and drought, Mberego and Sanga-Ngoie (2014) reason that farmers must adopt appropriate agricultural adaptation practices. Bearing the foregoing in mind, the six climate smart agricultural practices promoted in the direct partnership that exists between the government and end-users are analysed below.

10.1.3.1 Water management

Research by the South African Weather Services Indicator (2008) as well as Mthembu and Zwane (2017) found that the dry weather conditions in Msinga are a major concern for the prevalent rain-fed and commercial agricultural practices in the area. It is therefore notable that the extension practitioners promoted a climate smart practice of water management in their interactions with end-users.

> *"They introduced the product which is called WEMA, which is* ***Water Efficiency in Africa****. Of which was introduced all over Africa. Those trials now eh they have adopted it very well. Because, they have tried in other places, and also here in Msinga we have tried it and it did very well"* (P1).

The above view was echoed in the following excerpts:

"And also for the household gardens. We encourage farmers here to ***reuse water****, the water that is used for washing, we encourage them* ***to use it for watering their small household*** *gardens"* (P3).
"We encourage farmers to ***store water****. To eh to buy* ***water tanks so that they can harvest and store water in it****"* (P5).

As shown in the excerpts above, climate smart agricultural practices such as **water harvesting** are promoted in the direct partnership that exists between the government and the end-user. The participants emphasised that "**farmers are encouraged to reuse water**" and to "**harvest and store water using water tanks**". Promoting this CSA (water management) practice is particularly important, given that Msinga is very prone to drought (Joseph & Hamilton, 2013). Beyond Msinga, the scarcity of water for agricultural activities remains a major threat to food security, poverty, and sustainable development in South Africa (Kahinda & Taigbenu, 2011).Therefore, promoting water management strategies such as **water harvesting** and **recycling** could help smallholder farmers during drought events.

10.1.3.2 The use of sustainable farming approaches

Lipper et al. (2014) argue that CSA aims to support efforts at all levels for **sustainably using agricultural systems** to **achieve food and nutrition security** for all people at all times while integrating necessary adaptation and capturing potential mitigation. The analysis shows that **sustainable farming approaches**, such as **conversion of weeds or grasses to animal feed** is promoted in place of bush burning.

"We do advise our ***farmers about burning fires****, because sometimes the fire brings out too much smoke"* (P6).
"That ***they must take the weeds or grasses for animal feeding****,* ***other than burning them****"* (P6).

The extension practitioners advised the end-user against bush burning because "*fires bring out too much smoke*". So*, "instead of burning the weeds",* they were advised to *"use them to feed animals*". Though this CSA practice may sound simple, however, it is a commendable sustainable agricultural practice. Carbon dioxide (smoke) as a greenhouse gas contributes enormously to climate change (United Nations Framework Convention on Climate Change, 2007). According

United States Environmental Protection Agency (2018), carbon dioxide accounted for 81 percent of the greenhouse gases emitted in 2016. As explicitly stated, farmers are discouraged from **"burning fires, because sometimes the fire brings out too much smoke"**. By advising farmers against bush burning, the extension practitioners are encouraging them to adopt sustainable or climate smart approaches to farming that is not harmful to the environment.

10.1.3.3 The use of animal traction in place of tractors

Animal traction is the use of animals such as bulls, oxen, cows, donkeys, mules, horses, goats, camels, water buffaloes, etc. to assist farmers in carrying out the tasks such as planting, ridging, mowing, ploughing and transportation of loads (Department of Agriculture, n.d). Simalenga and Jongisa (2000), reason that the use of animal traction is an environmentally friendly and appropriate option for smallholder farming communities who cannot afford farming machines like tractors. In this sense, the analysis shows that the extension practitioners promote the use of animal traction in place of tractors as illustrated below.

> *"And another thing we are* ***encouraging our farmers to do is if they don't have mechanization tractors, they can use the animal traction instead of using tractors****. They are also* ***promoting that climate smart thing***" (P3).

As explicitly stated in the above, the participants encourage the **use of animal traction in place of tractors** or in the case that they do not have tractors. One can infer that animal traction is promoted in line with climate smart agriculture. As highlighted in the excerpt above, "*they are also promoting that climate smart thing*". Perhaps the participants considered the use of animal traction to be more environmentally sustainable and friendly given that animals do not emit the quantity of carbon dioxide tractors emit. In addition, the use of animal traction can be considered to be more economically viable and accessible to smallholder farmers than tractors, even though it maybe be more labour intensive, particularly in South Africa. As Simalenga and Jongisa (2000) reasoned, the access to tractors has remained unaffordable and uneconomical for smallholder farming systems in South Africa.

10.1.3.4 The use of environmentally friendly pest control techniques

Sivakumar (2006) outlined agricultural adaptation to include practices such as adjusting the efficacy in applying inputs such as fertilizers, insecticides, and pesticides. The analysis shows that the climate smart pest control approach is promoted by the government in their direct partnerships with end-users.

> **"***Okay, also the* ***problem of chemicals****.* ***Such as pesticides"*** (P4).
>
> *"Farmers are* ***encouraged to use the innovative ways to control those pests****. Using* ***the ash and mixing it with water and spray*** *it on the farm. So, when pest come and smell the solution, they will run away from the farm"* (P5).
>
> *"Like eh* ***instead of using these pesticides they can use animal stools****, put it in a plastic for about 7 days or 10 days and after that they can dump it in the farm. It will also serve as manure"* (P2).

The above excerpts prove that innovative approaches to pest control are promoted in the partnership between the extension practitioners and the end-users. Evidently, **"***Farmers are encouraged to use innovative pest control techniques such as mixing ash with water and spraying it to control pests***"**. Furthermore, the analysis reveals that farmers are encouraged to use "*animal stools***"** to control pests. The use of stools for pest control serves a double purpose. First it is used for pest control and thereafter, the stool is converted to farm manure.

These practices are popular homemade pest control solutions amongst smallholder farmers that help them to grow their plants organically. These approaches are considered to be more environmentally friendly and hence climate smart because the approach addresses the problems of pests without harming the environment, unlike chemicals/pesticides which are considered problematic by the participants.

10.1.3.5 The use of mulching

Research by Speranza (2010) found that the practice of mulching improves soil resilience to climate change. In addition, mulching increases soil humus content, improves soil structure and soil organic carbon content and in turn improves its resilience to climate change (Speranza, 2010).

"Okay like, using mulching. ***We encourage them to use mulching****. Okay, let's say you plant, maybe the spinach seedlings, then you cover that eh eh seedlings with a grass so that* ***you protect that seedling from the sun from penetrating it and drying it****".* (P1)

As can be seen from the above excerpt, the farmers are encouraged to adopt methods such as mulching when planting seedlings such as spinach. These practices *protect the seedlings from the sun from penetrating it and drying it,* as indicated in the above excerpt. This shows that the practice of mulching is beneficial to farming in a number of ways. The above CSA approach has been identified as one of the important sustainable land management practices for adaptation to climate change in countries like Democratic Republic of Congo (Nwajiuba et al., 2015). Mulching has the ability to reduce soil temperature, and enhance carbon sequestration while increasing the length of growing season (Ibid.).

10.1.3.6 The use of information communication technology

Lipper et al. (2014) who suggest that tools such as radio programmes and other forms of information and communication technologies (ICTs) can be used to strengthen the capacities of extension systems to disseminate agricultural context specific information. Lipper et al. (2014) maintain that, though these systems (ICT) are already in place in most countries and contexts, they should be expanded to include information relevant to CSA practices. In this regard, the extension practitioners encouraged farmers to "*listen to radio to listen, to learn about things happening that day in relation to weather and farming."*

"The use of ***technologies such as telling farmers to listen to radio****, to learn about things happening that day about weather* (P6).

"In terms of the weather (P1).
"In terms of the temperature for the season, ***so that they will know if it will be okay for planting certain crops for that period.*** *Yeah."* (P6)

It is significant to note that farmers are encouraged to **listen to the radio** so as to get information about the **weather and temperature** as indicated in the above excerpts. This will enable the farmers to decide "*if it will be okay for planting certain crops for that period*". In other words, listening to the radio and getting information on weather conditions will enable the farmers to make informed decisions.

Still on promoting/disseminating ICT, the analysis shows that technologies such as "*extension switch online*" are promoted in the partnership. The data shows that extension switch online represents new ways of accessing "*information related to farming like pollution, new cultivars*, etc., as illustrated below.

> *"Farmers must get involved, must be aware of the extension switch online. It is the new information you get about the new innovations, the new cultivars, pollution or whatever it is in connection to agriculture. Whether is in animal production, cropping, etc."* (P6).

This means that access to climate smart agricultural technologies such as extension switch online (ICTs) and radio will contribute significantly to rural or smallholder agricultural practices. The above comments, affirmed by Nwajiuba et al. (2015), recommend that agricultural extension practitioners at all levels need foundation training to acquire core proficiencies in CSA. The authors reason that extension training modules need to have high impact communication and training materials, using innovative and modern ICT and media. Perhaps this will enhance the knowledge and skills needed to disseminate information on CSA. Concurring with the above, Westermann et al. (2015) reason that CSA underlines the need for smallholder farmers to adopt climate smart practices and technologies, which will involve new and innovative ways of increasing productivity in agriculture.

10.1.4: End-user-government direct partnerships

As indicated in figure 45 above, two types of climate smart agricultural practices are promoted in the direct partnership that exists between the end-users (Msinga smallholder farmers) and the government stakeholder group (agricultural extension practitioners) (see Table 62 below).

Table 62: Promotion of CSA in partnerships

Do these partnerships promote climate smart adaptation technology in everyday agricultural practices?	Type of Partnership	What type of CSA practice is promoted?
• Yes	End-users/culture-based public (direct partnership)	• The use of fertilizer • Change in planting dates

The two-climate smart agricultural practices promoted in the direct partnership that exists between the end-users and government are analysed below.

10.1.4.1 Use of fertilizers

According to the report by the International Fertilizer Association (2016), fertilizer usage is estimated to contribute to about 50% of today's food production, hence CSA cannot happen without fertilizers. According to the report, "*fertilizer help achieve all of CSA's "triple wins"- increasing agricultural productivity; adapting and mitigating agriculture to climate change realities; and achieving global food security*" (Report of International Fertilizer Association, 2016, p. 12). The analysis reveals that climate smart agriculture technology in the form of fertilizers was promoted in the existing partnership between the end-users and the government stakeholder group.

> *"The Department of Rural Development once provided us with **fertilizer and seedlings**"* (P5).

This view was echoed by P7 as shown below.

> *"The support was **very helpful because we did not have any fertilizer**, they gave us some fertilizer, they gave us **cabbage and tomato seedlings**"* (P7).

As seen in the above excerpts, climate smart technology adaptation such as fertilizer was promoted in this partnership. Perhaps receiving fertilizer as well as seedlings were considered "*very helpful*" because the lack of CSA technologies and farm inputs such as fertilizers is identified as one of the problems that hinders CSA adoption in smallholder farming communities (Senyolo et al., 2018). Fertilizer is considered essential in the achievement of food security and development goals (International Fertilizer Association, 2016). Moreover, scholars such as Sullivan et al. (2012, p. 1) argue that climate smart agriculture can be used to address food insecurity and improve the livelihoods of the rural poor by increasing their access to valuable inputs such as "seeds and fertilizer". Therefore, having access to fertilizer and seedlings will perhaps improve the adoption of CSA and by extension increase the adaptation to climate change in rural contexts such as Msinga.

10.1.4.2 Changing planting dates

Changing of planting dates is one of the common climate smart adaptation practices adopted by farmers in Nigeria, according to a study conducted by Onoja, Abraha, Girma, and Achike (2019) in Nigeria and Ethiopia. The study, which engaged about 240 farmers from Ethiopia and Nigeria, found that in Nigerian farms, changing of planting dates was adopted by 76%, diversification of crops were used by 71% and planting of high resistant varieties was adopted by most (82%). This shows that the CSA practice of changing of planting dates is widely adopted by smallholder farmers in sub-Saharan Africa.

> *"We wanted to start planting beans in July* ***but the extension advisors told us that we must only start in August because they saw the weather conditions****"* (P10).

As shown above, the CSA practice of "changing planting" dates is promoted in the partnership between the end-users and the government stakeholder group. It is thus significant that end-users (Msinga smallholder farmers) are advised to *"only start in August because they saw the weather conditions*". By implication, farmers are advised to adjust their farming practices in relation to climatic condition.

These finding on CSA practices being promoted in the direct partnership between government and end-users resonates with the findings of the study conducted by(Nwajiuba et al., 2015). According to Nwajiuba et al. (2015), farmers in Nigeria, Cameroon and Democratic Republic of Congo are already implementing climate smart agriculture practices, even though they do not have a conceptual or theoretical understanding of what CSA mean. For example, climate smart practices such as mulching, change of planting dates, manure fertilize and application, soil conservation, livestock integration, etc. were practised by the smallholder farmer engaged in the study (Ibid.).

10.2: DO THESE PARTNERSHIPS PROMOTE THE USE OF INDIGENOUS KNOWLEDGE SYSTEMS IN EVERYDAY AGRICULTURAL PRACTICES? IF SO, HOW AND WHY?

According to Maluleka et al. (2006), Indigenous Knowledge Systems (IKS) refers to knowledge forms found in the tradition of the people living within a particular locality. These knowledge forms cover technologies and practices that have been and are still used by local people for survival and adaptation in a variety of environments (Onwu & Mosimege, 2004). The analysis of research question four, as stated above, highlights that the partnerships identified do indeed promote the use of Indigenous Knowledge Systems (IKS) strategies in everyday agricultural practices of Msinga smallholder farmers. The type(s) of IKS promoted within each partnership are presented in Figure 46 below. As illustrated in the figure, the indirect partnership between academia and end-user shows that one type of IKS practice is promoted, namely the use of storytelling (case study). The direct partnership between the government and end-users yielded two types of CSA practices, these are, the use of animal traction rather than tractors and the use of ground manure. Furthermore, the direct partnership between end-users and the government shows one type of CSA practice is being promoted, namely, weather prediction and agricultural decision making.

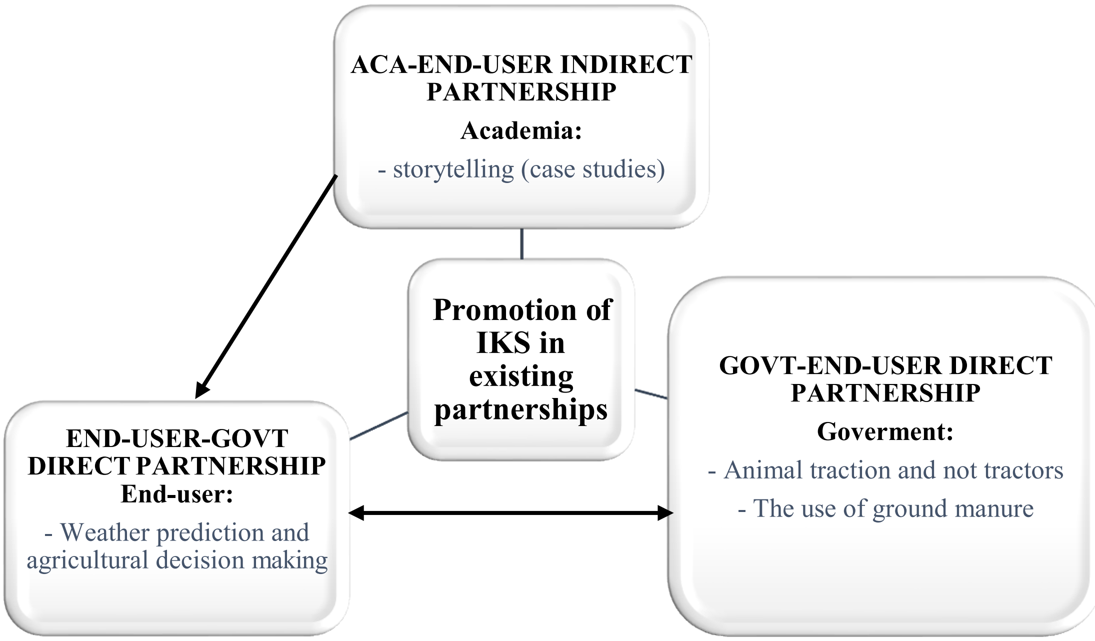

Figure 42: Promotion of IKS in the partnerships between academia, government and end-users

10.2.1 Academia - end-user indirect partnership: Story telling (case studies)

As shown in Figure 42 above, one type of climate smart agricultural practice is promoted in the indirect partnership that exists between academia and end-users (see Table 63 below). As indicated in Chapter 9, academia (agricultural extension lecturers) is involved in an indirect partnership with end-users (Msinga smallholder farmers) through student engagement during internships and field trips.

Table 63: Promotion of IKS in in this partnership

Do these partnerships promote indigenous knowledge systems in everyday agricultural practices?	Type of Partnership	What type of practice is promoted?
• Yes	Academia - End-users (Indirect/representative partnership)	• Story telling (case)

According to Mawere (2014), IK is not acquired through books; rather it is handed down from one generation to another orally in the form of storytelling (legends) or via apprenticeship by those who hold it such as elders (experienced practitioners) in the community. The analysis shows that story telling in the form of case study is the indigenous knowledge promoted by academia in their indirect partnership with end-users.

> *"We do try and make the students conscious, for example if you, if you are taking them on a **field trip** or you are looking at something more uh you are in the classroom, you're **talking to them about uh this different ideas and philosophies and processes and whatever**, and you can make them conscious of things, for example, **you can tell stories about different farmers**, so **you tell a story about a farmer**, **why does the farmer plant his pumpkins in the bottom of the hill?** Because he knows that's where most of the water is, and why does a group of farmer plant in the straight rows, uh, well, the extension officer came and told them they had to do that. **But these people are still relying on their knowledge and they are, you can see they've integrated stuffs** and because they understood where the water is, where the temperature is correct, and so on and so on. And so, **so you can build on those stories from real life**"* (P1).

Story telling (case studies) about different farmers and their farming practices is being promoted in the indirect partnership that exists between the farmers and the end-users. The lecturers share **stories** that relate to implementation of indigenous knowledge systems by "different farmers" and why they plant certain seedling (pumpkins) in certain places like the "bottom of the hill". It is interesting that academia (as represented by the agricultural extension lecturers) chose to promote storytelling (case studies) in this partnership, especially because storytelling is the main method of transmitting indigenous knowledge from one generation to another generation or from one person to another. This means that the end-users will be more receptive when they interact with the prospective extension practitioners given that they are already familiar with the IKS practice of storytelling.

Furthermore, the analysis shows that academia promotes indigenous knowledge systems in an integrated manner. Though the focus of the question was on what IKS practices are being promoted in the partnership, the analysis also revealed the method through which the participants promote

IKS. Specifically, when teaching topics related to innovation, the lecturers promoted indigenous knowledge (in an integrated manner), as seen in the excerpt below.

> *"Uhm we touching it in innovation, mmm but it's not like, yeah…"* (P2).

> *"..**innovation, I was going to say innovation**, but it's building on, it's not like, what they used to do in the past but it's, it's building on. So I think in **an integrated manner and yes, but not as a topic in itself"*** (P2).

Interestingly, this method synchronizes with the method mentioned earlier in this chapter by participants with regards to CSA promotion. The lecturers indicated that CSA was implicitly promoted through topics such as conservation agriculture. Analytically, this could mean that academia (as represented by agricultural extension lecturers) perceive IKS and CSA to be similar in terms of characteristics. Both practices are known to be environmentally sustainable. More so, the above findings on how IKS is being promoted responded to calls made by scholars such Semali and Kincheloe (1999), Emeagwali (2003) and Singh-Pillay, Alant, and Nwokocha (2017) for the integration of indigenous knowledge systems into formal educational processes across Africa. The analysis also made explicit the fact that IKS is not taught as a "topic itself". The excerpt is shown below.

> *"With indigenous knowledge, farmers make observations, but sometimes they **don't have the sort of scientific understanding behind those observations, our streams of training are in a position to help them make sense of those observations**"* (P1).

