CAPACITY OF EXTENSION AND ADVISORY SERVICES IN SUPPORTING FARMERS TO ADAPT TO CLIMATE CHANGE IN THE EASTERN CAPE, SOUTH AFRICA

by

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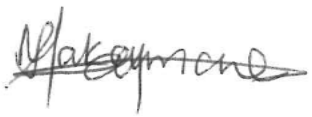

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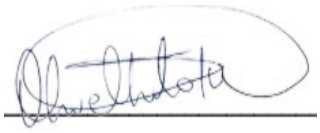
Signed  Date: 28 July 2023

Dr Olwethu Loki (Co-Supervisor)

DECLARATION B - PUBLICATIONS

The research described in this thesis is based on the following articles, all under review.

Publication and Conference presentation

Publication 1 – Chapter 4 of the thesis:

Makamane, A., Swanepoel, J., Loki, O., Climate change awareness and level of understanding of extension practitioners: Empirical evidence from Eastern Cape, South Africa (*South African Journal for Agricultural Extension* under review)

Publication 2 – Chapter 5 of the thesis:

Makamane, A., Swanepoel, J., Loki, O., Farmers' Perceptions of the capacity of extension services on climate change in the Eastern Cape Province of South Africa (*Journal of Agricultural Extension and Rural Development* under review)

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Makamane, A., Swanepoel, J., Loki, O., Channels used by extension practitioners to deliver services to farmers and source of information from Eastern Cape, South Africa (*South African Journal for Agricultural Extension* under review)

DEDICATION

To my late aunt, Thandekile “Sis Lovey” November. May your beautiful spirit continue to rest in peace

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“I come as one but stand as 10,000.”

— Maya Angelou

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I will give thanks to you, Lord, with all my heart; I will tell of all your wonderful deeds.

Psalm 9:1

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ABSTRACT

This study investigates the capacity-building needs of agricultural extension practitioners in the Eastern Cape Province, South Africa, focusing on their awareness and understanding of climate change and their ability to effectively communicate climate change adaptation strategies to smallholder farmers. The study employs a mixed-methods approach, including questionnaire surveys and focus group discussions, to gather data from a sample of 126 extension practitioners and managers selected using random sampling. The findings reveal that while most practitioners are aware of climate change and its impacts on agriculture, there are significant knowledge gaps due to limited formal and informal training on climate change. Furthermore, the study identifies a lack of capacity-building initiatives, with the majority of practitioners (80.2%) having never received formal or informal climate change training. The study highlights the need for a coordinated strategy for capacity-building and climate change adaptation to enhance practitioners' understanding and communication skills.

Additionally, the study explores farmers' perceptions of extension practitioners' capacities related to climate change adaptation. Data from 175 farmers indicate that 72.6% perceive practitioners as knowledgeable about climate change and value the information they receive from them. Farmers also emphasize the importance of technical climate knowledge and continuous training for practitioners. The study recommends regular engagement with practitioners, ongoing training focusing on technical skills, and renewed attention to the management and education of indigenous knowledge.

Furthermore, the study examines the channels used by extension practitioners to deliver services and the factors influencing the use of these channels. It finds that 60.3% of practitioners prefer interpersonal channels for communication, such as in-person visits and farmer-to-farmer interactions, over mass media and ICTs. The study suggests expanding written communication as a source of information and using mass media as communication channels to enhance practitioners' preparedness for climate change communication.

Overall, the study underscores the need for targeted capacity-building initiatives, ongoing training, and improved communication channels to strengthen the resilience of smallholder farmers to climate change in the Eastern Cape Province. These findings have important implications for policy and practice, highlighting the importance of continuous professional development and training for extension practitioners to effectively address climate change challenges in agriculture.

LIST OF ACRONYMS/ABBREVIATIONS

AESA	Agricultural Extension in South Asia
AGRA	Alliance for a Green Revolution in Africa
AIS	Agricultural Innovation Systems
APAP	Agricultural Policy Action Plan
ARC	Agricultural Research Council
AU	African Union
CCSPAFF	Climate Change Sector Plan for Agriculture, Forestry and Fisheries
CER	Centre for Environmental Rights
CGIAR	Consultative Group on International Agricultural Research
CH_4	Methane
CO_2	Oxide
COP17	17th United Nations Climate Change Conference of the Parties
CPD	Continuing Professional Development
CSA	Climate-Smart Agriculture
CSIR	Council for Scientific and Industrial Research
CTA	Technical Centre for Agricultural and Rural Cooperation
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DEDEAT	Eastern Cape Department of Economic Development, Environmental Affairs, and Tourism
DEFF	Department of Environment, Forestry and Fisheries
DoA	Department of Agriculture