Drawing from the above comments, it is clear that the reason for promoting IKS in this manner is to equip the future extension practitioners with scientific knowledge to support farmers adequately. As explicitly indicated, farmers may not have the scientific knowledge to explain certain observations and phenomena. So, the extension personnel, who in this case are pre-service extension practitioners, are being equipped with scientific knowledge in order to effectively assist end-users in making sense of such phenomena or observations. Furthermore, the analysis shows that the farmers are assumed to not have "the sort of scientific understanding behind those observations", hence they are assisted to make sense of it. Though not explicitly stated, this perception of the farmers being less scientifically knowledge may have contributed to them functioning or playing the roles of recipients of information and services, as highlighted in Chapter 9.

10.2.2 Government - End-user direct partnership

As indicated in Table 67 above, two types of IK practices are promoted in the direct partnership that exists between the government (agricultural extension practitioners) and end-users (Msinga smallholder farmers) through extension – farmer interactions (see Table 64 below).

Table 64: Promotion of IKS in in this partnership

Do these partnerships promote indigenous knowledge systems in everyday agricultural practices?	Type of Partnership	What type of IKS practice is promoted?
• Yes	Government - End-users (direct partnership)	• The use of animal traction rather than tractors • The use of ground manure

10.2.2.1 The use of animal traction rather than tractors

According to Simalenga and Jongisa (2000), animal traction is still a widely used, sustainable, affordable, available and appropriate to option machinery in smallholder farming communities across South Africa despite the neglected support services . Animal traction provides smallholder farmers with vital power for cultivation and transportation (Department of Agriculture, 2011). Again, Manjengwa (2011) asserts that animal traction improves soil fertility by ploughing manure from draught animals back into the soil. The foregoing views show that the use of animal traction is beneficial to smallholder farmers. Perhaps this explains why the government stakeholder group "*encouraged farmers to use animal traction instead of using tractors*"

> *"Indigenous knowledge is things like* ***instead of using tractors, we try to encourage them to use animal tractions*** *when they are planting or when they are trying to plough"* (P1).

As reflected in the excerpt above, the extension practitioners promoted indigenous knowledge or practices such as “animal traction instead of tractors” in their partnership with smallholder farmers. As stated earlier, the promotion of animals may not be unconnected to the economic and environmental benefits linked to the use of animal traction. Therefore, this finding shows that the use of animal traction is still an affordable and sustainable option for improving smallholder agricultural activities in contexts like Msinga. Interestingly, the participants from the government stakeholder group had earlier linked the use of animal traction in place of tractors to climate smart adaptation. They identified this approach as one of the climate smart agricultural practices being promoted in their partnerships with smallholder farmers. Based on the above perspective, one could infer that there is a correlation between climate smart agriculture and indigenous agricultural/adaptation practices.

10.2.2.2 The use of manure

The use of farm manure is not new in smallholder farming content in sub-Saharan Africa. According to Speranza (2010), agriculture in sub-Saharan Africa is dependent on environmental principles and farmer’s knowledge and is largely characterised by use of animal manure and mixed cropping. The data shows that the indigenous farming practices such as the use of “ground manure” is promoted in the partnership between the extension practitioners and the end-users as illustrated in the excerpt below.

> *“**Instead of using fertilizer, we are encourage them** to use **ground manure”*** (P2).
>
> “*Yes, for subsistence farmers. Because to be honest, as my colleagues have said. For those who are planting for marking is not easy. But for home garden, yes **we are encouraging them to use what they have in their household farming**”* (P3).
>
> *“And **because of financial constraints, we are encouraging them to use indigenous knowledge,** because is affordable”.*

It is clear that end-users were encouraged to use ground manure over fertilizer, perhaps because manure is organic. Moreover, manure is affordable and more easily accessible than fertilizer, which is costlier. Promoting the use of manure will mean that the smallholder farmers and their farming systems will not be limited by their inability to afford fertilizer, which is considered very important in farming. As Morse and McNamara (2013) state, economic capital in the form of cash, credit and assets are considered to be very essential in sustaining the livelihoods of individuals and group. However, Mugambiwa and Tirivangasi (2017) found that lack of access to agricultural capital and other essential facilities makes it difficult for smallholder farmers to adapt to climate change. By implication, the use of manure will be beneficial to smallholders in their agricultural practices, given that they have limited access to the economic capital needed to support their farming activities.

10.2.3 End-user – government direct partnership: Weather prediction and agricultural decision making

As shown in Figure 46 above, one type of climate smart agricultural practice is promoted in the direct partnership that exists between the end-users and government (see Table 69 below). As indicated in Chapter 9, the end-users (Msinga smallholder farmers) is involved in a direct partnership with government stakeholder group (agricultural extension practitioners).

Table 65: Promotion of IKS in this partnership

Do these partnerships promote indigenous knowledge systems in everyday agricultural practices?	Type of Partnership	What type of IKS practice is promoted?
• YES	End-users - Government (direct partnership)	• Weather prediction and agricultural decision making

10.2.3.1 Weather prediction and agricultural decision making

A study by Abdulrashid (2013) suggests that weather forecasting is an important component for farmers and pastoralists, given that they depend on the observation and interpretation of certain occurrences to make decisions about farming. The study, which examines how farmers of semi-arid areas of Katsina state sustain the use of indigenous knowledge in forecasting and recording rainfall, used a series of focus group interviews to engage about 8-12 participants (farmers and pastoralist) in Kastina state, Northern Nigeria. The study found that farmers relied on observation and interpretations of certain phenomena, such the behaviour of some animals, the sky, the direction and intensity of the wind, in marking farming decisions. Similarly, a study conducted by Jiri, Mafongoya, Mubaya, and Mafongoya (2016) in Southern African countries revealed that rural farmers use their indigenous knowledge of weather prediction to cope and adapt to climate change. This shows that indigenous agricultural practices of weather prediction are popular amongst smallholder farmers in sub-Saharan Africa.

> *"**We use our own knowledge**. We **know that in summer there is rain and in winter there isn't any**, even though it now happens that the rain only comes in winter only but **we can distinguish between winter and summer**. In the summer as rain falls, **we plant those things that require rainfall and in winter we plant those we know they can resist cold**"* (P6).

As seen in the above excerpt, the end-users promoted their "*own knowledge"* and they *"know that in summer there is rain and in winter there isn't any.* This shows that they are aware of changes in climatic conditions. In their own words: "…*even though it now happens that the rain only comes in winter only*…**"** This implies that they are aware of recent changes in climate phenomena and the implications of such change in their farming activities. As a result, they draw on their knowledge of **weather patterns** to make farming decisions, such as planting seedlings that **"require rainfall"** in summer and those that do not require rainfall in winter.

10.3 CONCLUSION

This chapter presented the analysis for research question three and four in the main study. Research question three focused on the promoting of Climate Smart Agriculture (CSA) in the partnerships amongst the three stakeholders engaged in this study. On the other hand, research question four explored the promotion of Indigenous Knowledge Systems (IKS) in the partnerships amongst the three stakeholders engaged in this study. In line with the two questions, this chapter was divided into two main sections or parts, namely, section 10.1 and 10.2. Section 10.1 discussed the promotion of CSA in the existing partnerships amongst the three stakeholder groups while section 10.2 addressed the promotion of IKS in these partnerships.

In section 10. 1 which addressed research question three, the analysis revealed that:

- Climate smart agriculture practices were promoted by the stakeholders in their respective partnerships.

- The analysis showed that the academia stakeholder group (represented by agricultural extension lecturers) promoted CSA technology such as **conservation agriculture**. This was done by emphasising the **philosophy of conservation** agriculture.
- On the side of the agricultural extension practitioners (who shared partnerships with academia and end-users), the analysis revealed that one practice was promoted in the partnership between them and academia, namely the use of drought resilient crop varieties. On the other hand, six distinct CSA technologies were promoted in the partnerships with end-users. These are, the use of: **sustainable farming approaches; animal traction in place of tractors**; **environmentally friendly pest control techniques**; **mulching** and **information and communication technology (ICT)**.
- Equally, the analysis showed that two CSA technologies were promoted by the end-user. These are **the use of fertilizer** and **change in planting dates**.
- The above findings have offered insight on the types of CSA practices that can be mainstreamed in climate change adaptation policies and programmes in smallholder farming communities such as Msinga.
- Thus, the implication of these findings is that climate smart adaptation strategies can be mainstreamed in smallholder farming communities such as Msinga through Aca-Govt-Comm partnerships.
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The analysis in section 10.2 which addressed research question four revealed that:

- Indigenous knowledge systems were promoted by the three stakeholder groups in their partnerships.
- The university stakeholder group were found to be promoting the use of storytelling (case studies) in their indirect partnership with the end-users. The analysis pointed to the fact that smallholder farmers relied on their IKS for decision making, hence the reason for promoting it in the indirect partnership that exists between them.
- Significantly, the analysis highlighted the correlation in the way CSA and IKS were promoted by the lecturers.

- Furthermore, the analysis showed that the agricultural extension practitioners promoted IK practices such as "**the use** of **animal traction rather than tractors**" and" **the use of ground manure**".
- In addition, the analysis showed that the end-users (MSF), promoted the IK practice of "**weather prediction and agricultural decision making**". These findings on the promoting of IK practices are in alignment with the argument of Nwajiuba et al. (2015), who emphasise that IKS need to be integrated into mainstream local, national and international agricultural development policy and planning processes.
- By implication, there is a space and place for IKS in the partnerships towards climate smart adaptation mainstreaming. This space and place have been implicitly and explicitly activated or highlighted by the three stakeholder groups in this study. In the next chapter, the discussion of the findings will be presented.

CHAPTER ELEVEN
SUMMARY AND DISCUSSIONS OF FINDINGS

INTRODUCTION

This chapter presents the summary of findings and discussion of the preliminary study as well as the main study. Also presented in this chapter are the study implications, contribution to knowledge and conclusion. The discussion is divided into two broad parts: the first discussion is based on the preliminary study, while the second part is based on the main study. The discussion is guided by the questions asked in each section.

According to Sullivan, Mwamakamba, Mumba, Hachigonta, and Majele Sibanda (2012, p. 1), climate smart agriculture (CSA) consists of agricultural practices that sustainably increase agricultural productivity while reducing the emission of greenhouse gases. Climate smart agriculture helps to ensure that climate change adaptation and mitigation are directly incorporated into agricultural development planning and investment strategies (Sullivan, Mwamakamba, Mumba, Hachigonta, & Majele Sibanda, 2012, p. 1). CSA represents agricultural practices that increase productivity, while supporting climate change adaptation and mitigation (Lipper et al., 2014). Explaining further, Lipper and Zilberman (2018, p. 20) stated that the main objectives of CSA are to: sustainably increasing food security through increases in productivity and incomes, build resilience and adaption to climate change, and reduce greenhouse gas. This means that adaptation, mitigation and food security are central (pillars) to the concept of climate smart agriculture practices. Therefore, it could be said that CSA is a direct response to the effects of climate change on agriculture, especially smallholder agriculture. By implication, individuals and groups will remain vulnerable if they are unable to adapt, mitigate climate change and achieve food security.

Against this background, this study was concerned with two major issues, namely:

(c) the challenges faced by smallholder farmers in South Africa, and Africa in general, in adapting to the negative impacts of climate change (Turpie & Visser, 2013; FOA, 2015).

(d) the neglect of IKS in various contemporary adaptation arrangements (policies and programmes) in the African context, even though IK adaptation technique is perhaps the most widely used technique in rural African contexts (Nyong et al., 2007; Ngcoya, 2017).

According to Sullivan, Mwamakamba, Mumba, Hachigonta, and Majele Sibanda (2012), the challenges associated with climate change, agriculture and food security cannot be addressed by any single sector. Similarly, Stephens et al. (2008) suggest that the challenges of climate change and the urgency to tackle them demands that stakeholders engage and work together in innovative ways. In this regard, the study at broader level explored how partnerships amongst three stakeholder groupings, i.e. Aca – Gov – Comm (representing university, government and smallholding farming communities, respectively) can facilitate the *mainstreaming of climate smart technology adaptation in everyday agricultural practices of rural farmers* in Msinga. Theoretically, this study interrogated the place and space accorded to Indigenous Knowledge Systems (IKS) in existing partnerships amongst these three stakeholder groups. The study was thus divided into two parts. Part 1, the preliminary study, focused on gaining insight into the types of knowledge and awareness that these rural farmers have on climate change as well as the support mechanisms available for climate change adaptation through agricultural extension services (as provided by government and academic institutions). Part 2, the main study, focused on the existence of partnerships in this rural farming community for climate change adaptation and the extent to which these partnerships promote the use of climate smart agricultural practices and indigenous agricultural practices. The summary of findings in the preliminary study is presented in Table 66 below.

11.1 SUMMARY OF THE FINDINGS FROM THE PRELIMINARY STUDY

Table 66: Preliminary research questions and summary of key findings

Research questions	Key Findings
Are Msinga smallholder farmers aware of climate change? *If yes, what is their awareness and knowledge of climate change?*	**YES** Four categories of description w.r.t knowledge and awareness were established, namely: - Evidence of climate change - 47.8% - Causes of climate change - 11.7% - Effects of climate change - 29.4% - Solution to climate change - 23.5%
Are in-service agricultural extension practitioners in rural contexts adequately trained to offer extension services related to climate change adaptation to smallholder farmers?	**NO**
- What is the level of education of the extension practitioners?	DL (17.6%); ADL (5.9%); BDL (70.6%); NS (5.9)[1]
- Does the education & training expose these extension practitioners to knowledge climate change?	No (58.8%); Yes (29.4%); NS (11.8%)
- Have in-service the extension practitioners received in-service training on climate change?	No (58.8%); Yes (41.2%)
- How does the extension practitioners rate their level of competence in disseminating climate change information?	Excellent (5.9); Good (17.6%); Average (47.1%); Poor (17.6%) NS (11.8%)
Is climate change and climate change adaptation being accommodated in the Agricultural Extension and Rural Development programme of higher education institutions?	NO (According to the BAPT (2009); AERDL (33.3%)) YES (implicitly accommodated by Agricultural Extension and Rural Development lecturers (66.7%))
- *If yes, to what extent?*	Integrated into the following topics: "social sustainability, environmental sustainability and economic sustainability"
- *If not, what areas are foregrounded*	BATP (Extension; Agricultural Production; Farm Business Management; Resource Management and Farm Engineering, BAPT, 2009). AERDL (Conservation agriculture; Natural resources, Facilitation for development).
- *Why are those areas foregrounded?*	AERDL (Conception of Extension work; Conceptions of climate change; Farmers are knowledgeable; Process of accreditation of programme and module credits; The shift from technical extension to process extension)

[1] DL = Degree Level; ADL = Above Degree Level; BDL= Below Degree Level; NS = No Selection
According to Department of Agriculture (2005, p. 8), the requirement for extension advisor is NQF level 7 (B Tech/Bachelors/Hons degree in Agriculture).
BAPT (2009) = Bachelor of Agriculture Programme Template (2009); AERDL = Agricultural Extension and Rural Development Lecturers

11.1.1 Msinga smallholder farmers' (MSFs') knowledge and awareness of climate change

The preliminary part of this study showed that Msinga smallholder farmers are knowledgeable and aware of climate change and its impact on their agricultural practices. A total of 34.3% (twelve out of 40) farmers (end-users) that participated in the first part of the study rated themselves as having "*very good*" knowledge and awareness of climate change. Similarly, 34.4% (twelve out of 40) of farmers perceived themselves as having "*good*" knowledge and awareness of climate change. This means that a total of 68.6% were certain that they are knowledgeable and aware of climate change. On the other hand, 14.3% of the farmers (five out 40) perceived themselves as being "average" with respect to knowledge and awareness of climate change. This was interpreted as being unsure of their level of knowledge and awareness. Equally, 14.3% (five out 40) rated themselves as having "*poor*" knowledge and awareness of climate change while 2.9% perceived themselves as having very poor knowledge and awareness of climate change. (Details in Chapter five).

Through focus group discussions, the participants that perceived themselves as being knowledgeable and aware, of climate change offered insight into knowledge and awareness and these were classified into four categories, namely,

- Evidence of climate change
- Causes of climate
- Effects of climate change and
- Solutions to climate change.

The above categories are unpacked briefly below.

11.1.1.1 Evidence of climate change

The awareness and knowledge of climate change was presented in the form of evidence of climate change. A total of eight out of 17 (47%) of the participants offered insight in the form of evidences of climate change within their community. The analysis as presented in chapter five showed that *climatic events such as drought, heavy rainfall and extreme* conditions were recurrent in the Msinga area. For instance, the analysis showed that temperature increase was identified by four participants out of 17 (23.5%) as evidence of drought conditions in the area, while wind, hailstorms and lightning were identified by four out of 17 participants (23.5%) as evidences of extreme conditions.

11.1.1.2 Causes of climate change

In sharing their knowledge of climate change, two out of 17 participants (11.7%) identified and or spoke about the causes of climate change to include dust/dirt in the ozone layer and human activities. In the words of the participant, **"***I think climate change is caused by dust or dirt in the ozone layer. The number of cars in this area has increased the dust ozone layer*" (P1 & P8). This result is consistent with the position of scholars on the causes of climate change. For example, Stern (2006) argues that activities such as electricity generation, land use changes (particularly deforestation), agriculture and transport results in the emission of high concentration of greenhouse gases contributes to climate change. In a similar vein, the United Nations Framework Convention on Climate Change (2007) found that continuous fossil fuel burning, and land use changes have emitted, and continue to emit, increasing quantities of greenhouse gases into the Earth's atmosphere, thereby contributing to climate change.

Furthermore, the findings on the causes of climate change corresponded with studies conducted by Plutzer et al. (2016), which focused on teachers' knowledge of climate change. According to Plutzer et al. (2016), human activities contribute 95% of recent global warming and climate change. In concurring to the above finding, 75% of respondents in a study piloted by Shi, Visschers, Siegrist, and Arvai (2016) agreed that climate change is mainly caused by human activities. When considered in the light of the foregoing, it is worrisome that only two out of 17 (11.7%) of the participants shared their knowledge and awareness with respect to causes of climate change, especially given that a good number provided a range of evidence of climate change.

11.1.1.3 Effects of climate change

The effects of climate change are locally and universally recognised/felt. In Msinga, where this study was conducted, the result showed that the effects of climate change are rife. The findings highlighted that climate change is not only detrimental to agricultural activities, but it also poses a great danger to human lives and infrastructure in the area. In the words of the participants, *"another danger that comes with this climate change is that the lightning kills. It does not only kill the livestock, that is animals, goat and stuffs, but it also kills people".* Furthermore, the analysis showed that climate change leads to a decline in agricultural productivity and in some cases loss of agricultural inputs such as "*mielies*", "*potatoes*", "*tomatoes*" as well as" *loss of income*" (P4 & P6). A total of five out of the 17 participants (29.4%) offered insight on the effects of climate change within their locality. When compared to other studies conducted within South Africa, it can be concluded that these harsh climate events are not isolated cases or events in Msinga, rather they are widespread occurrences across smallholder farming communities in the country. For instance, the South African Department of Environmental Affairs (2011) reveals that climate change impacts negatively on human health, agriculture, biodiversity and the entire ecosystem.

11.1.1.4 Solution to climate change

The findings showed that the participants find solutions to climate change using their indigenous knowledge systems. A total four out of 17 (23.5%) of the participants explained how they adapt to the effects of climate change. For instance, "*no till planting*" was adopted as a solution to the problems of erosion. Sustainable farming practices such as "*shifting cultivation*" was employed to address "*soil infertility*". Shifting cultivation is believed to increase productivity and sustain the farms/land and is practised in other smallholder farming contexts across Africa. According to a study piloted by Ezeudu, Nkokelonye, and Adigwe (2013), smallholder farmers in Nigeria promoted the practice of not cultivating the land annually (skipping farming in a particular parcel of land for one year) to enable the land to replenish naturally. During this year, manure (dung and some leaves) are deposited on the empty land in order to enrich it and prepare it for the next farming season/year (Ezeudu et al., 2013). This practice contributed to the quantity and quality of farm products produced when the land is eventually cultivated (Ibid.).

Also, "*contour ploughing*" was adopted as the solution to the problem of flooding in the fields/farm. In addition, "*rituals*" were used to solve the problem of "*loss of livestock and humans*". The above solutions are similar to adaptation strategies identified in other rural sub-Saharan African contexts. Example, research piloted by Speranza (2010) shows that smallholder farmers in Africa employ strategies such as zero tillage to adapt to and to mitigate the challenges of climate change. The author explain that zero tilling enhances the soil structure and the resistance of the soil to climate change. Hypothetically, these results mean that efforts towards the mainstreaming of climate smart technology adaptation in a rural context such as Msinga could be greatly enhanced, given that the more knowledge people have about climate change, the more their chances of adapting to its effects.

11.1.2 Level of preparedness of agricultural extension practitioners to deliver extension services to smallholder farmers

11. 1.2.1 Education of participants

Furthermore, the preliminary study probed the competencies of extension personnel to effectively offer extension services related to climate change. The results showed that in-service agricultural extension practitioners, which represent the government stakeholder group, are not well equipped to offer extension services related to climate change. This is per the Norms and Standards for Extension Advisory Services in Agriculture (2005) which stipulates that the minimum requirement for appointment as agricultural extension advisors/office should be a Bachelor of Agriculture degree. According to the findings, 70.6% (i.e. twelve out of 17) of the extension practitioners that took part in the preliminary study do not have this qualification. As shown in Chapter 6 they have a qualification that is below the required degree level.

- *three out of the 17 participants (17.6%) possess Matric certificates*
- *two out of the 17 participants (11.8%) possess higher certificates*
- *seven out of the 17 participants (41.2) have a national diploma as their highest qualification*

The analysis revealed that the participants with national diploma qualifications were higher in number than other qualifications. This qualification is rated at NQF level 6 in the National Qualification Framework. According to the Department of Agriculture (2005), the diploma qualification is inadequate for equipping extension practitioners with the requisite skills and knowledge to achieve the desired outputs as agricultural advisors. Does this mean that the agricultural extension practitioners involved in this study were not adequately equipped to offer extension services to farmers (end-users), especially extension services related to climate change and climate change adaptation?

11.1.2.2 Inclusion of climate change content in the agricultural extension curriculum and training of in-service extension practitioners

It is significant to note that 29.4% of the participants (five out of 17) indicated that content on climate change was included in their curriculum during their training. However, 58.8% (10 out of 17) of the extension practitioners stated that climate change and climate change adaptation were not included in their curriculum and that they had not received in-service training on climate change and climate change adaptation. 11.8% (two out of 17) of the participants did not respond to the question (see details in Chapter seven). In addition, the Bachelor of Agriculture programme template (2009) of the higher education institution engaged in this study revealed that climate change and climate change adaptation content and concepts were not accommodated in the pre-service extension training programme. This finding was confirmed by the academic staff members. The academic staff stated that climate change and climate change adaptation were not explicitly accommodated in the training of agricultural extension practitioners; rather concepts related to climate change were implicitly accommodated in some topics. Based on the foregoing, it could be inferred that Msinga smallholder farmers may not be effectively supported in their quest to adapt to, and mitigate climate change, and achieve food security under climate change. So, attainment of livelihood outcomes such as adaptation to climate change and reduced vulnerability will be difficult. By implication, the academics engaged in this study may have failed in fulfilling their roles (as conceived in the QHIM) of developing the relevant human capital.

11.1.2.3 In-service training on climate change by KZN Department of Agriculture

Given the finding that a higher proportion of the extension practitioners engaged in this study were not exposed to content knowledge related to climate change, it was necessary to explore if the participants have received in-service training on climate change. The findings revealed that 41.2% of the participants (seven out of 17) have received in-service training on climate change. In contrast, findings revealed that 58.8% of the participants (ten out of 17) have not received in-service training on climate change. This number corresponded to the number of participants that were not exposed to content related to climate change during their pre-service training.

Evidently, the number of participants that have not received training on climate change is higher than those that have received in-service training on climate change. This will perhaps impact negatively on the delivery of information related to climate change and climate change adaptation to end-users in the study area.

11.1.2.4 Level of competency in disseminating climate change information to end-users

The result of the analysis in Chapter 7 showed that the only 5.9% (one of 17) of the participants from the government stakeholder group acknowledged or rated their competency level in disseminating information related to climate change to end-users (farmers) as excellent. This implies that a small proportion of the population is very competent in terms of climate change information dissemination. Also, 17.6% (three out of 17) indicated that their competence level is good while 47.1% (eight out of 17) rated themselves as average. This meant that a higher proportion (47.1%) of the extension practitioners engaged in the study perceived themselves as in-between being competent and being incompetent with respect to their competences and abilities to deliver information related to climate change.

On the other hand, the findings showed that 17.6% (three out of 17) of the participants rated their competency with respect climate change information dissemination as poor. Lastly 11.8% (two out of 17) of the participants did not make any selection with respect to their competency level. This made it difficult to make a clear demarcation in the total number of participants that are professionally competent and those that are incompetent to deliver extension services related to climate change to end-users. What is significant to note is that there was a correlation amongst level of education, lack of exposure to climate change content and ability to disseminate climate change information to end-users. The participants with lower level qualifications (diploma and below) and those that were not exposed to content knowledge on climate change, as well as those that have not received in-service training, rated themselves as average and poor in terms of their competency level in disseminating climate change information.

11.1.3 Inclusion of climate change and climate change adaptation in pre-service agricultural extension curriculum and training

It is important to note from the onset that previous studies have identified gaps in the curriculum and training of agricultural extension practitioners as well as policy documents related to climate change in South Africa. For example, Montmasson-Clair and Zwane (2016, p. 6) reveal that key South Africa's national policy documents, strategies and action plans in relation to agriculture and climate change do "*not acknowledge the need to capacitate extension services and strengthen weather and climate forecasting and risk management tools*". This necessitated the analysis of the Agricultural Extension and Rural Development programme of one of higher education institutions involved in the training of extension workforce. Two sets of data, generated from a combination of document analysis of the Bachelor of Agriculture Programme Template (BAPT, 2009) and from the focus group discussion with the Agricultural Extension and Natural Resources lecturers, were analysed in response to preliminary research question 3. Analysis of the

BAPT (2009) revealed that climate change and climate change adaptation contents were *"not explicitly*" included in the Agricultural and Resource Management programme template of the pre-service extension programme (see Chapter 8 for details). Rather, the following five streams or content areas were foregrounded in the programme template, namely:

- Extension
- Agricultural Production;
- Farm Business Management;
- Resource Management and
- Farm Engineering (BAPT, 2009).

The above revelation perhaps validated the findings made in Chapter 7, which showed that 58.8% of the participants were not exposed to content related to climate change during their training. Also, this result concurred with Zikhali (2016), who reported that climate change and climate change adaptation were not included in the agricultural extension curriculum of the participants engaged in her study. This result is significant when considered in terms of the critical role/position of extension practitioners in tackling the challenges of climate change in rural/smallholder farming communities.

However, the findings of the focus group discussion showed that climate change and climate change adaptation were "*implicitly integrated/accommodated"* by the academic staff members of the Agricultural Extension and Rural Development programme in their teaching activities. With respect to the level of integration, the analysis showed that climate change and climate change adaptation concepts were integrated into modules such as "*natural resources"*, "*conservation agriculture"* (*soil fertility*), and *"facilitation"*. When asked why contents and concepts related to climate change/climate change adaptation were not explicitly integrated in their programme template, the following reasons were revealed:

- Conception of extension work
- Conception of climate change
- Farmers are knowledgeable
- Process of accreditation and limited module credits
- Shift from technical extension to process extension**.**

Based on the findings made from these two data sources, it was clear that climate change and climate change adaptation were not explicitly integrated in the programme. However, content and concepts on climate change and climate change adaptation were accommodated/integrated in an implicit manner.

11.2 DISCUSSION OF KEY FINDINGS FROM THE PRELIMINARY STUDY

This section presents the discussion of the findings in the preliminary study. As indicated in Table 11.1 above, the preliminary study was guided by three research questions as outlined. The findings of these three research questions were presented in Chapters 6, 7 and 8 respectively.

11.2.1 Knowledge and awareness of climate change

It is significant to first emphasise that about 68.6% of the farmers perceived or rated themselves from "*good"* to "*very good*" with regard to their awareness and knowledge about climate change. This finding differed from the finding of the study piloted by Gbetibouo (2009b) in Limpopo River Basin. The study, which sought to understand adaptation methods in farm level and factors that influences such options, found that there is a lack of knowledge about climate change amongst the farmers (especially farmers with low level of education) engaged and this poses a barrier to adaptation to climate change in the area. However, the current study did not explicitly consider the link between level of education and the level of knowledge and awareness. This is considered as one of the limitations of this study.

The findings on the type of knowledge and awareness possessed by MSFs on climate change affirmed the findings of previous studies on climate change in Msinga. For instance, the "*evidence of climate change"* in the form of *"drought*" as proffered by MSFs, concurred with the findings of the study by Rukema (2010), which explored rural communities and government response to drought in South Africa. Rukema (2010) revealed that climatic events like drought are major challenges to smallholder agriculture and food security in rural communities like Msinga. Similarly, research piloted by Ngcoya (2017), which showed that Msinga is very prone to drought conditions, perhaps validated the findings on "*extreme events"* as "*evidence of climate change*" knowledge and awareness. The study by Ngcoya (2017) further shows that the area experienced very low rainfall, excessive heat waves and an extreme increase in temperature between 2010 and 2015. The author maintained that drought events pose a major threat to smallholder agriculture and food security in Msinga area (Ngcoya, 2017).

Similarly, the findings on knowledge and awareness encapsulated under "*the effects of climate change*" is consistent with result of the study by Department of Agriculture, Forestry and Fisheries (2016). The study revealed that the volume of field crop production in South Africa has decreased by 60% due to severe drought conditions. Agreeing to the above perspectives, Mugambiwa and Tirivangasi (2017) reason that climate change poses a great danger to South African agriculture and achievement of food security. The authors suggest that climate change contributes to poor yield in crops and other agricultural products. In addition, research by Ubisi, Mafongoya, Kolanisi, and Jiri (2017) with smallholder farmers in Limpopo province showed that climate change events, such as drought, led to crop failure of about 73.3% in 2016.

The findings on the effects of climate change illustrated that climate change *"does not only kill the livestock, that is animals, goat and stuffs, but it also kills people"* (as presented in Chapter 5). This has earlier been reported by scholars such as Elum et al. (2017), who examined farmers' perception of climate change and responsive strategies in some provinces of South Africa. According to Elum et al. (2017, p. 249), South Africa has recorded climate-related disasters that caused huge damage to infrastructure and deaths in some cases. The foregoing perspectives shows that the above findings on the effect of climate change in Msinga are also felt in other parts of the country and the continent at large. Nonetheless, the findings revealed that the participants have always used their indigenous knowledge to find "*solutions"* to effects of climate change in their locality. For instance, the problem of "*no tilling planting"* was used to address the problem of "erosion" in the fields/farm while "*rituals*" were used to address the problem of "extreme events" such as lightning and thunderstorms. Comparing these findings with the results of previous studies, it can be concluded that the farmers engaged in this study are indeed aware and have knowledge about climate change. Furthermore, these findings show that IKS indigenous knowledge systems are in line with the tenets of the Sustainable Livelihood Approaches (framework) from a theoretical and practical point of view. As Semali and Kincheloe (1999) state, IKS exemplifies ways in which the indigenous people organise their traditional knowledge or understanding of flora and fauna, cultural beliefs and history to improve their living conditions.

The above findings on the perceived level of knowledge and awareness, as well as the classification thereof, have great implication for policy and research on climate change and its adaptation in South Africa. This is particularly important, because previous studies by Nyong et al. (2007) and Ngcoya (2017) have shown that smallholder farmers in sub-Saharan Africa and their vast agricultural indigenous knowledge or livelihood approaches have been previously excluded in climate change adaptation policies and programmes. These findings not only presented evidence of climatic events, such as those highlighted in Table 66 above and discussed in Chapter 5, but it also offered insight on the causes, effect as well as solutions or adaptation practices adopted by the end-users. Therefore, the finding on knowledge and awareness is very significant, given the notion that, the more knowledgeable people are about climate change, the more they are likely to adapt to it. This will imply that facilitating climate change and climate change adaptation information amongst the farmer participants will be greatly enhanced.

Theoretically, the findings show that end-users possess the fundamental and key human capital (which relates to knowledge, skills, ability to labour, etc.) needed to effectively pursue and sustain their livelihoods, as highlighted in the SLF. So, this will make it a lot easier for the academic system to fulfil its traditional role of knowledge and skill development, as conceived under the QHIM. In addition, these findings offer the needed roadmap through which indigenous knowledge/practices of agriculture can be integrated into future government (especially the local government in Msinga) policies and programmes on climate change adaptation in rural communities. By implication, these findings have positioned the end-users to contribute to current discussions on climate change and emphasise the need for end-users to be afforded a space and place in climate change adaptation policy formation and implementation.

11.2.2 The level of preparedness of agricultural extension practitioners to deliver extension services to smallholder farmers

According to Sulaiman and Van den Ban (2003), as well as Fosu-Mensah et al. (2012), agricultural extension personnel occupy a critical position in the promotion of climate literacy and improvement of agricultural productivity across all levels of farming. Several other studies, such as Elum et al. (2017) and Belay, Recha, Woldeamanuel, and Morton (2017), have reported that access to extension services improves the adaptive capacity of farmers, while lack of access to extension services constrains or presents a barrier to adaptation and agricultural productivity. Elum et al. (2017), who used random sampling with the aid of questionnaires to engage 150 farmers in Limpopo, Gauteng and Mpumalanga provinces, revealed that 75.70% of cabbage farmers and 78.22% of potato farmers identified absence of extension services as barriers to agricultural production and adaptation to climate change. Similarly, the study by Belay et al. (2017) showed that access to extension services increases the probability of adopting different adaptation practices. Having access to extension services increased the likelihood of applying adaptation practices such as soil and water conservation (Ibid.). The foregoing underlines the importance of knowledgeable agricultural extension practitioners in the promotion of climate change adaptation and achievement of food security in sub-Saharan Africa

However, studies conducted locally in Botswana by scholars such as Chakeredza et al. (2008), as well as in South Africa by Zikhali (2016) suggest that agricultural extension practitioners in smallholder farming communities are not well equipped/trained (educationally and conceptually) to offer services related to climate change to farmers (smallholder farmers). In this study, the findings from the analysis on the "*level of preparedness of the extension practitioners*" showed that 70.6% of the extension practitioners engaged in this study have qualifications that are below the required Bachelor of Agriculture degree needed to function as an agricultural extension advisor. This finding is comparable to the findings of the study conducted by Afful (2016) in four municipalities of Limpopo province. The study, which explored the extension agents' competencies, regarding their climate variability knowledge and skills to support dryland smallholder grain farmers' production, engaged 24 field extension agents, 11 extension managers and 194 smallholder farmers. The result of the study shows that 50% of the extension practitioners (agents) had a diploma certificate as their highest qualification. In addition, the study reveals that the extension managers engaged were of the view that there is lack of adequate and technically qualified extension practitioners (agents) at the field-level to support farmers with climate variability and climate change information.

The foregoing perspective is not surprising, given that the extension practitioners with diplomas are described as *Agricultural Development Officers* (Department of Agriculture, 2005. p. 7). According to the Department of Agriculture (2005), the diploma qualification is inadequate for equipping extension practitioners with the requisite skills and knowledge to achieve the desired outputs as agricultural advisors. Perhaps this confirms the assertion by Zikhali (2016), that the level of education acquired by extension advisors influences their ability to deliver information related to climate change to end-users. By implication, the higher the qualification of extension practitioners, the more knowledgeable they would be about climate change and, perhaps, the more efficient they will be in delivering extension services relating to climate change to farmers.

Interestingly, agricultural extension practitioners with a diploma as their highest qualification constituted 68% of the total extension personnel in all the provinces of South Africa (Department of Agriculture, 2005). This again validates the findings, which show that 70.6% (thirteen out 17) of the participants had degrees that are below the required Bachelor of Agriculture degree. This meant that most of the agricultural extension practitioners were not educationally qualified to offer extension services to farmers (end-users), especially extension services related to climate change and climate change adaptation.

11.2.3 Inclusion of climate change content in the agricultural extension curriculum/training of in-service extension practitioners

According to Chakeredza et al. (2008), agricultural extension advisors in most rural contexts across sub-Saharan Africa are unable to offer extension services related to climate change as a result of the lack of content knowledge of climate change arising from the lack of integration of climate change in their curriculum and training. This assertion was confirmed by the findings on the inclusion of clime change content in the curriculum and training of in-service extension practitioners. The result showed that 58.8% (ten out of 17) of the extension practitioners were not exposed to content related to climate change during their training.

This result confirm the findings of Zikhali (2016) on gaps in the curriculum and training received by extension practitioners operating in rural areas of South Africa. The author suggests that a high proportion of agriculture extension advisors in the study area (Limpopo province) did not receive formal training on climate change during their training at the tertiary institution. Interestingly, this trend is not limited to South Africa. For instance, a study piloted by Mberego and Sanga-Ngoie (2014) in the Makonde District of Zimbabwe revealed that the 20 agricultural extension practitioners engaged in the study were not exposed to content related to climate during their training. Therefore, there is need for a review of curriculum and training of agricultural extension curricula in South Africa and Sub-Saharan Africa, in order to meet with current environmental challenges and global imperatives.

Beyond Africa, a study conducted earlier by Dinon, Breuer, Boyles, and Wilkerson (2012) in North Carolina, USA found that 84% of extension agents have not been formally trained in climate change related subjects. By implication, the findings on lack of exposure to content related to climate change during training is not peculiar to Africa. Nonetheless, the study by Dinon et al. (2012), which engaged 109 respondents, revealed that more than 80% of the extension practitioners engaged in the study believe that their work is affected by climate events and that their clientele would benefit from the utilisation of climate forecasts for agricultural decisions. This highlights the need to exposure agricultural extension practitioners to knowledge related to climate change. In this regard, a study piloted by Diehl et al. (2015), which drew 50 participants from Alabama, Florida, Georgia, and South Carolina, suggested that extension practitioners require additional training in order to effectively enhance climate literacy and empower the farmers to make informed decisions focused on mitigating or adapting to effects of climate variability and change.

11.2.4 In-service training on climate change by KZN Department of Agriculture

The findings from the analysis on in-service training indicates that 58.8% (ten out of 17) of the participants were yet to receive in-service training on climate change and climate change adaptation. This is perhaps worrisome, given that the same number of participants indicated that they were not exposed to content related to climate change during their academic training. This concurs with findings of Mberego and Sanga-Ngoie (2014), whose study revealed that there is currently no specific programme or training in place on agro-metrology or climate change in the Makonde District of Zimbabwe. In contrast, the study piloted by Diehl et al. (2015) in the USA found that 70-80% of respondents indicated that they have attended at least one climate change related training in the last two years. When considered appropriately, one can argue that the lack of exposure to climate change content during the pre-service training of extension practitioners can be considered as a global trend, however, the lack of in-service training on climate change is more prevalent in the African states. This finding on the lack of in-service training and skills development amongst a high percentage of the participants engaged in this study has major implications for agricultural extension services and their adaptation to climate change in South Africa.

12.2.5 Perceived level of competency in disseminating climate change information to end-users

The findings on level of preparedness and competence of extension practitioners to offer extension services to end-users showed a correlation between level of education, lack of exposure to climate change content and ability to disseminate climate change information to end-users (farmers). The participants with lower level qualifications (diploma and below) and those that were not exposed to content knowledge on climate change, as well as those that have not received in-service training, rated themselves as average and poor in terms of their competency level in climate change information dissemination. This implies that Msinga smallholder farmers may not be receiving adequate support in relation to climate change from the agricultural extension practitioners engaged.