EAS	Extension and Advisory Services
FAO	Food and Agriculture Organisation
FGD	Focus Group Discussion
GCARD	Global Conferences on Agricultural Research for Development
GDP	Gross Domestic Product
GFRAS	Global Forum for Rural Advisory Services
GHGs	Greenhouse Gases
HRD	Human Resource Development
ICT	Information and Communication Technology
IFAD	International Fund for Agricultural Development
IFAMA	International Food and Agribusiness Management Association
IFPRI	International Food Policy Research Institute
INTRAC	International NGO Training and Research Centre
IPPC	Inter-governmental Panel on Climate Change
IV	Carbon
MLR	Multinomial Regression Model
N_2O	Nitrous Oxide
NCCRWP	National Climate Change Response White Paper
NDMC	National Disaster Management Centre
NDP	National Development Plan
NELK	New Practitioners Learning Kit
NPC	National Planning Commission
NSTF	National Science and Technology Forum
OLT	Organisational Learning Theory

PRM	Participatory Ranking Technique
SACNASP	South African Council for Natural Scientific Professions
SADC	Southern African Development Community
SASAE	South African Society of Agricultural Extension
SAVC	South African Veterinary Council
SAWS	South African Weather Service
SSA	Sub-Saharan Africa
TAP	Tropical Agricultural Platform
TPB	Theory of Planned Behaviour
TRALAC	Trade Law Centre
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WMO	World Meteorological Organisation
WWF	World Wildlife Fund

CHAPTER 1 :
INTRODUCTION

1.1 BACKGROUND OF THE STUDY

A total of 1.5 billion individuals worldwide work in agriculture, and many of these people reside in developing countries where much of their gross domestic product (GDP) comes from farming and exporting agricultural products (World Bank, 2015). Agriculture in these countries is vital as it supplies food and fibre to meet the basic needs of households (Department of Agriculture, Forestry, and Fisheries [DAFF], 2012). Furthermore, the 2021 Global Hunger Index (GHI) report emphasizes the crucial role of smallholder farmers in ensuring food security and rural livelihoods in developing countries. It highlights that smallholder farmers, who typically operate on small plots of land, account for about 65% of the food consumed in developing countries. Additionally, smallholder agriculture employs nearly 80% of households in underdeveloped nations, making it a primary source of income and employment in rural areas (International Food Policy Research Institute IFPRI, 2021).

There are, however, numerous constraints confronting the smallholder agricultural sector, which include production on marginal lands, dilapidated and outdated infrastructure and farming equipment, lack of market information, lack of financial assistance, and lack of support services (Khapayi & Celliers, 2016; Loki, 2022; World Bank, 2015). With population growth projected to reach 8.5 billion people by 2030 and 9.7 billion by 2050 (United Nations [UN], 2019), the provision of sufficient food becomes a serious issue, given the challenges confronting the agricultural sector.

According to the Alliance for a Green Revolution in Africa (AGRA, 2018), FAO (2016), and the World Bank (2015), the demand for healthy and nutritious food already exceeds the supply, particularly in developing countries, putting more pressure on agricultural productivity. The situation is further aggravated by erratic climatic conditions which, according to the Inter-governmental Panel on Climate Change (IPCC, 2014), lead to poor farm returns because agricultural activities are sensitive and vulnerable to climate change and variability.

According to the IPCC (2014), climate change refers to a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and the variability of its properties that persist for an extended period. Similarly, Brekke et al. (2009) define climate

change as a change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere. That is in addition to natural climate variability observed over comparable periods.

Climate change became a prominent global issue in the 21st century, emphasised in both media and international and national policy processes. The 4th Assessment Report of the IPCC (2007) warned that the expected impacts of climate change should serve as a wake-up call for policymakers and the public alike. Projected future climate change includes a continued rise in temperature, increased incidence of heat waves, heavy precipitation events, decreased rainfall in sub-tropical areas, and rising sea levels (IPCC, 2007).

Developing countries are the most vulnerable to climate change and variability due to high dependence on ecosystem services, rain-fed subsistence agriculture, and high levels of poverty (European Union, 2011; Hlomendlini, 2016). Observed climate trends and projections in Africa for countries in the Southern African Development Community (SADC) show an increase in temperatures (especially minimum temperatures) and inter-annual variability of rainfall events (AGRA, 2018; Brown et al., 2012). South Africa is also expected to experience these increases in temperature, declining rainfall patterns, and increased frequency of extreme climate events (such as droughts and floods) due to climate change. Hassan and Nhemachena (2008), Hlomendlini (2016), and Ziervogel et al. (2014) all attest to these concerns about climate change in South Africa.