This finding resonates with other studies on the competencies of extension personnel to effectively offer extension services related to climate change to farmers. For instance, the study by Mberego and Sanga-Ngoie (2014) suggests that the extension advisors engaged in their study lacked the knowledge and competencies to deliver extension services related to climate change to end-users. The authors hence recommended that university scientists and agro-climatologists should get involved in facilitating adaptation to climate change in the agricultural sector. Similarly, the study by Afful (2016) found that 61% (eight out of 24) extension agents lacked the skills and knowledge or information needed to support farmers in their farming activities. The study by Afful (2016) further revealed that 94% of the participants indicated that they needed training in climate variability issues in order to equip them with skills, knowledge and information to effectively support farmers in their agricultural activities. This means that 94% of these extension practitioners are yet to receive in-service training on climate change and variability. Based on the above evidence, it has become imperative to critically evaluate and update the current agricultural extension curricula and programmes of the higher education institutions in South Africa.

11.2.6 Inclusion of climate change and climate change adaptation in pre-service agricultural extension curriculum and training

Academia, as represented by the agricultural extension academic staff and their programme template, is pivotal to the training and development of the future workforce in the agricultural sector, especially in the context of climate change. Given that 58.8% of extension practitioners were not exposed to content and in-service training related to climate change, and hence may have perceived themselves as being incompetent in offering extension services related to climate change, it was necessary to ascertain the level of inclusion of climate change content in the current extension training of one the higher education institution engaged in this study. The findings revealed that climate and climate change adaptation were not accommodated in the programme template. Equally, the findings from the focus group discussion with the academic staff confirmed that climate change and climate change adaptation were not explicitly included in the programme as a content area or stream. However, concepts related to climate change were implicitly accommodated in the teaching and learning activities of other content areas as illustrated in Chapter 8 and summarised above. Could this then mean that climate change is not given much consideration by the gatekeepers in this particular institution?

The fact that academic staff members maintained that climate change is an important concept (see Chapter 8), but are not teaching it, explicitly denies the pre-service extension practitioners the opportunity to explicitly acquire what can be considered as one of the most critical areas of information and knowledge in the 21st century. In addition, the lack of inclusion of climate change in the training of extension practitioners places the clientele (farmers) in a disadvantaged position with respect to climate change information needs. This finding on the non-inclusion of climate change and its adaptation in the pre-service agricultural extension curriculum and training resonates with other studies conducted in South Africa on the curriculum and training of extension personnel and their roles in facilitating climate change adaptation. For instance, a study piloted by Yanda et al. (2010) on the approaches used to teach climate change issues in Southern African universities found that the integration (implicit inclusion) of climate change in existing modules is the leading teaching approach in the region. The authors argued that this approach will enable students to link or relate climate change issues to water resources and other components of the environment. This is relatable to the way climate change concepts and contents were taught by the academic staff members engaged in this study. However, the study by Yanda et al. (2010) further revealed that integration of climate change in modules depended on the interests of individual lecturers.

Additionally, the study (Ibid.) found that a few universities in the region have introduced the teaching of climate change as a stand-alone module while others teach about it in the form of short courses. The authors suggested that teaching climate change as a stand-alone module will ensure that climate change issues are adequately covered in teaching. Furthermore, the study by Yanda et al. (2010) revealed that the major hindrances to the teaching of climate change concepts and content in the Southern African region is lack of expertise in the subject matter. The authors were of the opinion that the majority of teaching staff were trained long before climate change became a recognized problem that needs to be addressed through research, teaching and learning in universities. In concurring with the foregoing assertion, the study by Mberego and Sanga-Ngoie (2014) in Zimbabwe found that the current extension advisory training and programmes that seem to relate to climatic variability were developed long before global climate change and variability became an issue of concern. By implication, the current agricultural extension curriculum and training offered in South Africa and in some other sub-Saharan African countries is outdated and hence cannot appropriately equip extension practitioners to address the challenges of climate change.

Another hindrance to the teaching of climate change content is the perception that teaching of climate change issues is the duty of climatologists and meteorologists alone (Yanda et al., 2010). In view of the foregoing, it is not surprising that some of the in-service extension practitioners (engaged in this study) stated that they were not competent in terms of the dissemination of information related to climate change and climate change adaptation. Hence, Chakeredza et al. (2008) reason that lack of integration of climate education in the curricula of universities and agricultural extension training institutions is responsible for the failure of agriculture extension practitioners to effectively deliver extension services on climate change to end-users (farmers). In terms of theory, academia is failing in its responsibilities of developing the human capital needed to tackle current societal challenges, as highlighted in QHIM. This will impede the attainment of livelihood outcomes such as adaptation to climate change and achievement of food security. These results are vital to agricultural extension educational gatekeepers and climate change policy makers in South Africa.

11.3 SUMMARY OF THE FINDINGS FROM THE MAIN STUDY

A study piloted by Montmasson-Clair and Zwane (2016) found that, though there are numerous policies and strategic plans on climate change in South Africa, they are generally fragmented (sector-specific) and or too broadly framed. Hence, these policies offer very limited scope for addressing the complexity of climate change adaptation (Montmasson-Clair & Zwane, 2016). This implies that there is a need to articulate policies and programmes that encompass and transverse different sectors, given that the problems and complexities of climate change cannot be addressed by one sector. In this regard, this section presents the summary and the discussion of the findings from the main study. The main study was guided by four critical research questions, as outlined in Table 67 below. The findings of these four research questions were presented in Chapters 9, 10 and 11 respectively. It is important to note that three participants from academia (as represented by Agricultural Extension and Rural Development lecturers) took part in the main study. A total of 13 participants from the government stakeholder group (as represented by the agricultural extension practitioners from the Department of Agriculture) took part in the main study. Equally, 13 end-users (as represented by Msinga smallholder farmers) partook in the main study (refer to Chapter 4 for sampling and sample size).

Table 67: Research questions and key findings in the main study

Research questions	Key Findings: Academia	Key Findings: Government	Key Findings: End-users
Do partnerships exist amongst universities, government and small-holding communities? - ***If so, what type of partnership exists amongst these actors with respect to changing weather and climate patterns and its impact on Agriculture in South Africa?*** - ***If not what exists? What is its nature?***	**YES (2)** (Indirect/Representative Partnership; Direct Partnership) • Academia - End-users (IP) • University - NGO (DP) **NO (1)** • Nothing	**YES (11)** (Direct Partnership) • Government - End-user – Academia (ARC, Agric College) • Government – End-user **NO (2)** • Consultation	**YES (11)** (Direct Partnership) • End-user – Government • End-users – Academia (SETA) **NO (4)** • Self-reliance
What are the roles of each of the actors in these partnerships and why are these roles foregrounded?	- Advisory, consultation and skills development\ - Liaison - Researcher	- Advisory and conscientisation - Mediation	- Recipients of information and services
Do these partnerships promote climate smart adaptation practices in everyday agricultural practices? - ***If so, what CSA practice is promoted?***	**YES** **Academia -End-users** • Conservation agriculture	**YES** **Government-Academia-End-users** • Planting of drought resilient crop varieties **Government – End-user** • Water management • The use of sustainable farming approaches • The use of animal traction in place of tractors • The use of environmentally friendly pest control techniques • The use of mulching • The use of information communication technology	**YES** **End-user-Government** • Supply of fertilizer • Change in planting dates
Do these partnerships promote the use of indigenous knowledge systems in everyday agricultural practices? • ***If so, what IKS practice is promoted?*** [2]	**YES** **Academia -End-users** • Story telling (case study)	**YES** **Government – End-user** • The use of animal traction instead of tractors • The use of ground manure	**YES** **End-user-Government** • Weather predication and agricultural decision making

[2] IP = Indirect partnership; DP = Direct partnership; ARC = Agricultural Research Council

11.3.1 Partnerships in existence between academia, government and end-users

The findings from main research question, one which inquired if partnerships exist amongst the three stakeholder groups engaged in this study, showed that the majority of the participants from the three stakeholder groups are in partnerships with each other. Two out of the 3 (66.7%) participants from academia indicated that they are in partnership with the end-users and as well as with an NGO. On the other hand, one of the 13 participants (84.6%) from the government stakeholder group indicated that they are in partnership with other two stakeholder groups. Similarly, one of the 15 participants (73.3%) from the end-users (farmers) stakeholder group stated that they are in partnership with other stakeholders group engaged in this study. The findings further showed that there are different types and number of partnerships in existence amongst the stakeholders. In total, two types of partnerships were established. These partnerships were classified as "*direct partnerships*" and "*indirect/representative partnership*". The result further showed that "*direct partnerships*" are three in number whereas the "*indirect/representative partnership*" is only one in number.

The indirect or representative partnership exists between the academics (as represented by agricultural extension lecturers) and the end-users (as represented by Msinga smallholder farmers). In this indirect or representative partnership, the result showed that academia/the education system is "*indirectly*" involved with end-users through "*students' engagement*" in the form of "*internship and field trips*". Through this arrangement, both stakeholder groups share/exchange relevant knowledge related to climate change and climate change adaptation. Apart from the indirect partnership between academia and the end-users, the analysis revealed that academia is equally in direct a partnerships with "*Non-governmental organisations (NGOs)*" (See details in Chapter 8). The findings on partnerships in existence is significant, given the importance of academia in knowledge development and propagation. `

Furthermore, the findings showed that the government stakeholder group (as represented by agricultural extension practitioners in the department of agriculture) are in **"***direct partnerships*" with academia (as represented by university lecturers) as well as with end-users (Msinga smallholder farmers). Under these partnership arrangements, the stakeholders from the government interacts with the other two stakeholder groups on climate change and its effect on agriculture. Additionally, the analysis showed that the end-users (as represented by Msinga smallholder farmers) are in a "*direct partnership"* with the other two stakeholders engaged in this study. It is important to point out that the natural environment was implicitly involved in all the partnerships identified in this study, as articulated in the Quintuple Helix Innovation Model (QHIM)**.** A summary of the findings with respect to partnership existence is further illustrated in Figure 43 below.

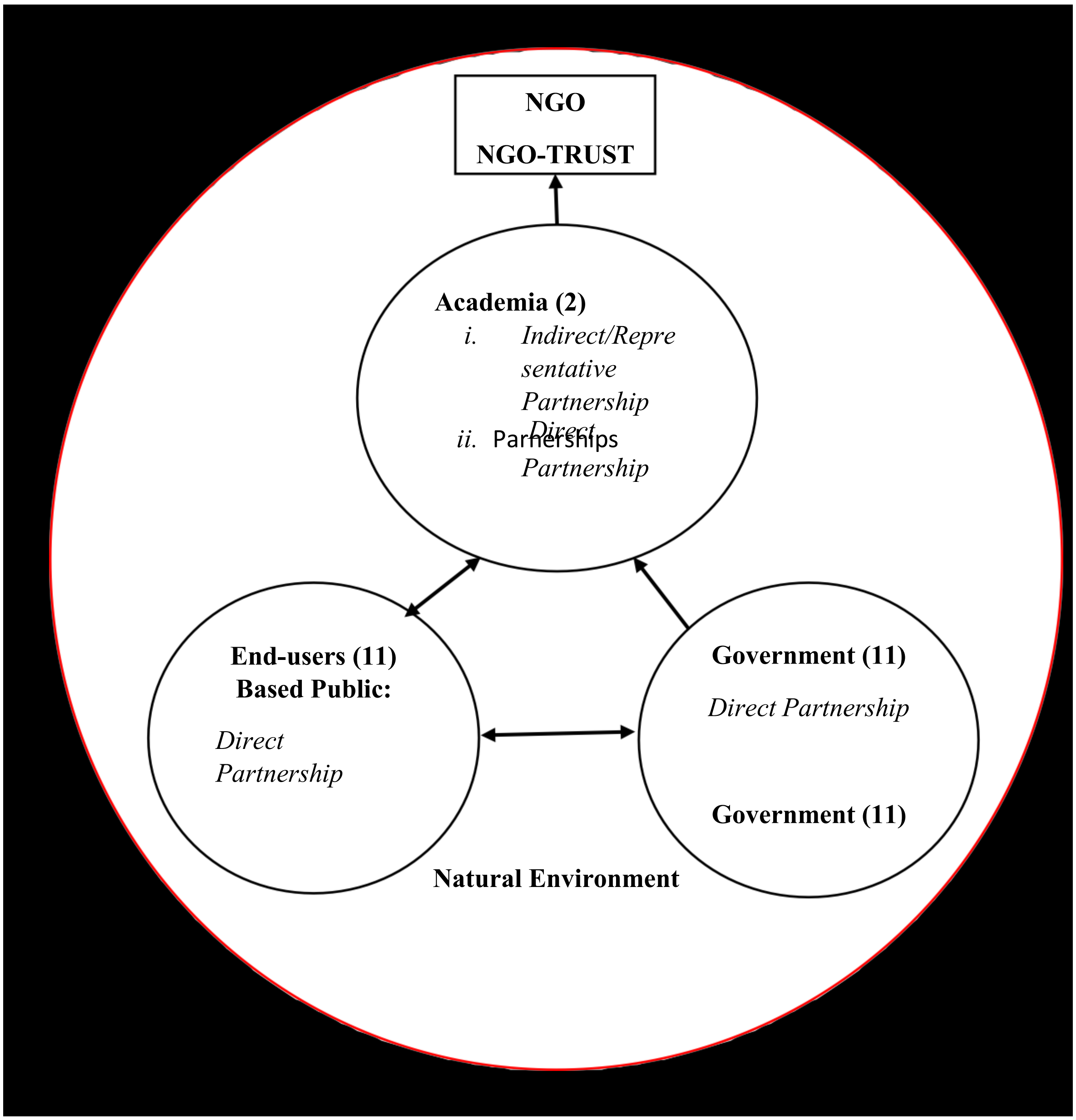


Figure 43: Summary of findings on types of partnerships in existence

11.3.2 Non-existence of partnerships between academia, government and end-users

The findings from research question one showed that one of the 3 (33.3%) participant from academia is not in partnership with other stakeholders. Also, two out of 13 (15.4%) of the participants from the government indicated that they are not in partnership with the other stakeholder groups. Equally, four out of the 15 (26.7%) participants from the end-user stakeholder group indicated that they are not in partnership with the other stakeholders. Additionally, the result showed that some of these participants that are not in partnerships with respect to climate change are involved in one activity or the other, though they did not specify who (which groups) such activities or service are offered to. For instance, the findings showed that the government stakeholder group are involved in activities that were classified as *"consultation"*. This involved activities such as:

- production planning, advice on crop production, as well as survey and need identification;
- production planning and consolidation of business plans

The findings further showed that the farmer that are not in partnership with the other stakeholders with respect to climate change address their challenges themselves. This was classified as being '*self-reliant*". This was informed by the fact that the extension practitioners (advisors) are no longer working in the fields with farmers as they used to do in the past (details in Chapter 8). This implies that these participants (four out of 15) are unable to access extension services and perhaps may struggle to align (adapt) their farming activities to current changes in weather and climate.

11.3.2 Roles of the stakeholders in the existing partnerships

The analysis showed that the three stakeholder groups engaged in this study (Aca-Gov-Comm) played different roles in the partnerships that exists amongst them. The findings with respect to the roles of the three stakeholders are summarised in Figure 44 below.

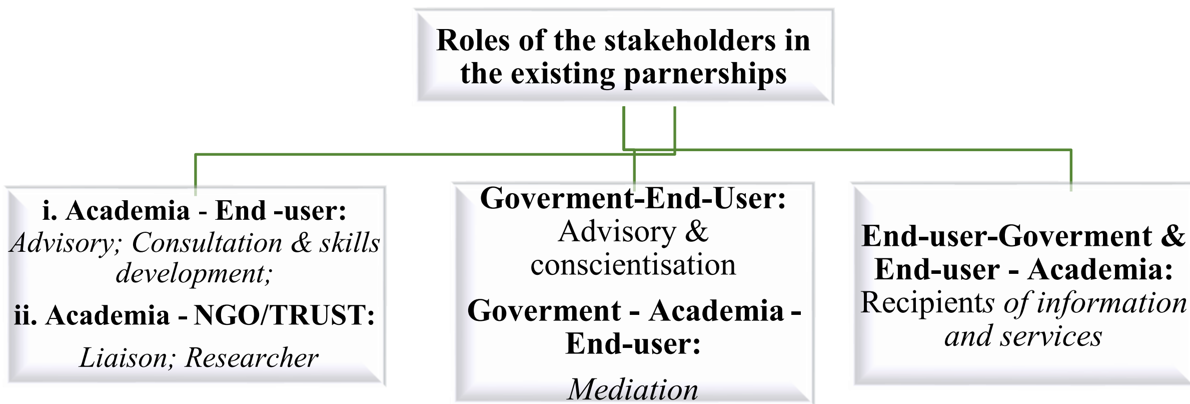


Figure 44: Summary of findings on roles of each stakeholder group in the existing partnerships

As illustrated in figure 44 above, the findings on research question two clearly showed that each stakeholder group plays certain roles in the partnerships that exist amongst them. For instance, the findings showed that academia plays "*an advisory*, *consultation* and *skills development*" role in its indirect partnership with end-users. Furthermore, it plays a "*meditation (liaison) and researcher"* role in the direct partnership existing between itself and NGOs. In addition, the result showed that academia played these roles in order "*to update the teaching programmes*" thereby deepening the knowledge and skills of future extension personnel. This finding is significant, given that lack of exposure to knowledge/skill on climate change is considered as one of major challenges affecting agricultural extension services in South Africa (Zikhali, 2016).

It is equally significant to note that academia is partnering with NGO on "*community food security*" (see Chapter 10 for details). This is significant given that food insecurity is rife and remains a major challenge in rural communities across South Africa and sub-Saharan Africa at large (Mugambiwa & Tirivangasi, 2017).

The government stakeholder group were found to be playing two major roles in their partnerships with the end-users and with academia; these are *"advisory and conscientisation*" as well as "*mediation"* roles. As presented in Chapter 10, the result showed that the government stakeholder group engaged the other stakeholders on a number of issues related to agriculture and agricultural decision making (see Chapter 9). For example, the findings explicitly showed that the extension practitioners advised farmers to "*plant their vegetables according to the climatic conditions of the area*". Furthermore, the result showed that famers are encouraged to *"consider climate when planting since weather has a huge impact on agricultural production"*. Still on the roles of the government stakeholder group, the findings indicated that the government stakeholder group are the "*intermediaries (liaison)"* between smallholder farmers and other stakeholders such as higher education institutions. Basically, they initiate and coordinate the interaction between farmers and higher education with respect to climate change and climate change adaptation.

Additionally, the result indicated that end-users are not playing any specific roles in the partnership that exist between them and the other stakeholder groups, rather, the end-users were found to be "*receiving information and services"* from the other two stakeholder groups. This finding is critical, given that the end-users engaged in the preliminary study proved to possess vast agricultural indigenous knowledge and skills (see Chapter 5). Perhaps the end-users may have considered themselves to be less knowledgeable and hence deserving of assistance, when they interact with the other stakeholders. This could also be traced to past experience or events where indigenous people and their knowledge systems have been previously neglected in climate change adaptation discussions, policies and programmes. Several studies conducted locally and internationally have shown that indigenous people and their knowledge systems are totally excluded in climate change mitigation and adaptation arrangements (Nyong et al., 2007; Chakeredza, et al. 2008; Parkinson, 2010; Ngcoya, 2017).

11.3.3 Promotion of climate smart adaptation practices in existing partnerships

According to Aggarwal et al. (2018), climate-smart agriculture (CSA) aims to increase sustainable agricultural production by adapting to and building resilience to climate change, while reducing the emission of greenhouse gases. The authors went on to explain that CSA addresses critical issues such as food security, climate change adaptation and mitigation. Bearing the foregoing in mind, the findings from main research question three showed that various climate smart adaptation practices were promoted by the three stakeholder groups in their respective partnerships. As presented in Chapter 11, the analysis showed that climate change adaptation strategies, such as "*conservation agriculture",* were promoted in the "*indirect partnership"* between academia and the end-users. This result confirmed the earlier position of academia during the preliminary study, that climate change and climate change adaptation is addressed implicitly (in an integrated manner) in the teaching of contents such as *conservation agriculture*. Conservation agriculture is considered a climate smart adaptation technology because it embodies and demonstrates the fundamental characterises of climate smart agriculture. This result is significant to research and policy on climate change adaptation in South Africa.

Furthermore, the government (as represented by the agricultural extension practitioners) in its partnership with academia promoted climate smart technologies such as "*planting of drought resilient crop varieties"*. Equally, the findings revealed that six climate smart adaptation technologies were promoted in the partnership between the government and the end-users. These are;

- water management
- the use of information technology
- the use of animal traction in place of tractors
- the use of environmentally friendly pest control
- the use of mulching
- the use of information communication technology

Evidently, this particular partnership between the government and end-users promoted the most climate smart adaptation practices and perhaps should drive the mainstreaming thereof. Analytically, this implies that agricultural extension practitioners are not only critical stakeholders in climate change adaptation discusses, but they are indispensable in the attainment of livelihood outcomes (in this case, adaptation and food security) in smallholder farming communities like Msinga.

Furthermore, the results showed that the end-users equally embraced and promoted agricultural practises or technologies that are considered climate smart. CSA practices such as *"the use of fertilizers"* and *"changing planting dates"* were adopted by the end-users through their partnership with the government. Changing planting dates is a popular agricultural practice within the context of climate change in sub-Saharan Africa. For instance, research conducted in Oromia Regional State of Ethiopia by Belay et al. (2017) found that changing planting dates, crop diversification, soil and water conservation are some of the adaptation strategies practices by smallholder farmers engaged in their study. The study, which sampled 200 households, revealed that "*changing planting dates*" is a key climate change adaptation strategy amongst the sampled population. Equally, "*the use of fertilizer*" in agriculture is considered a fundamental component of CSA according to a report by International Fertilizer Association (2016). Fertilizer application contributes to increase in agricultural productivity and global food security (Ibid.). Drawing from the foregoing, it evident that the practices promoted by the end-users in their partnership with the extension practitioners are climate smart.

11.3.4 Promotion of indigenous knowledge systems in existing partnerships

The findings showed that Indigenous Knowledge Systems (IKS) were encouraged by the stakeholders in their partnerships with each other. Academia (as represented by Agricultural Extension and Rural Development lecturers) promoted indigenous knowledge systems and practices such as "*storytelling (case studies)*" in the indirect or representative partnership existing between them and the end-users. The result, as presented in Chapter 11 highlighted that the IKS practice of storytelling was promoted by the education system/academia during teaching their activities.

Moreover, the findings indicated that the desire to help the end-users/culture-based public to make sense of their "*observations scientifically*" was the reason why they promoted IK practices of storytelling in an integrated manner. By implication, the end-users were considered to have less knowledge and understanding of scientific observations. This perception of end-users as scientifically unknowledgeable may be contributing to the exclusion of end-users in discussions and policy articulation on climate change and its adaptation. This is consistent with Gerrard (2008), who argued that there has been little space afforded for dialogue and collaboration with indigenous peoples about their responses to climate change. In addition, this could be the reason why the end-users play no major roles, besides receiving information and services, as established in Chapter 10.

Furthermore, the findings revealed that indigenous agricultural practices such "*animal traction rather than tractors"* and the use of "*ground manure"* were promoted by the government stakeholder group (as represented by the agricultural extension practitioners in the Department of Agriculture) in the partnership that exists between them and the end-users. This finding concurs with other studies on indigenous practices used to adapt to climate change in other sub-Saharan African countries and smallholder farming contexts. For example, Eze and Ike Nnia (2013) report that farmers in Northern Nigeria use animals to till the land in order to reduce the difficulty in tilling the land manually with hoes. This implies that the use of animal traction is more convenient and efficient than the use of hoes.

In addition, the result showed that end-users promoted indigenous practices of "*weather prediction and agricultural decision making"* in their direct partnership with the other stakeholder groups. The result explicitly showed that the end-users knew what *"seeds to plant in summer and in winter"* because they have sound knowledge of weather. Indigenous weather prediction and agricultural decision making are popular agricultural practices within smallholder farming contexts across Africa (Nwajiuba et al., 2015).

11.4 DISCUSSION OF KEY FINDINGS FROM THE MAIN STUDY

This section presents the discussion of the findings in the main study. As indicated in Table 11.2 above, the main study was guided by four research questions. The findings of these four research questions were presented in Chapters 8, 9 and 10 respectively. The discussion in this section is presented under these points:

- Partnerships in existence between the three stakeholder groups
- Roles of the stakeholder groups in existing partnerships
- Promotion of climate smart adaptation practices in existing partnerships
- Promotion of indigenous knowledge systems in existing partnerships

11.4.1 Partnerships existence between the three stakeholder groups

The findings from main research question one on partnership existence amongst the stakeholders revealed that the majority of the participants (Aca – 66.7%; Gov – 84.6%, Comm – 73.3%) engaged from the three stakeholder groups are in partnerships. These partnerships are *direct* and *indirect/representative* in nature. This implies that there is a strong stakeholder interaction amongst the stakeholders engaged, contrary to recent research by the Academy of Science of South Africa (2017), which revealed that the linkages between research, teaching, and extension are poor. The study, whose objective was to provide a situation analysis of South African Agricultural Extension Training (AET), amongst others, recommended better coordination within the research-teaching-extension knowledge interaction. This finding also differs from those of Pinkse and Kolk (2012), whose study highlighted that there is lack of multi-stakeholder interaction on climate change adaptation and sustainable development in developing countries. Given the foregoing perspective, this findings on partnerships existence between the three stakeholders seem to have responded to the above gaps, thereby providing the appropriate foundation for further interaction and knowledge development on climate change in smallholder farming communities like Msinga.

Furthermore, this finding is very significant, given that that the problems of climate change cannot be address by one single sector. According to Sullivan, Mwamakamba, Mumba, Hachigonta, and Majele Sibanda (2012), the issues of climate change, agriculture and food security cannot be addressed by any single sector, hence, there is a need for synergies and partnerships across sectors in order to effectively address the problem. The authors suggested that partnerships offer the appropriate platform for interaction, negotiation and understanding that could provide new sources of information necessary for diagnostic and decision making on climate change adaptation. By implication, the above findings offer the needed roadmap for the establishment of a more robust partnership arrangement between academia, government and end-users, as well other relevant stakeholders, such as NGOs, in the agricultural sector within the study area and perhaps beyond.

Though only three out of the five institutional spheres of QHIM are involved in this study, however, the interaction amongst the stakeholders is driven by the need to address a societal problem (climate change) that affects all the stakeholders, as conceived in QHIM. According to Carayannis et al. (2012), production and exchange of knowledge amongst the spheres in QHIM should be driven by the need for socioecological transformation and sustainable development. In the light of the above findings on partnership existence, one can argue that the partnership model for mainstreaming climate smart technology adaptation technology in Msinga everyday agriculture entails collaboration involving three spheres (academia, end-users, government) of the QHIM, but with different types and levels of interaction.

11.4.2 Roles of the stakeholder groups in existing partnerships

The findings on the roles of the stakeholder groups (example, "advisory", "consultation" and skills development"; liaison, researcher; advisory and conscientisation; mediation, etc.) in their respective partnerships showed that the stakeholders played roles that are linked to their professional or institutional roles as conceived in QHIM. For instance, the *advisory, "advisory, consultation* and *skill development"* roles played by academia is in line with the roles of higher education institutions, according to Odora Hoppers (2001, p. 79) and Stephens et al. (2008). The authors reason that the roles of higher education include but are not limited to knowledge production, skills development and dissemination. Furthermore, these are relatable to the subsystems functionality of the helices in QHIM, where knowledge moves from one subsystem to another subsystem in a circular manner (Grundel & Dahlström, 2016). An input of knowledge into one subsystem will inspire a process of innovation or knowledge creation in another subsystem (Ibid.).

As the academia stakeholder group indicated under the indirect partnership, their *"…main role is in the form of advising and consulting on learning interventions and in providing future officers with practical farming skills".* In addition, their interaction with an NGO under the direct partnership was aimed at "*latest developments with respect to climate change observations and policies with a view to updating their teaching programme*". This implies that the input of knowledge in the "*indirect*" interaction or collaboration between academia and end-users via student engagement will lead to new knowledge or innovation – "*practical farming skills*". Likewise, the input of knowledge in the *direct interaction* between academia and NGOs will perhaps lead to innovation in teaching – *"upgraded and innovative teaching programme".* One can infer from this that academia is tacitly fulfilling its roles as articulated in the QHIM and highlighted by scholars such as Stephens et al. (2008).

Again, findings showed that government played advisory and conscientisation, as well as mediation roles, in their partnership with end-users and academia. This shows that some of the smallholder farmers in the study area are being supported by the government stakeholder group on how to adapt their farming practices and activities to the climate conditions of their communities.

This finding is significant on different fronts. First, it shows that the extension practitioners understand climate change and its impact on agriculture and hence can be considered knowledgeable. This is contrary to the findings of the preliminary study (see Chapter 6), which revealed that the majority of the extension practitioners are underqualified, ill-equipped and perhaps incompetent to deliver services related to climate change to end-users. Secondly, this finding is significant, given the fact that farmers with access to extension services are more likely to access climate information and also adapt their farming activities to current climate conditions (Fosu-Mensah et al., 2012; Belay et al., 2017). In addition, this finding shows that the government stakeholder group is playing a very important role in facilitating adaptation to climate change amongst smallholder farmers in Msinga Local Municipality.

Furthermore, the finding which relates to "advisory and conscientization role" as well as mediation role" concurred with Agrawal et al. (2009, p. 20) who argued that the local government is indispensable in climate change adaptation efforts within rural communities given that:

- the local government bridges and promote two-way communication between higher and local policy levels;
- assist and guide locally the implementation of climate change adaptation activities;
- mobilizes local participation in climate change adaptation programmes.

In this regard, the authors reasoned that the local government have advantage over other levels of government in facilitating climate change adaptation. This confirmed the assertion by scholars such as McSweeney and Perrin (2008), Dovers and Hezri (2010) as well as Measham et al. (2011), that the government stakeholder group, as represented by the agricultural extension practitioners in this study, are critical stakeholders in promoting climate change adaptation in rural communities given their proximity to the end-users and the other levels of government. Therefore, these findings on the roles played by the extension practitioners are crucial to policy makers and other stakeholders on climate change adaptation.

In relation to theory, the roles played by the government (as represented by extension practitioners) in the current study synchronizes with the anticipated roles of government under the QHIM. The government (represented as political systems under QHIM) formulates polices and determines the direction of the state on every issue (Carayannis et al., 2012, p. 6). They also administer and oversee programmes across levels in the society (Ibid.) It is equally important to state that the government is mostly responsible for the provision or supply of economic capital, which relates to finances/funds and physical capital needed for the basic infrastructure and production facilities that enable the attainment or sustenance of livelihood (Scoones, 1998; Etzkowitz, 2003). Perhaps, the roles played by the government in this study will facilitate the achievement of livelihood outcomes of food security, adaptation to climate change and reduced vulnerability which depends on access to livelihood capitals, such as presented in Chapter 3 and summarised above. Hence, it can be argued that the position and roles of the government stakeholder group in the current study will drive the mainstreaming of climate smart practices (technology adaptation) within Msinga.

However, the findings on the roles of end-users, which was classified as "*recipients of information and services*", contradict the conception of partnerships and the stipulated roles of end-users under the QHIM. Partnerships, especially in the context of climate change, are about collaborative arrangements in which stakeholders from different sectors are involved in a non-hierarchical process, and through which these actors endeavour to address the problems of climate change (Van Huijstee et al., 2007; Pinkse & Kolk, 2012). According to Kolk et al. (2008), partnerships create the platform for greater learning opportunities, increased social capital, access to partners networks, etc. This means that a partnership presents the opportunity for different actors to access and acquire competences they may be lacking individually, and share or contribute their core areas of strengths with other stakeholder groups.

In this regard, it is expected that each individual stakeholder group in a partnership arrangement should contribute in one way or the other. In addition, the end-users under the QHIM and SLA embodies the social capital which relates to knowledge or information of tradition and practices in relation to agriculture, social networks, values, goodwill or "Ubuntu" in short. This means that end-users possess wealth of knowledge (as seen in Chapter 5 and summarised above) and therefore positioned to contribute to development of innovation for climate change adaptation mainstreaming. It is thus surprising that they were seated at the periphery (decentred) in the current discussion. As indicated earlier in the summary section, the end-users perceiving themselves as "*recipients of information and services*" may be linked to the historical exclusion of the local people and their knowledge systems in policy articulation and programmes.

According to Chakeredza et al. (2008, p. 328), farming communities are usually excluded from the design and delivery of agricultural curriculum even though such curriculums are designed to satisfy the agricultural needs of the host communities. In the context of climate change, Ngcoya (2017) argued that local farmer's experiences and practices of climate change are not considered by those in charge of climate change policy making. In another study, Gerrard (2008) found that there has been little space afforded for dialogue and collaboration with indigenous peoples about their responses to climate change. This could be the reason why the end-users did not see the need to contribute in their partnership with the other stakeholder groups. Alternatively, their poor economic status may have affected their participation and agency as it is believed that the poorer one is, the less agency you have. Whatever the case, this finding with respect to the roles of end-user calls for further research, especially because of the need to involve indigenous people (in this cases MSF) and their knowledge systems in policies and programmes on climate change and climate change adaptation.

11.4.3 Promotion of climate smart adaptation practices in existing partnerships

The findings of main research question three, which inquired if these partnerships promoted climate smart adaptation practices in everyday agricultural practices revealed that the three key pillars of climate smart agriculture, namely adaptation, mitigation and food security, were indeed promoted in the respective partnerships as reflected in Table 68 below.

Table 68: Key findings on climate smart adaptation practices promoted

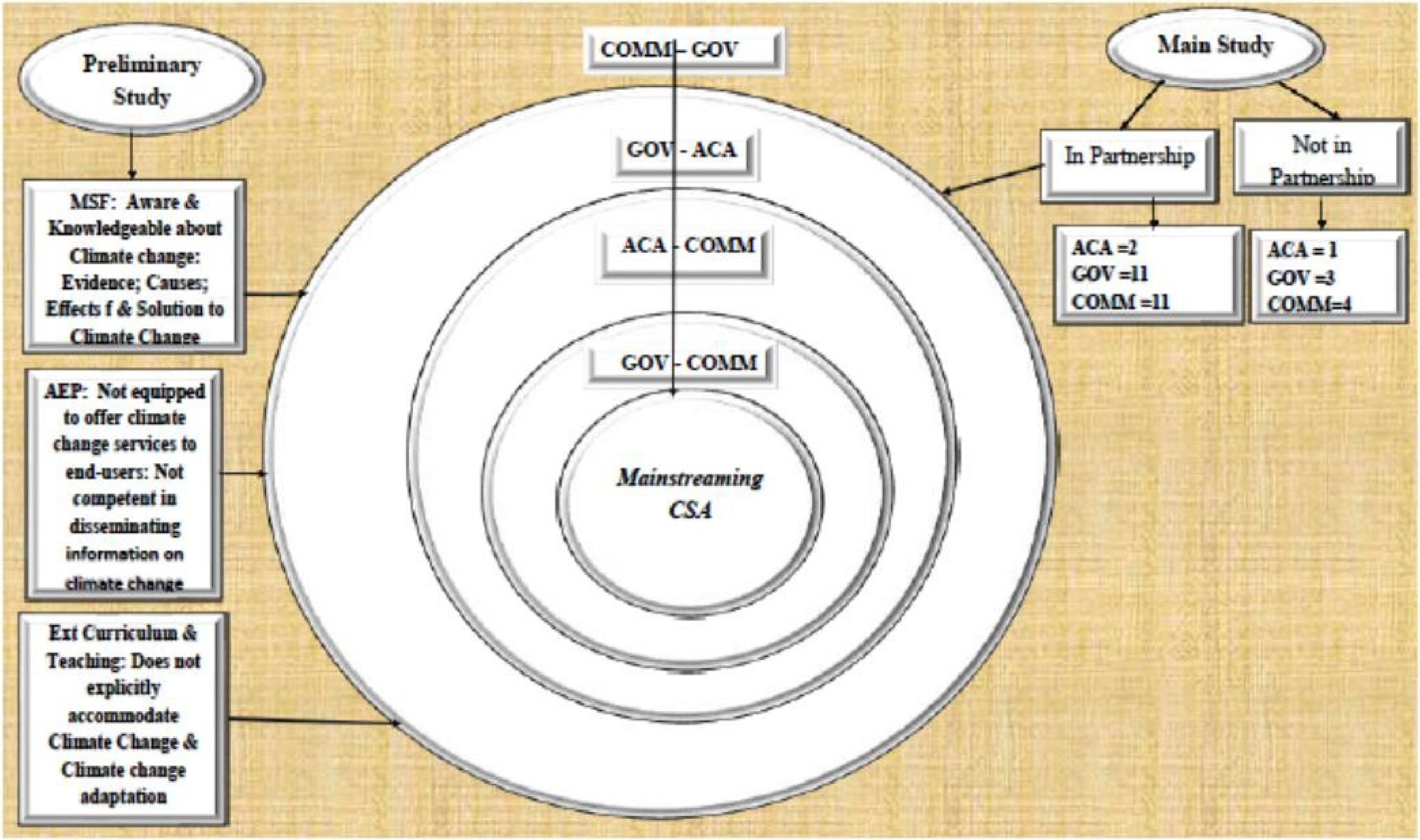
CSA Practices and Corresponding CSA Pillar		
ACA - COMM	**GOV – COMM** **GOV – ACA**	**COMM – GOV**
• Conservation Agriculture = *Adaptation, mitigation & food security*	• Water management = *Adaptation* • The use of sustainable farming approaches = *Mitigation* • The use of animal traction in place of tractors = *Mitigation and adaptation* • The use of environmentally friendly pest control techniques = *Mitigation and adaptation* • The use of mulching = A*daptation* • The use of information communication technology = *Adaptation and mitigation.*	• The use of fertilizer = *Adaptation and food security* • Change in planting dates = *Adaptation*

In analysing this, the findings with respect to research question three shows that the three pillars of CSA were present in the partnerships existing between academia, government and end-users. As illustrated in Table 68 above, the indirect partnership between academia and the end-users promoted the CSA practice of *conservation agriculture*. From a definitional point of view, conservation agriculture encompasses the three key pillars of climate smart agriculture - food security, adaptation and mitigation (Kimaro et al., 2016). According to Lipper et al. (2014), agricultural practices can be considered to be climate smart when those practices address issues such as sustainable increase in productivity, supporting farmers' adaptation to climate change and reduction of greenhouse gases.

As depicted in the Table 68 above, climate smart adaptation strategies such as *water management, sustainable farming approaches", the use of mulching,* "*environmentally friendly pest control techniques, etc.',* promoted by the government stakeholder group, encapsulated the key pillars of climate smart agriculture**.** The findings further highlighted that these climate smart practices "*reduce the emission of greenhouses gases while increasing productivity"*, hence can be considered climate smart (see Chapter 10). These findings correspond with Mwongera et al. (2017) whose study revealed that climate smart technologies such as mulching, contour ploughing, improved crop varieties, etc. are prioritized by farmers in rural communities in Tanzania and Uganda. These findings are therefore significant and perhaps pave the way for the mainstreaming of CSA into Msinga's everyday agricultural practices through Aca – Gov – Comm partnerships, a step which is considered imperative but never yet achieved, by scholars such as Chandra, McNamara, and Dargusch (2018). The study by Chandra et al. (2018) elucidate that the progress made on mainstreaming climate change in the agriculture sector is limited and hence they propose that there is an urgent need for integrated actions/collaborations. Chandra et al. (2018) further reason that new approaches are needed to transition to climate-resilient agricultural development in South Africa.

Furthermore, the findings on the CSA practice of "*changing planting dates*" to adapt to current weather and climate and the "*the use of fertilizer*" corresponds with other studies on adaptation measure adopted by farmers. A typical case in point is the study by Knox, Hess, Daccache, and Wheeler (2012), which revealed that farming practices such shifting planting dates and crop rotation are popular among smallholder farmers. These practices are used to offset some negative impacts of climate change such as low productivity and loss of agricultural inputs (Knox et al., 2012). It is clear from the foregoing that various climate smart technology adaptations are already being promoted in the direct and indirect partnerships that exist amongst the actors engaged in this study. These findings are significant to research and policies on mainstreaming CSA in smallholder farming contexts such as Msinga.

Drawing from these findings from the preliminary study and the findings from the main study, with specific reference to partnership categories generated, roles played by each stakeholder group and CSA practices promoted, a model for mainstreaming CSA adaptation technologies or practices among various stakeholders in rural contexts was developed through the adopted features of the QHIM. Figure 45 below depicts the nature of the model and the different types of interaction amongst the stakeholders.



[3] **Figure 45: Model for mainstreaming climate smart technology adaptation through university-government-community partnerships (Nwokocha, 2019)**

[3] ACA = Academia; GOV = Government; COMM = Community; Ext = Extension; AEP = Agricultural Extension Practitioners; MSF = Msinga smallholder farmers CSA = Climate Smart Adaptation

Figure 45 above reflects the types of interactions between the three stakeholder groups (spheres) engaged in this study in relation to QHIM and the pathways for mainstreaming climate smart technology adaptation in everyday agricultural practices of Msinga smallholder farmers. These stakeholder groups or helices, as conceived in the QHIM, are represented in this study as:

ACADEMIA • **ACA - COMM**	Representative from College of Agriculture such as Agricultural Extension and Rural Development lecturers, students, curriculum and programme templates
GOVERNMENT • **GOV - COMM** • **GOV - ACA**	Representative from Department of Agriculture and Rural Development such as agricultural extension advisors and managers
END-USERS • **COMM - GOV**	Representatives from smallholder farming communities such as Msinga smallholder farmers

As earlier indicated, the development of this model is premised on the findings from the preliminary study (as presented in Chapters 5, 6 and 7, and discussed above) and findings from phases 1 to phase 3 of the main study (presented in Chapters 8, 9 and 10, and discussed above). Significantly, these findings offer new information and knowledge on climate change, climate change adaptation practices and climate change partnerships/interactions in rural communities, and perhaps will drive the mainstreaming of climate smart technology adaptation within the context of agriculture in smallholder farming communities. As Stuart-Hill (2015) states, integrating new information and knowledge on climate change is an important aspect of the mainstreaming process.

11.4.4 Promotion of indigenous knowledge systems in existing partnerships

As articulated in earlier in this chapter, the second concern of this is the neglect of IKS in various contemporary adaptation arrangements (policies and programmes) in the African context, even though the IK adaptation technique is perhaps the most widely used technique or sustainable livelihood approach in rural African contexts (Nyong et al., 2007; Ngcoya, 2017). In this regard, research question four sought to identify the types of IKS practices being promoted in the partnerships existing between the three stakeholder groups, in order to locate the space and place of IKS in the mainstreaming of climate change adaptation via partnerships. The findings, based on this research question, showed that the use of indigenous knowledge systems (IKS) in the form of indigenous agricultural practices was indeed promoted in the partnerships identified in this study.

The findings showed that IKS practice of storytelling was promoted in the "*indirect*" partnership between academia and the end-users. This is significant given that the practice of storytelling is widely recognised as the main approach through which IKS is acquired and transmitted from one person to another or one generation to generation. Eze and Ike Nnia (2013) as well as Mawere (2014) expound that indigenous knowledge and practices are transmitted from one generation to another through storytelling. According to Eze and Ike Nnia (2013), lifelong lessons and knowledge of different aspects of life are usually embedded in these stories.

Similarly, the findings showed that the government stakeholder group promoted "*the use of animal traction rather than tractors*" and "*the use of ground manure*" in their interactions with end-users. Both indigenous agricultural practices are widely practised in smallholder farming communities across sub-Saharan Africa. For instance, the study by Ezeudu et al. (2013) reported that smallholder farmers in Nigeria use resources such as leaves and animal dungs as manure during farming, to enhance the growth and yield of crops and other farm products. Also, a study piloted by Simalenga and Jongisa (2000) found that the practice of using animal traction is still widely used in South Africa, despite the neglected support services. The use of animal traction is considered as a more sustainable, affordable and available option to machinery in smallholder farming communities such as Msinga (Ibid.). So, it is not surprising that this popular practice was promoted in the *direct partnership* between the extension practitioners and Msinga smallholder farmers.

Furthermore, these indigenous farming practices may be considered less burdensome financially and environmentally, as they are freely accessible. Given that smallholder farmers in South Africa find it difficult to access agricultural capitals and facilities, according to Mugambiwa and Tirivangasi (2017), promoting these indigenous agricultural practices will assist them in their farming activities and in achieving livelihood outcomes like food security. More so, the two practices are not harmful to the environment, hence they are sustainable practices. This shows the relevance of IKS in climate change adaptation and hence illuminates the place and space of IKS in climate change discussions.

Additionally, the findings on the promotion of IKS revealed that the IK *practice of weather prediction and agricultural decision making* was promoted by the farmers in their interactions with the government. This corresponds with other studies related to IKS and agriculture in sub-Saharan Africa. For example, the study by Ajani et al. (2013) showed that rural/smallholder farmers in many sub-Saharan Africa countries make use of their indigenous knowledge in making weather predictions and farming decisions. The study made reference to smallholder farmers in Niger Republic and Nigeria, who makes decisions on cropping patterns based on local predictions of weather and decisions on planting dates, based on complex cultural models of weather. Similarly, Chanza (2015b) draws our attention to the fact that smallholder farmers in some Southern Africa countries, such as Zimbabwe make certain farming decisions by studying the behaviour of migration birds and certain flowering plants. These studies have proven that smallholder farmers in Msinga, like their contemporaries/counterparts in other African contexts, have vast indigenous knowledge of weather prediction and agricultural decision making. When considered, one can argue that these agricultural indigenous practices, such as discussed above, should be accorded a space and place in the mainstreaming of climate smart technology adaptation in smallholder contexts like Msinga. This will significantly reduce the vulnerability of smallholder farmers and increase adaptation to climate change, as well as achieve food security in a rural context which are critical livelihood outcomes.

11.5 CONCLUSION

This chapter has presented a discussion of the findings made in the preliminary and main study. The chapter first discussed the preliminary findings and concluded with discussions of the findings from the main study. The next and final chapter of the study presents the conclusion and implications of the findings and the contribution that the study is making to the body of existing knowledge on the mainstreaming of climate smart technology adaptation.

CHAPTER TWELVE

CONCLUSION, CONTRIBUTION TO KNOWLEDGE AND IMPLICATIONS OF THE FINDINGS

INTRODUCTION

This chapter presents the conclusion to the study, implications of the findings, and contribution that this study is making to the body of knowledge. The chapter begins with the conclusion, by way of reflecting on different aspects of the study and ends with the contribution which the study makes to knowledge.

This section presents the conclusion to the thesis, which aimed to explore how *the partnerships amongst university, government and smallholding farming communities (Aca – Gov – Comm) can enable the mainstreaming of climate smart technology adaptation in everyday agricultural practices of rural farmers in Msinga.* To this end, the study sought to locate the place and space accorded to indigenous knowledge systems in these partnerships. This was done to facilitate innovation/knowledge production, dissemination and interchange amongst the three stakeholder groups engaged in this study. This section begins with an overview of the entire study, with a consideration of the various chapters as presented below.

12.1 OVERVIEW OF THE STUDY

The first chapter of the study outlined the orientation of this thesis, which is based on the subject of the study, by providing insights on the context and concept of mainstreaming climate smart technology adaptation, on the contextual background, and on challenges facing climate change adaptation in South Africa. The rest of the chapter included the statement of the problem, purpose of the study, research questions, and significance of the study. A review of related literature was done in Chapter 2. This was followed by Chapter 3, where the frameworks employed in the study were presented. Chapter 4 of the study highlighted the methodology employed to gather and analyse data generated in the study. The analyses of data generated in the preliminary study were presented in Chapters 5, 6 and 7, whilst those of the main study were in Chapters 8, 9, and 10. Discussion of the findings was presented in Chapter 11. The conclusion, implications of findings and contributions to knowledge were outlined in Chapter 12.

12.1.1 Reflection on contextual background

Research by several scholars such as Müller, Cramer, Hare, and Lotze-Campen (2011), Global Climate Risk Index (2016) and Mthembu and Zwane (2017) revealed that climate change is an endemic problem, especially within developing countries (regarded today as the global south) and particularly in Africa. In South Africa, the impact of climate change events such as drought and flood in the agricultural sector is widely recognised and well researched (Turpie & Visser, 2013; Mbatha & Masuku, 2018). In smallholder farming contexts like Msinga, where this study was conducted, research by Rukema (2010) as well as Mthembu and Zwane (2017) reported that climatic phenomena such as drought are a threat to the predominant smallholder agriculture. In response to the foregoing, many scholars such as Sullivan, Mwamakamba, Mumba, Hachigonta, and Majele Sibanda (2012), Nwajiuba et al. (2015) and Partey et al. (2018) suggest that Climate Smart Agriculture (CSA) holds the answer to negative impacts of climate change in agriculture and perhaps is the future of African agriculture. CSA is an innovative way of increasing agricultural productivity, while reducing the emission of greenhouse gases (Sullivan et al., 2012; Westermann et al. 2015). According to Lipper and Zilberman (2018, p. 20) CSA is driven by the desire to achieve three critical livelihood outcomes, namely, adaptation, mitigation and food security. This demands that CSA should be mainstreamed (integrated) in all efforts (policies and practices) towards climate change adaptation within the context of agriculture for greater impact (Wright et al., 2014). Mainstreaming CSA will then mean that CSA is considered, taken into account, reflected on and integrated into broader decision making processes and activities related to climate change (Jordan et al., 2012).

Nonetheless, research by Sullivan et al. (2012) as well as Lipper and Zilberman (2018), has acknowledged that addressing the problems of climate change through CSA requires coordinated efforts from different actors as the problem of climate change (especially in the agriculture sector) is multifaceted and hence cannot be addressed by any single sector. Conceptually, partnership is described as a collaborative arrangement in which different institutions or sectors of the society (such as educational institutions, financial institutions, non-governmental organisations, etc.), are involved in a non-hierarchical process, and through which these actors strive for a sustainability goal (Van Huijstee et al., 2007). Against this background, this study explored how partnership arrangement between university, government and smallholding communities can facilitate the mainstreaming of climate smart technology adaptation in everyday agricultural practices in rural

Msinga. The aim was to strengthen existing climate smart agricultural practices and develop a new model of partnership for the mainstreaming of climate smart technology adaptation in rural contexts like Msinga. In doing this, the study sought to identify the place and space accorded to IKS in the existing partnerships. This is because indigenous/local adaptation strategies are yet to be recognised or accorded a space in public/government policies and programme on climate change within South Africa (Makhubele et al., 2016; Ngcoya & Mvuselelo, 2017).

12.1.2 Reflection on the frameworks

Three frameworks were employed in the study, namely Jansen and Reddy's (1994) document analytical tool, Sustainable Livelihood Approaches (SLA) and the Quintuple Helix Innovation Model (QHIM). The Jansen and Reddy's (1994) document analytical tool (framework) was used in the 2nd phase of the preliminary study to evaluate the extent to which the agricultural extension programme prepares extension practitioners to facilitate adaptation to climate change in smallholder farming contexts. The Sustainable Livelihood Approaches (SLA) was used as both an analytical framework and as a theoretical lens. The framework was applied throughout the preliminary study and in the last two phases of the main study. SLA explores livelihood challenges faced by individuals and groups in contexts like Msinga and how they follow different livelihood pathways to overcome these challenges. It emphasises that access to livelihood capitals, such as human capital, economic capital, social capital, natural and physical capital, enables the attainment of livelihood outcomes. On the other hand, the framework highlights that lack of access to the abovementioned capitals will hamper the attainment of livelihood outcomes, which includes but is not limited to adaptation, mitigation and food security. The last framework employed in this study is the Quintuple Helix Innovation Model (QHIM). It was employed as an analytical tool in the preliminary and main study. The QHIM advocated for collaboration between five helices, namely, the education system (recognized in this study as academia), the culture and media based public (recognised as end-users), the economic system (industry), the political system (recognised in this study as the government) and the natural environment. QHIM argues that development of knowledge and innovation must take the context or environment into account and the only way to achieve that is to include or consider the natural environment as a helix (sphere) in every innovative interaction.

12.1.3 Reflection on review of related literature

Both empirical and theoretical literature relating to climate change adaptation from different parts of the world were reviewed in this study. This was necessitated by the need to gather the necessary information on recent developments on climate change adaptation mainstreaming and partnerships across the globe. From the literature reviewed, it was found that most countries in sub-Saharan Africa and South Asia are disproportionately affected by the effects of climate change, such as hunger and food insecurity, even though they contribute the least to the causes of climate change. Notwithstanding this, it was found that these smallholder farmers possess vast indigenous knowledge of agriculture and have constantly drawn from these knowledges to adapt to climate change even though such knowledge is yet to be recognized by policy makers. Furthermore, it was noted from the literature that mainstreaming CSA is one way to mitigate and adapt to climate change and equally address food insecurity in smallholder farming communities across sub-Saharan Africa. In addition, it was noted that mainstreaming CSA will have greater impact when it is done through stakeholder partnerships involving academia, government and smallholder farmers themselves.

12.1.4 Reflection on research methodology

An exploratory qualitative case study design, involving questionnaires (open and closed-ended), document analysis and focus group discussions, was employed for generating and analysing data in the study. Data generated for phase one of the preliminary study was collected and analysed through a combination of statistical analysis, using SPSS (frequency tables and bar charts) and thematic analysis. The data was generated through open-ended and closed-ended questionnaires, as well as focus group interviews. Data for phase two of the preliminary study was collected via closed-ended questionnaires and analysed statistically using SPSS. The data for the third phase of the preliminary study was collected through a combination of document analysis and focus group interviews. The analysis for this phase was done thematically. Data for the main study was generated and analysed through a combination of statistical analysis using SPSS (frequency tables and bar charts) and thematic analysis. The data for phase 1 of the main study was collected through a combination of open and closed-ended questionnaires as well as focus group interviews. The data generated from the closed-ended questionnaire was analysed statistically using SPSS, while the data from the open-ended questionnaires and focus group discussions was analysed thematically. The data for the second phase was collected through focused interviews and analysed thematically. Similarly, the data for the third phase as well as the fourth phase, which was the final phase of the main study, was collected through focused interviews and analysed thematically.

12.1.5 Reflection on response to the research questions (major findings)

Findings from research question 1 in the preliminary study revealed that the smallholder farmers engaged in this study are aware and knowledgeable about climate change and its impacts on their agricultural practices and livelihoods at large. Their knowledge and awareness were classified into four categories, namely: evidence of climate change, causes of climate, effects of climate change and solutions to climate change. Embedded in these classifications of knowledge and awareness were experiences of climate events such as drought, heavy rainfall, etc. Embedded in the effects of climate change are loss of agricultural inputs, loss of income, loss of lives, etc. Equally, solutions to climate change such as no till planting, rituals, etc. were embedded in the MSFs' knowledge and awareness on climate change. The findings, based on research question two in the preliminary study, showed that in-service agricultural extension practitioners (the government stakeholder group) are not well equipped (in terms of level of qualification and content knowledge received) to offer extension services related to climate change. 70.6% of the extension practitioners engaged did not have the required level of qualification needed to operate as extension advisors. Furthermore, 50.8% of the extension practitioners stated that climate change and climate change adaptation was not included in their curriculum and that they have not received in-service training on climate change and climate change adaptation. The last question in the preliminary study, research question three, revealed that climate change and climate change adaptation content and concepts were not accommodated as content areas or streams in the pre-service extension training programme template (curriculum). This finding was affirmed by the academic staff members, who stated that climate change and climate change adaptation was not explicitly accommodated in the training of agricultural extension practitioners; rather concepts related to climate change were implicitly accommodated in the teaching of some topics.

Findings from the main study revealed that there is a high level of partnerships between the stakeholders engaged in this study. These partnerships were classified as indirect and direct partnerships. 66.7% (two out of 3) of the participants from academia were in indirect partnerships with the end-users and in a direct partnership with NGOs. The findings revealed that 84.6% (11 of

13) of the participants from the government stakeholder group are in direct partnership with academia and end-users. Lastly, 73.3% (one out of 15) of the end-users were found to be in a direct partnership with government and academia. In contrast, the findings revealed that 33.3% (one of 3) of participants from academia are not in any form of partnership with respect to climate change. Also, 15.4% (two out of 13) of the participants from the government stakeholder groups were not in partnership with the stakeholder groups engaged in this study. In the absence of partnership involvement, the findings revealed that they were into consultation. However, the findings did not make explicit the people they offer such services to. Equally, the findings showed that 26.7% (four out of 15) of the end-user were not involved in partnerships with the other stakeholders with respect to climate change adaptation. In the absence of partnership involvement, the findings showed that they were self-reliant, when it comes to climate change issues.

The findings based on research question two in the main study showed that these partnerships encompassed some of the features and functions of the helices in the QHIM. The findings revealed that academia played three main roles in their indirect and direct partnership with NGO and end-users, namely, advisory and consultation, liaison and researcher. These were related to the functions of academia under the QHIM and contribute to the attainment of livelihood outcomes, as conceived in SLA. The findings revealed that the government stakeholder group played two main roles in their partnership with end-users and academia, these are, advisory and conscientisation and mediation. Again, these roles are relatable to the roles of government as par the QHIM and SLA. However, the findings revealed that the end-users were not playing any roles in their partnerships with the government and academia; rather they were found to be receiving information and services from the other stakeholder groups. This was contrary to the envisaged contribution or function of end-users in the QHIM.

The findings with respect to research question three of the main study revealed that academia promoted one climate smart agricultural practice, the practice promoted being conservation agriculture. Equally, the findings revealed that the CSA practice of planting of drought resilient crop varieties was promoted in the partnership between the government stakeholder group and academia. On the other hand, six CSA practices were promoted in the partnership between the government and the end-users, namely, water management, the use of information technology, the use of animal traction in place of tractors, the use of environmentally friendly pest control, the use of mulching and the use of information communication technology. This partnership promoted the highest number of CSA practices, thereby affirming the relevance and prominence of the government stakeholder group, represented by agricultural extension practitioners, in mainstreaming climate change adaptation through partnerships. Furthermore, the finding implicitly revealed that the extension advisors not being educationally qualified and exposed to climate change content (as shown in the preliminary study) does not necessary imply that they are incapable of offering extension services related to climate change. Additionally, the findings revealed that end-users promoted two CSA practice in their partnership with government; these are, the use of fertilizer and changing planting dates. From the newly generated partnership categories and the roles played by the actors, a new model is supported for mainstreaming climate smart technology adaptation partnerships, involving different types of interaction between academia, government, smallholder and farming communities, using the QHIM in order to pursue the envisaged livelihood outcomes as outlined in SLA.

Further, the findings from research question four of the main study revealed that academia promoted one indigenous knowledge or practice in their indirect partnership with end-users. The IK practice promoted is storytelling or case study. Similarly, the findings revealed that two IK practices were promoted in the partnership between the government and end-users, namely, the use of animal traction instead of tractors and the use of ground manure. Lastly, the findings showed that the end-users promoted the practice of weather prediction and agricultural decision making. These findings confirmed the perspective that IKS practices include key livelihood capitals, such as human and social capital, and perhaps can engender the attainment of livelihood outcomes. Hence, IKS practices synchronize with CSA practices and therefore should be accorded a place and space in climate change adaptation discussions.

12.2 CONTRIBUTION TO KNOWLEDGE

This section presents the contribution this study makes to existing knowledge on mainstreaming of climate smart technology adaptation in everyday agricultural practices of rural farmers in Msinga, through partnerships amongst University, Government and Smallholding Farming Communities.

12.2.1 Theoretical framework

As earlier indicated, this research was guided by two theories, namely Sustainable Livelihood Approaches (SLA) and Quintuple Helix Innovation Model (QHIM). The SLA was used to explore Msinga smallholder farmers' knowledge and awareness of climate change and the appropriateness of the support systems (agricultural extension curriculum and training, as well as practices) needed to adapt to climate change. It was equally applied in the last phase of the main study to underline the place and space of IKS in mainstreaming of climate smart technology adaptation through partnerships. Even though the first part of the study highlighted the need to upgrade and retrain the current extension support services, such as the Agricultural Extension and Rural Development programme of higher education institutions and the in-service agricultural extension practitioners in order to effectively deliver extension services, it equally revealed that there was no correlation between lack of exposure to climate change education (content) and the quality of services being delivered by extension practitioners.

The QHIM was applied across the two phases of the study to first highlight the significance of the functions, practices or roles played and or not played by the different stakeholder groups (helices) and their implication for climate change adaptation, mitigation and food security (livelihood outcomes) in smallholder farming communities. Furthermore, the theory guided the development of the model for partnerships for mainstreaming climate smart technology adaptation in rural contexts like Msinga. Though the findings highlighted the non-contribution of end-users in the development of innovation within the identified partnerships, which is a prerequisite for partnership arrangements (Van Huijstee et al., 2007) and for the articulation of QHIM (Carayannis et al., 2012), the findings also flag the impact of the historical exclusion of end-users (Ngcoya, 2017) in previous policies on climate change and the production of innovation. For instance, end-users were considered as consumers and hence were not included in the articulation of innovation in the triple helix model, which had academia, government and industry as its constituents (Grundel & Dahlström, 2016). So, this study has revealed that interactions between the stakeholders and the type and volume of contribution made differ, which is contrary to the conception of partnership, but does relate to the aspirations of sustainable livelihood approaches which highlight that access to livelihood pathways such as physical capital (infrastructures, farm technology/input), political capital (polices and intervention programme) and human capital (knowledge, skills or innovation, etc.) will enable end-users to adapt to and mitigate climate change, and achieve food security.

As Scoones (1998) argues, access to one livelihood resource or capital is an essential antecedent for gaining access to others. For instance, access and development of human capital depends greatly on access to economic capital (funds) and vice versa. Equally, an input in one sphere or helix under QHIM, such as education, for instance, will lead to an output of developed human capital (Carayannis et al., 2012), which serves as a prerequisite for the attainment of other livelihood outcomes. So, having access to knowledge and innovation in the form of climate smart practices from academia and government, as revealed in this study, will enable end-users to achieve the desired livelihood outcomes. In addition, the study revealed the prominence of government (as represented by agricultural extension practitioners) as the key stakeholder group needed to drive the partnership for mainstreaming climate smart technology adaptation in rural contexts. This agrees with the literature, which recognizes the government (especially local government) as a major stakeholder that drives policies, intervention programmes and also provides access to key livelihood capitals such as economic and physical capitals in rural contexts (Agrawal , 2010; Aggarwal et al., 2018). These are considered as advancements in knowledge in the frameworks employed, which are the contribution this study has made theoretically to the body of knowledge.

12.2.2 Literature on mainstreaming climate smart technology adaptation through partnerships

The review of related literature on mainstreaming climate change adaptation shows that most of the studies explored climate change adaptation mainstreaming from a national and regional policy point of view. A typical example is Levina and Tirpak (2006), who theorize that mainstreaming adaptation is about the integration of adaptation objectives, ideas, policies, measures or operations, to the point that they become part of the national and regional development policies, processes and budgets at all levels and stages. So far, none of the existing studies in South Africa have included smallholder farmers (end-users) in partnership arrangements for mainstreaming climate change adaptation, as opposed to this study, which has not only included them, but has also advanced the place and space of their knowledge systems in these partnerships. This was earlier revealed by Organisation for Economic Co-operation and Development - OECD

(2009) whose policy report found that, though local government is a critical level, given that the impacts of climate change is felt locally, however, individuals and entities at this level are not usually consulted in climate change policy decision making. Rather, decision making for local actors take place at higher levels, such as the provincial or national government levels (OECD, 2009). Where there has been some form of inclusion of local stakeholders, the mainstreaming guidance did not clarify whether mainstreaming processes envisage a bottom-up process, where local adaptation strategies will be replicated and scaled-up to reach wide audience s,or it will be a top-down approach in which large-scale government delivers predetermined adaptation plans (Wright et al., 2014).

Furthermore, from the perspective of this study, there is little or no research in South Africa on mainstreaming climate smart technology adaptation through efforts and collaboration between local communities who are most disproportionately affected, local government, as represented by extension practitioners, and academia, as represented by agricultural extension academic staff members as well as their programme template (curriculum). Therefore, this study has provided information on the knowledge and awareness of smallholder farmers on climate change and the opportunities as well as anticipated barriers of including the identified knowledge into higher level policy and programmes on climate change in South Africa. Additionally, this study identified types and level of partnerships existing between the stakeholders engaged and highlighted the climate smart practices offered to smallholder farmers within these partnerships. By these findings, this study has contributed to the body of existing knowledge on debates around the discourse on mainstreaming climate change adaptation through multi-stakeholder partnership in smallholder farming communities within South Africa and sub-Saharan Africa. It has also contributed to the discourse on the need to include indigenous knowledge systems (adaptation practices) in climate change adaptation programmes. Again, this study has contributed to the body of knowledge and discussion on the need to upgrade current curriculum and training of agricultural extension practitioners in South Africa in order to facilitate adaptation to climate change in rural contexts.

12.3 IMPLICATIONS OF THE FINDINGS

The findings made in this study has major implications for mainstreaming climate smart technology adaptation or climate smart agriculture through collaborations between academia, government and end-users. These implications could be used for agricultural extension and rural development academic reforms and development as well as climate change adaptation policy and practice reformulation and development, in South Africa and other sub-Saharan African countries. Equally, these implications could inspire a change in the way smallholder farmers and their knowledge systems are perceived by other institutions.

12.3.1 Implications for academia

Part of the findings of this study highlighted the non-inclusion of climate change and climate change adaptation in the Agricultural Extension and Rural Development academic programme of the higher education institution engaged in this study. The findings further highlighted that content related to climate change was implicitly accommodated/integrated during teaching and learning activities. This confirmed the perspectives that current agricultural extension curricula in most South African higher education institutions do not adequately equip extension practitioners with the needed skills and knowledge to facilitate adaptation to climate change in smallholder farming communities (Zikhali, 2016; Ngcoya, 2017). Similarly, this findings affirmed the view of Yanda et al. (2010), who argue that integration of some climate change concepts is the way through which content related to climate change is covered in most universities in Southern Africa. Only a few academic staff members in South African universities integrate content related to climate change into their teaching, because most academic staff members in charge of teaching agricultural extension do not have sufficient content knowledge, given that the majority of them were trained before climate change became a core issue (Ibid.). This has major implication for extension services and agricultural practices in South Africa, given that the government and society depend on academia to produce the latest knowledge, innovation and practices as par their institutional roles and position (Odora Hoppers, 2001, p. 79; Cortese, 2003). In this regard:

- The agricultural extension curricula of the higher education institution engaged in this study are outdated and do not address current societal challenges such as climate change and climate change adaptation.
- Mainstreaming of climate change education (clear inclusion of contents and concepts related to climate change and its adaptation) in the higher education curricula and programmes of pre-service extension practitioners in South Africa has become imperative, in order to help pre-service extension practitioners attain the desired proficiency levels that will ensure effective delivery of extension services to smallholder farmers.

- There should be in-service training for academic staff members in order to update their knowledge about climate change. An upgrade in curriculum would be futile, if the facilitators do not have deep understanding of the content of the curriculum.
- Academia is in a direct and an indirect partnership with government, NGOs and end-users and has offered support to smallholder farmers through its teaching activities.
- The existence of direct and indirect partnerships between the stakeholder groups engaged in this study disproves the assertion by scholars such as Pinkse and Kolk (2012) that there is lack of interactions/partnership towards sustainable development in developing countries.
- Establishing partnerships with end-users and government creates avenues for student engagement and field trips, thereby enabling cross-vegetation of ideas amongst the actors. This allows pre-service extension practitioners to put theory into practice, which will enrich their knowledge, while helping the end-users in their farming activities
- The support offered by academia to end-users in their indirect partnership (through student engagement) addressed the three key pillars of climate smart agriculture, namely adaptation, mitigation and food security.

12.3.2 Implications for government (extension services)

The findings showed that in-service agricultural extension practitioners (who represent the government stakeholder group) are not well equipped in terms of exposure to content knowledge, in-service training and required qualification to offer extension services related to climate change. This has affirmed the popular perspective that the majority of extension practitioners in different contexts are not exposed to content knowledge related to climate change during their academic training (Chakeredza et al., 2008; Dinon, Breuer, Boyles & Wilkerson, 2012; Mberego & Sanga-Ngoie, 2014; Zikhali, 2016). Notwithstanding this, extension practitioners in this study partnered with academia and end-users to offer support to farmers in relation to climate change adaptation.

- Hypothetically, the extension practitioners may not be able to deliver extension services related to climate change and climate change adaptation and therefore may be considered incompetent.
- In this regard, the end-users (Msinga smallholder farmers) may not be effectively supported by the extension practitioners in their quest to adapt, mitigate and achieve

food security under climate change and hence may remain vulnerable to the effects of climate change.

- Upskill or capacitate in-service extension practitioners (especially those operating in smallholder farming communities) through continuing professional development (CPD) to be able to facilitate adaptation to climate change in smallholder communities
- The government stakeholder group partners directly with end-users and academia, and plays a pivotal role in promoting climate smart technology adaptation within these partnerships.
- The partnership between government and end-users yielded the highest amount of CSA practices and has proved to be the most critical in mainstreaming CSA in rural communities such as Msinga.
- Agricultural extension practitioners, though assumed to be conceptually ill-equipped are mediating the interaction between academia and end-users, and also educating the end-users on agricultural decision making, within the context of climate change.
- Not having the required qualification and not being exposed to certain content does not necessarily mean that the extension practitioners are incapable of offering extension services related to climate change adaptation, when considered in light of the types of support (CSA practices) they offer to smallholder farmers.
- The three pillars of CSA have permeated the direct partnership between the government and academia.
- The government stakeholder group, as represented in this study by extension practitioners, remains a key stakeholder group in the partnership toward climate smart technology adaptation in rural communities such as Msinga.

12.3.3 Implications for end-users (smallholder farmers)

Msinga smallholder farmers are aware and knowledgeable about climate change. Hypothetically, this result meant that efforts towards the mainstreaming of climate smart technology adaptation in rural contexts such as Msinga will be greatly enhanced, given that the more knowledge people have about climate change, the more their chances of adapting to its effects.

- Efforts towards the mainstreaming of climate smart adaptation in rural Msinga will be greatly enhanced, if the end-users and their existing knowledge/agricultural practices are incorporated into the articulation and implementation of policies.
- The end-users partner with government and academia stakeholder groups, but play no clear role in promoting climate smart technology adaptation within these partnerships.
- Hence, having knowledge and being aware of climate change doesn't necessarily translate into agency, during interactions with other stakeholders.
- The partnership between the stakeholders has promoted the use of indigenous knowledge systems (IKS) in the form of indigenous agricultural practices. This illuminates the places and spaces of end-users (smallholder farmers) and their agricultural practices/knowledge systems in discussions on climate change adaptation (mainstreaming) within rural contexts such as Msinga.

12.4 LIMITATION AND SUGGESTIONS FOR FURTHER STUDIES

This study drew participants from one local municipality, and this limited the breadth of the study. Future research may be conducted to explore smallholders' knowledge, awareness and behaviour towards climate change across the country. Due to limitations of time and the scope of the study, this study was limited to extension services in one local municipality in KZN. This scope can be extended to include other local municipalities in KZN and across the country. In doing this, an analysis of the training received by current extension practitioners and the policy imperatives for climate change adaptation in smallholder farming contexts in South Africa is needed

From an educational perspective, whilst this study drew information from the Agricultural Extension and Rural Development Programme template of one higher education institution and agricultural extension academic staff members, there is need to analyse other educational policies and documents in relation to extension training in the country. Also, the study should be extended to all higher education institutions within the country that offer Agricultural Extension and Rural Development courses/certificates.

A study could be conducted on the level of mainstreaming and partnerships on climate change within local farming communities across the country. In terms of partnership towards mainstreaming climate smart technology adaptation, studies should be conducted to include other stakeholders within the government sector, especially those in charge of climate change policy articulation and implementation. Equally, the study could be expanded to include industry collaboration with academia, government, NGOs and end-users, as articulated in the QHIM.

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APPENDIX A: INFORMED CONSENT LETTER

UNIVERSITY OF KWAZULU-NATAL

School of Education, College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus, Durban,
South Africa

Dear Participant

My name is, Godson Chinenye Nwokocha I am a PhD student studying at the University of KwaZulu-Natal, Edgewood campus, South Africa. My topic is as follows:
Mainstreaming Climate-Smart Technology Adaptation in Msinga's Farmers' Everyday Agricultural Practices through University, Small – Holding Farming Community and Government Partnerships: The Place and Space for Indigenous Knowledge Systems. I am interested in asking you some questions via open-ended questionnaire and focus group interviews.
Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.
- The open-ended questionnaire may take you 20 minutes to complete and focus group interview may last for about 30 minutes and may be split depending on your preference.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- The research aims to explore how partnerships between University, Government and Small-holding Communities can help in mainstreaming climate smart technology adaptation in everyday agricultural practices.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.

- If you are willing to be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow the interview to be recorded by the following equipment:

	willing	Not willing
Audio equipment		
Photographic equipment		
Video equipment		

I can be contacted at:
Email: godsonnowkocha@gmail.com
0719192216
.

My supervisor is Dr. B. P. Alant who is located at the School of Education, Science and Technology cluster, Edgewood campus of the University of KwaZulu-Natal.
Contact details: Email:alantb@ukzn.ac.za; Tel: 031-260 7606.

You may also contact the Research Office through:
P. Mohun
HSSREC Research Office,
Tel: 031 260 4557 E-mail: mohunp@ukzn.ac.za

Thank you for your contribution to this research.

DECLARATION

I____(full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

__________________ ________________

Signature of participant Date

APPENDIX B: INCWADI YESIVUMELWANO

UNIVERSITY OF
KWAZULU-NATAL

School of Education, College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus, Durban,
South Africa

Mhlanganyeli

INCWADI YESIVUMELWANO

Igama lami ngingu Chinenye Nwokocha owenza izifundo ze PhD e-University of KwaZulu-Natal, Edgewood Campus, eNingizimu Afrika.
Isihloko engicwaninga ngaso yilesi esilandelayo:
Ukubheka izindlela ezintsha kwezolimo ezihambisana nokuguquguquka kwesimo sezulu kubakimi bendawo yase Msinga. Lokhu kuzokwenzeka ngokubambisana nezinhlaka zabalimi emphakathini zibambisene nezinhlaka zolimo zikaHulumeni kusetshenziswa nezindlela zakudala zokulima. Kunenhlolokhono nemibuzwana ocelwa ukuba uhlanganyele ngayo kulolu cwaningo.
Qaphela Lokhu:

- Kunesiqiniseko sokuthi uvo lwakho lohlala lungolwakho futhi luyimfihlo.
- Imibuzwana izothatha imizuzu engamashumi amabili (20) kanti inhlolokhono yona engamashumi amathathu (30) kuye ngokuthi wena ikhethe kuphi.
- Ulwazi olunikile ngeke ujikelwe ngalo, kodwa luzosetshenziselwa izinhloso zocwaningo.
- Ulwazi luzogcinwa endaweni ephephile kuze kuphele iminyaka emihlanu (5 Years).
- Ungazikhethela ukuba ingxenye noma ungabi iyona kumbe uhoxe ngesikhathi ofuna ngaso kulolucwaningo ngeke ujeziswe ngokwenzenjalo.
- Inhloso yocwaningo ukwenza ubudlelwano phakathi kwe University, uHulumeni nabalimi abasafufusa kwezolimo nokubhekana nezindlela ezintsha zokushintsha kwesimo sezulu kwezolimo nsukuzonke.
- Ukuhlanganyela kwakho kuqondene nezemfundo kuphela, akuhloswe nzuzo ngakho.
- Uma unesifiso sokuhlanganyela kulolucwaningo khombisa ngokugcwalisa isikhala esifanele sokuthi uyavumelana noma awuvumi ukuthi inkulumo yakho iqoshwe ngalezindlela ezilandelayo:

	Ngiyavumelana	Angivumelani
Ukulalelwa kwenkulumo (Audio Equipment)	✓	

ASISUKUME MSINGA CO-OP LTD
REG NO: 9807/201/1[illegible]
MAWELE LOCATION
NEAR MAWELE HIGH SCHOOL
P. O. BOX 323
TUGELA FERRY, 3010

Okwenzekayo okuqoshwe ngezithombe (Photographic Equipment)	✓	
Ukuqoshwa kwenkulumo ezobukelwa (Video Equipment)	✓	

Imibuzo ngalolucwaningo ngingathintwa:
Email : godsonnwokocha@gmail.com
Inombolo yocingo : 084 753 9451 / 071 919 2216
Umphathi wami ngu Dr. B.P. Alant osesikoleni sezeMfundo emkhakheni wezesayensi nezobuchwepheshe, eEdgewood kwiNyuvesi yaKwaZulu-Natali.
Izindlela ekuxhumaneka ngazo naye : Email : alantb@kzn.ac.za; Ithelefoni : (031)260-7606

Umsizi kamphathi wami ngu Dr. T. Ndarana osebenza kuphiko olubizwa nge Council for Scientific and Industrial Research, Pretoria.
Engathintwa lapha: Email : thando.ndarana@gmail.com; Ithelefoni : (031)841-3882
Ungathintana futhi nehhovisi locwaningo ngo:
P. Mohun
HSSREC Research Office,
Ithelefoni : (031)260-4557 Email : mohunp@ukzn.ac.za

Ngiyabonga ngokuzibandakanya kwenu kulolu cwaningo.

UKUZIBOPHEZELA

Mina THANDIWE GLADYS MADONDO (amagama aphelele omhlanganyeli) ngalokhu ngiyaqinisekisa ukuthi ngiyakuqonda okuqukethwe yilombalo kanye nesimo salolu cwaningo futhi ngiyavuma ukuzibandakanya nalolu cwaningo.

Ukusayina kukamhlanganyeli 2016/ 06/ 21
Usuku

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NEAR MAWELE HIGH SCHOOL
P. O. BOX 323
TUGELA FERRY, 3610

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TUGELA FERRY, 3610

APPENDIX C: LETTER TO MANAGER ASISUKUME MSINGA SMALLHOLDER COOPERATIVE

Science and Technology Cluster,
School of Education,
College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus, KwaZulu Natal
O9-06-2016

The Manager
Asisukume Msinga Small Holder Cooperative
Msinga Municipality
KwaZulu Natal

Dear Madam,

PERMISSION TO CONDUCT ACADEMIC RESEARCH

My name is Mr. Nwokocha Godson. I am a Doctor of Philosophy (PhD) student, with student no. 212558483. I am from the Science and Technology Cluster, School of Education, College of Humanities, University of KwaZulu-Natal. I am conducting a research titled: "Mainstreaming Climate-Smart Technology Adaptation in Msinga's Farmers' Everyday Agricultural Practices through University, Small – Holding Farming Community and Government Partnerships: The Place and Space for Indigenous Knowledge Systems".

A review of literature suggests that small-holding farmers across Africa are struggling to adapt to current day variable weather and climate. Most rural communities and places that depend on rain fed agriculture for the production of staple food are under the threat of hunger and starvation as a result of uncertainties in rainfall and their inability to adapt to weather and climate challenges.

In view of the foregoing, I intend to explore, using the critical paradigm and mixed method research approach, how partnerships between University, Government and Smallholders farming communities can help in addressing the impact of climate change on agricultural productivity in small holder communities.

The study will be conducted in Msinga Municipality with farmers drawn from the Asisukume Msinga small holder cooperative. While I carry out the research, I will observe the highest ethical standards and maintain the uppermost integrity at all times regarding the data gathering. The names of participants and the institution will be anonymized. Participation will be on a voluntary basis and confidentiality will be guaranteed because individual inputs will not be attributed to individual persons, but will be reported only as a population member opinion. Interviews will be audio recorded

I intend to gather data using individual and focus group interviews, each of which will be 25-30 minutes duration. Also, the participants will be required to complete a questionnaire, this will take about 10 minutes to be completed.

My supervisor is Dr. Busisiwe Alant from the Science and Technology Cluster, School of Education, Edgewood Campus UKZN and Dr Thando Ndarana from the Council for Scientific and Industrial Research, Pretoria. A letter of informed consent for the participants has been prepared and it is attached.

Your kind permission to carry out the research work is sought.

Yours sincerely,
Nwokocha G. C. (Mr)

APPENDIC D: APPROVAL LETTER BY MANAGER ASISUKUME MSINGA SMALLHOLDER COOPERATIVE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Science and Technology Cluster,
School of Education,
College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus, KwaZulu Natal
O9-06-2016

The Manager
Asisukume Msinga Small Holder Cooperative
Msinga Municipality
KwaZulu Natal

Dear Madam,

PERMISSION TO CONDUCT ACADEMIC RESEARCH

My name is Mr. Nwokocha Godson. I am a Doctor of Philosophy (PhD) student, with student no. 212558483. I am from the Science and Technology Cluster, School of Education, College of Humanities, University of KwaZulu-Natal. I am conducting a research titled: "Mainstreaming Climate-Smart Technology Adaptation in Msinga's Farmers' Everyday Agricultural Practices through University, Small – Holding Farming Community and Government Partnerships: The Place and Space for Indigenous Knowledge Systems".

A review of literature suggests that small-holding farmers across Africa are struggling to adapt to current day variable weather and climate. Most rural communities and places that depend on rain fed agriculture for the production of stable food are under the threat of hunger and starvation as a result of uncertainties in rainfall and their inability to adapt to weather and climate challenges.

In view of the foregoing, I intend to explore, using the critical paradigm and mixed method research approach, how partnerships between University, Government and

ASISUKUME MSINGA CO-OP LTD
REG NO: 9607/2011/1988
MAWELE LOCATION
NEAR MAWELE HIGH SCHOOL
P. O. BOX 323
TUGELA FERRY, 3010

Page 1 of 2

I, THANDIWE GLADYS MADONDO ..... (DIRECTOR AND (OPERATIONS MANAGER)) (Position held) hereby grant/~~do not grant~~ (delete which is not applicable) permission for the project titled "Mainstreaming Climate-Smart Technology Adaptation in Msinga's Farmers' Everyday Agricultural Practices through University, Small – Holding Farming Community and Government Partnerships." to take place in the Asisukume Msinga small holder cooperative '.

Signature: ....

Date: 2016/06/21

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NEAR [illegible] HIGH SCHOOL
P. O. BOX [illegible]
TUGELA FERRY, [illegible]

APPENDIX E: PRELIMINARY INTERVIEW PROTOCOLS FOR FARMERS

Preliminary Question: **How are Misinga Smallholders farmers adapting to the challenges of weather and climate change in their farming activities?**

In order to address the preliminary question above, the following protocol questions will be asked:

1. Have you observed any changes in weather in the past few years?
   (a) If so, what kind of weather changes have you observed? Please explain
   (b) How have these changes affected your life? Please elaborate
   (c) Have you discussed these changes in your community before? Please elaborate
   (d) If you have not, would you like to? Why would you like to discuss it?
2. Have you heard of climate change before?
   (a) If yes, where or who did you hear it from?
   (b) In your own words, what do you understand by climate change?
   (c) Has climate change had any effects in your life? If yes what kind of effects? Please elaborate
   (d) Have you discussed these changes in your community before? Please elaborate
   (e) If not, would you like to? Why
   (f) According to your own understanding? What are the causes of climate change?
3. Do you use weather (agro-weather) information in your farming practices or in making farming decisions? Please kindly elaborate.
   (a) If not, why? What informs/guides your farming practices?
   (b) If yes, how do you get such information?
4. Do you usually receive information about weather and climate change adaptation?
   (a) If yes, where do you usually receive the information from?
   (b) Do you receive any form of support from government (from local to national) or other institution/organization regarding climate change in your farming activities?
   (c) What adaptation measures are you applying currently for dealing with climate change issues? Please elaborate
   (d) How did you come up with this adaptation measures? Please elaborate

(e) At what level do you employ/apply these adaptive measures and why? That is, individual, community or regional level? Please elaborate on your answer.

(f) Any other comment?

APPENDIX F: PRELIMINARY INTERVIEW PROTOCOLS FOR FARMERS IN ZULU

Umbuzo osasingeniso (*Preliminary question*): Abanikazi Bamasimu Abasafufusa BaseMsinga Babhekana Kanjani Nezingqinamba Zesimi Sezulu Kanye Nokuguquguquka Kwaso Kwezolimo Noma Kwabakutshalayo (*farming activities*)?

Ukubhekana nalo mbuzo osasingeniso ongasenhla, le mibuzo engumhlahlandlela negunyaziwe iyona ezobuzwa:

1. Lukhona ushintsho osuke walubona kwisimo sezulu kule minyaka embalwa edlulile?
   a) Uma kunjalo, yiluphi ushintsho oluqaphelisisile? Chaza kabanzi.
   b) Lezi zinguquko zibe namthelela muni empilweni yakho? Chaza kabanzi.
   c) Senike nazidingida lezi zinguquko emphakathini phambilini? Chaza kabanzi.
   d) Uma ningakaze, ningakuthokozela ukuxoxa ngazo? Kungani ungathanda ukudingida ngakho?
2. Usake wezwa ngokuguquguquka kwesimo sezulu phambilini?
   a) Uma uvuma, wezwa kuphi noma wezwa ngobani ngakho?
   b) Ngamagama akho, yini oyiqondayo ngokuguquguquka kwsesimo sezulu?
   c) Kungabe ukuguquguquka kwesimo sezulu kwaba nawo umthelela kweyakho impilo? Uma impendulo kungu- yebo, ngumthelela onjani? Chaza kabanzi.
   d) Wake wazixoxa lezi zinguquko emphakathini wakho phambilini? Chaza kabanzi.
   e) Uma ungakaze, ungathanda ukuxoxa ngazo? Ngobani?
   f) Ngokwakho ukuqonda yini edala ukuguquguquka kwesimo sezulu?
3. Uyalusebenzisa ulwazi lwesimo sezulu olubizwa nge-*agro-weather* lapho sekutshalwa noma wenza izinqumo kwezolimo? Chaza kabanzi ngempendulo yakho.
   a) Uma ungalusebenzisi, kungani? Yini elawula ekumele kwenziwe noma ekumele kutshalwe lapho sekutshalwa?
   b) Uma ulusebenzisa, uluthola kanjani ulwazi ulwazi olunjengalolo?
4. Kungabe ujwayele ukuthola ulwazi mayelana nokumelana nesimo sezulu kanye nokuguquguquka kwaso?
   a) Uma uvuma, ujwayele ukulutholaphi ulwazi olufana nalolo?
   b) Lukhona uxhaso noma ngabe yiluphi oluvela kuhulumeni noma kwezinye izinhlaka olumayelana nokuguquguquka kwesimo sezulu kweziphathelene nezolimo?

c) Yikuphi okwenzayo njengamanje ukubhekana nezimo ezilethwa ukuguquguquka kwesimo sezulu? Chaza kabanzi.
d) Waqhamuka kanjani nale ndlela? Chaza.
e) Yimaphi amazinga la ubona kunesidingo sokusebenzisa lezi zindlela? Kungabeuwena wedwa noma isemphakathini. Chaza.
f) Kukhona okunye ofisa ukukusho noma umbono?

APPENDIX G: PRELIMINARY STUDY QUESTIONAIRE FOR AGRICULTURAL EXTENSION ADVISORS

UNIVERSITY OF KWAZULU-NATAL

INYUVESI YAKWAZULU-NATALI

School of Education, College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus, Durban,
South Africa

Dear Participants,

I would really appreciate it if you could spare me 20 or 30 minutes of your time to complete this questionnaire. The purpose of the questionnaire is to understand how you meet the information needs of Small Holder Farmers in the face of climate change. All the information provided will be treated as confidential. Thanking you in Advance.

Part I: Characteristics (please tick the appropriate box)

1.1 Gender

Male	Female

1.2 Age

20-30	31-40	40-50	50-60

1.3. Employment Status

Volunteer	Part Time	Full Time

1.4. Level of Qualification

Matric	Certificate	Diploma	Higher certificate	Degree	Postgraduate Degree

1.5 Which of the following areas do you specialise in?

Agricultural extension	Agricultural Science	Crop Science	Crop Science	Livestock Production	Animal Science	Others (please specify below)

1.6 Number of years of Experience in Extension Service Adversary

1-5	5-10	10-15	15-20	20-25	25-30	>30

Section B: Extension Officers Perception of Climate Change/variability

1.1 What is your current perception of climatic conditions?

1. Good ☐ 2. Bad ☐ 3. Constant ☐ d. unsure ☐

1.2 What is your view on temperatures in your municipality/ area of work over the last 5-10 years:

a. Increased ☐ b. Constant ☐ c. Decreased ☐ d. unsure ☐

1.3. Severity of drought in your municipality/area of work over the last 5-10 years:

a. Increased ☐ b. Constant ☐ c. Decreased ☐ d. unsure ☐

1.3. Severity/harshness of flooding in your municipality/area of work over the last 5 – 10 years:

a. Increased ☐ b. Constant ☐ c. Decreased ☐ d. unsure ☐

1.4. Severity/harshness of lightning in your municipality/area of work over the last 5-10 years:

a. Increased ☐ b. Constant ☐ c. Decreased ☐ d. unsure

1.5. Severity/harshness of wildfire in your municipality/area of work over the last 5-10 years:

a. Increased ☐ b. Constant ☐ c. Decreased ☐ d. unsure

1.6. Severity/harshness of hailstorm in your municipality/area of work over the last 5-10 years:

a. Increased ☐ b. Constant ☐ c. Decreased ☐ d. unsure

1.7. Incidence of crop failure experienced by farmers in your municipality/area of work over the last 5-10 years:

a. Increased ☐ b. Constant ☐ c. Decreased ☐ d. unsure ☐

1.8. Incidence of crop diseases experienced by farmers in your municipality/area of work over the last 5-10 years:

a. Increased ☐ b. Constant ☐ c. Decreased ☐ d. Unsure ☐

1.8. Incidence of crop diseases experienced by farmers in your municipality/area of work over the last 5-10 years:

a. Increased ☐ b. Constant ☐ c. Decreased ☐ d. unsure ☐

1.9. Incidence of livestock diseases experienced by farmers in your municipality/area of work over the last 5-10 years:

a. Increased ☐ b. Constant ☐ c. Decreased ☐ d. unsure ☐

1.10. Incidence of hunger/diseases experienced/reported by farmers in your municipality/area of work over the last 5-10 years:

a. Increased ☐ b. Constant ☐ c. Decreased ☐ d. unsure ☐

2.1 How do you assess/receive climate change information, other than the workplace?

a. Radio ☐ b. Internet ☐ c. Television ☐ d. Newspapers ☐ e. Social Media ☐ f. other (specify) ☐

2. 2. current understanding /knowledge on climate change is:

a. Excellent ☐ b. Good ☐ c. Average ☐ Poor ☐

Section C: Extension officer's pre- training (Curriculum) and In-service training.

3.1. Was climate change taught in the curriculum (school) during your training/qualification?

If 'Yes' please elaborate on some of the climate change concepts that was taught and how:

If no, do you think climate change contents/concepts should be included in the agricultural extension training programmes? Please elaborate:

1. Yes ☐ 2. No ☐

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3.2. Have you received any in-service training from KZN Department of Agriculture covering climate change?

1. Yes ☐ 2. No ☐

If yes kindly elaborate on what you were trained on:

………
………
………
………
………
……………………………………………………

3.4. How often are you provided information on climate change by KZN Department of Agriculture?

a. Weekly ☐ b. Monthly ☐ c. Quarterly ☐ d. annually ☐ e. Bi-annually ☐ (if none of the above please specify below)

………
………
…………………………………………………………………………………

3.4. If you receive information, what form is the Information disseminated to you? (If 'other' please specify)

1. Workshops ☐ 2. Conferences and Meetings ☐ 3. Pamphlets/ Booklets ☐ C. D's 4. ☐
5. Training manuals ☐ 6. Government Email

☐ 7. Provincial Government Websites ☐ 8. Radio ☐ 9. Other (Please Specify below
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………
…………………………………………………………………………………

3.5. What type of climate change information is covered? (Please explain below)

………
………

…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………

3.6. In your own opinion, what is your competency level in disseminating this information given by KZN Department to farmers is:

1. Excellent ☐ 2. Good☐ 3. Average☐ 4. Neutral☐

Section D: Suitability of Climate Information Disseminated as Perceived by Extension Officers.

4.1 What is the main agricultural enterprise/group of farmers you work with?

a. Subsistence farmers ☐ 2. Small Holder Farmers ☐ Commercial Farmers ☐

4.2. Do you disseminate climate information regularly to farmers? (If 'No', briefly explain why).

1. Yes ☐ No ☐

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4.4. What types of climate change information do you offer to farmers for climate change impacts/effect? (Please explain below below).

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4.5. How do you disseminate/ communicate climate change information to farmers? (Tick as many that apply)

1. Mobile communication ☐ 2. Internet ☐ 3. Radio☐ 4. Workshops ☐ 5. Face to Face communication ☐ 6. Information days

7. Other, Please Specify ……………………………………………………………………

What types of forecasting do farmers frequently ask for?

1. Weather forecast (Days to week)	2. Seasonal Climate Forecasts 3. (Month to years)	4. Long-range Climate Forecasts (Decades to longer)

4.7. Do you think Farmers are using the climate change information correctly?

Yes	No	Unsure

If no or unsure, please briefly explain why below:

…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………………………………………………………………………

4.8 Do you think the information you provide is suitable for the climate change challenges/ impacts faced by smallholder farmers? Please elaborate below:

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……………………………………………………………………………………………………
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APPENDIX H: PRELIMINARY STUDY FOCUS GROUP INTERVIEW PROTOCOL FOR EXTENSION LECTURERS

Preliminary Question: To what degree does Agricultural Extension Programmes (modules) prepare extension advisors to help/assist smallholder farmers and the society adapt to climate change in KwaZulu-Natal and South Africa at large?

Follow up Question:

1. Is climate change taught as a module or as a component of another module in your agricultural extension program? If not why?
2. Is climate change adaptation covered in your agricultural extension modules? If yes, how is it covered? If not, why?
3. What type of activities do students engage in when teaching topics related to climate change adaptation?
4. What teaching methods are used to organize learning when teaching topics/concepts on climate change adaptation?
5. How do students respond to these method?
6. Does these contents and concepts in your modules help people adapt to climate change? Please elaborate
7. Do you think the current programmes in agricultural extension can equip students and the society to adapt to climate change? Please elaborate
8. What are the difficulties or limitations you encounter when teaching concepts and topics on climate change adaptation in the classroom?

APPENDIX I: MAIN STUDY INTERVIEW PROTOCOLS FOR FARMERS

1) D**o** you belong to the Msinga-Top smallholder farming cooperative or any other farming cooperative?	YES	NO
	Total Total	

2. Is your farming cooperative in any form of partnership with any institution such as Government Departments (Agriculture, Water Resources, etc.), NGOs or Universities?

If yes, please indicate:

i). The institution you are in partnership with.

ii) Your role in this partnership?

3. Do you receive any form of support/help (as an individual or a group) from any of these partners that is Government Departments (Agriculture, Water Resources, etc.), NGOs or Universities in your farming activities?

If yes,

i). What type of support do you receive from these institutions?

ii). How often do you receive it (Monthly, Quarterly, Annually or Bi-annually)? Please elaborate.

Iii). Does the support you receive from these institutions help you in any way? Please elaborate.

iv). Does the support you receive from these institutions help you in understanding the changes in weather and climate and in adapting to these changes in your farming activities? Please elaborate.

4. Do these partnerships promote climate smart adaptation technologies in your everyday agricultural practices? If so, how and why?

5. Do these partnerships promote the use of indigenous knowledge systems in climate smart adaptation technologies in your everyday agricultural practices?

If so,

i). What Indigenous Knowledge systems/practices are promoted,

(i) How are those indigenous knowledge practices promoted

(ii) Why are those indigenous knowledge/practices promoted and why?

APPENDIX J: MAIN STUDY FOCUS GROUP INTERVIEW PROTOCOL FOR FARMERS IN ZULU

Emzamweni wokwethula umbuzo ngqangi walolu cwaningo, lemibuzo yephrothokholi elandelayo izobe iqondiswe kubalimi:

1. Ngabe uyingxenye yabanikazi bamapulazi amancane eMsinga Top?	YEBO	CHA
	Inani eliphelele	Inani eliphelele

2. Ngabe kukhona yini ukubambisana onakho nanoma yisiphi isikhungo, izikhungo ezifana neminyango kahulumeni (umnyango wezolimo, wamanzi neminye iminyango), izinhlangano okungezona ezikahulumeni NGOs noma amanyuvesi?

   Uma kunjalo, ngicela ucacise:

   (i) Isikhungo osebenzisana naso

   (ii) Indima yakho kulokhu kubambisana

3. Ngabe lukhona yini uxhaso enilutholayo kulezo zikhungo enibambisene nazo ezifana neminyango yahulumeni, izinhlangano okungezona ezikahulumeni noma amanyuvesi emisebenzini yakho yokulima?

   Uma kunjalo,

   (i) Hlobo luni loxhaso olitholayo kulezi zikhungo

   (ii) Uvamise ukulithola nini lolu xhaso (njalo ngenyanga, ngekota, ngonyaka, kabili ngonyaka)? Ngicela ucacise

   (iii) Ngabe kukhona indlela lolu xhaso elikusiza ngayo na? Ngicela ucacise

(iv) Ngabe liyakusiza yini uxhaso oluthola kulezi zikhungo ekutheni uqonde uguquguquko lwezimo zezulu nasekutheni ujwayele noma umelane nalolu guquko emisebenzini yakho yokulima? Ngicela ucacise

4. Ngabe lezi zikhungo obambisene nazo ziyazikhuthaza yini izindlela zobuchwepheshe zokukwazi ukumelana nokuguquguquka kwezimo zezulu emisebenzini yakho yansuku zonke yezolimo? Uma kunjalo, zikukhuthaza kanjani, zikwenzelani lokhu?
5. Ngabe lezi zikhungo ziyakukhuthaza yini ukusetshenziswa kolwazi lwendabuko ezindleleni zobuchwepheshe zokumelana noguquguquko lwezimo zezulu emisebenzini yakho yansuku zonke yezolimo?

   Uma kunjalo,

   (i) Yiziphi izinhlelo zolwazi lwendabuko ezizikhuthazayo?

   (ii) Zikhuthazwa kanjani lezi zinhlelo?

   (iii) Kungani lezi zinhlelo zikhuthazwa?

APPENDIX K: QUESTIONNAIRE ABOUT PARTNERSHIP INVOLVEMENT

Name:	
Type of Sector	
For how long have you been working in this sector?	
Gender	**Male** ☐ **Female** ☐

1. Are you in anyway involved with the Msinga Smallholder Farmers' Cooperative in helping them adapt to weather and climate change? **Yes** ☐ **N** ☐
2. If so, please elaborate on your level of involvement.

----

3. If not, are you involved in any other form of partnership with any Smallholder farming community in KwaZulu-Natal or South Africa.

4. If yes, in what capacity are you involved with them? Please elaborate.

5. Are you involved in any other form of partnership(s) with other relevant stakeholders such as NGO's, Government Departments, and Climate Scientists etc. with respect to climate change adaptation in South Africa? **Yes** ☐ **No** ☐

6. If so, please <u>indicate the name of the partners</u> and <u>comment</u> on your level of involvement.

----

7. If not, would you like to partner with other stakeholders in South Africa (such as Climatologists, NGOs, Government Department etc.) with respect to climate change adaptation in South Africa? Kindly elaborate on your response.

APPENDIX L: EDITING CERTIFICATE

Crispin Hemson
15 Morris Place
Glenwood
Durban 4001

hemsonc@gmail.com
0829265333

This is to confirm that I have undertaken language editing of a doctoral thesis by Godson Nwokocha, entitled **Mainstreaming climate smart technology adaptation in Msinga's farmers' everyday agricultural practices through university, smallholding farming community and government partnerships: the place and space for indigenous knowledge systems**

Crispin Hemson

8th December 2019

APPENDIX M: TURNITIN REPORT: Godson Nwokocha

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