Agricultural production is deeply interconnected with temperature, weather patterns, and dominant climate factors. The agricultural sector is thus inherently sensitive to climate conditions and is one of the most vulnerable sectors to the risks and impact of global climate change (Mdoda, 2014; Parry et al., 2005). Instances of climate shocks such as drought, flooding, and heatwaves result in loss of lives and long-term disruption of livelihoods due to reduced productive assets, compromised health, and damaged infrastructure, as emphasised by Ncoyini-Manciya (2019). These climate shocks, along with prolonged climate variability, intensify risks, especially for vulnerable populations, and contribute to poverty, conflicts, migration, and other consequences that undermine economic and social progress, as highlighted by Mdoda (2014) and Ncoyini-Manciya (2019). According to Habib-ur-Rahman et al.,(2022) , agricultural production is under threat due to climate change in especially in food insecure regions

The adverse effects of climate change on crops and land-based food production are evident in several parts of the world (Porter et al., 2014). According to Bibi & Raman (2023), these

impacts, which severlyimpactthe crops physiological response have posed an enormous threat to food security and the agroecosystems. The global community has long recognised that the worldwide response to climate change is critical. For agriculture to maintain the food supply for the population's well-being, it needs support from various stakeholders (Loki et al., 2020; Niles et al., 2017).

Extension and advisory services (EAS) are at the heart of this support. Their primary role is to facilitate knowledge and transfer of skills to farmers for change in behaviour and practices to increase farm returns and income (Maponya & Mpandeli, 2013). According to Ozor (2009), this definition confers the mandate to educate about climate change to agricultural extensionists. Antwi-Agyei and Stringer (2021) point to the importance of extension practitioners in helping farmers analyse data from varied climate media sources.

Since the turn of the 21st century and changes in weather patterns, farming activities have become specialised, unique, and environmentally specific, thus requiring technology-led modern techniques (World Bank, 2015). Therefore, agricultural extension needs to broaden its perspective beyond the limited perspective of disseminating technology.

1.2 CONTEXTUALIZATION OF THE PROBLEM STATEMENT

Farmers in sub-Saharan Africa (SSA) are implementing various production practices to mitigate the adverse effects of climate change on their agricultural activities. These practices include using different varieties of the same crop, practising mixed cropping, and adopting water conservation techniques. Below et al. (2012) and Komba and Muchapondwa (2015) conducted studies revealing that farmers primarily employ low-cost adaptation measures such as adjusting planting dates and diversifying crops. Commercial farmers, on the other hand, tend to invest in more expensive measures like irrigation systems. A study by Zelda et al. (2017) focused on South Africa and explored farmers' perceptions of climate change and their responsive strategies in three selected provinces. The findings indicated that planting drought-tolerant crop varieties was the most common strategy employed by farmers. Therefore, it is crucial to improve farmers' access to improved drought-tolerant seeds and efficient irrigation systems. Another study by Senyolo et al. (2018) examined climate-smart agricultural innovations in South Africa and identified conservation agriculture, rainwater harvesting, and drought-tolerant and early-maturing seed varieties as potentially suitable technologies, particularly for smallholder farmers.

However, challenges such as high initial costs, increased labour requirements, and management intensity associated with conservation agriculture and rainwater harvesting may arise in South Africa. Makate et al. (2016), drawing lessons from Southern Africa, highlighted the importance of gender-sensitive and context-specific institutional and policy efforts to address resource constraints hindering farmers' adoption of complementary climate-smart agricultural practices like conservation agriculture, drought-tolerant maize, and improved legume varieties.

Despite these practices, smallholders struggle to cope with the effects of climate change and variability, particularly in rural areas (Call et al., 2019). These farmers and those dependent on them are rendered vulnerable to abject poverty and food insecurity, living with constant threats to their livelihood. Ncube et al. (2016) reiterate that rural households are generally poor and lack the know-how and resources to adapt to or mitigate the impact of climate change. This knowledge indicates the great need for effective agricultural EAS. The National Policy of Extension and Advisory Services published by DAFF (2014, p.2) states that

> *in its current form, the public extension service cannot facilitate the accelerated capacity development of a range of producers that is desired to address challenges of rural and economic growth, food and nutrition insecurity, inequality and unemployment.*

The above statement shows that significant knowledge gaps exist in South African government-led extension services in terms of building farmers' capacity to cope with climate and other socio-economic challenges. The relationship between extension capacity gaps and factors that create barriers to farmers' ability to adjust to the changing climate successfully needs to be made clear. Furthermore, few studies address the link between South African smallholder farmers' adaptation and extension practitioners' knowledge transfer capabilities about climate change. The focus has primarily been on supporting and capacitating farmers to adapt without observing and assessing how agricultural extension practitioners can be more effective. Against this background, this research project investigates, provides empirical evidence related to, and contributes to the literature discussions on the capacity of EAS to support farmers' adaptation to climate change.

1.3 PROBLEM STATEMENT

The Eastern Cape Province recognises the significant role played by extension services in promoting farmers' welfare and productivity and empowering them to address climate change

effects; however, the province's lack of reliable and detailed empirical data on the efficiency and knowledge gaps relating to the capacity-building needs of extension practitioners themselves makes it difficult for the provincial government to intervene effectively. The FAO (2018), found that only 60% of African countries have comprehensive data on their extension services, and even fewer have data on the specific needs of extension practitioners. Against this background, this research project provides empirical evidence on whether EAS can effectively help improve farmers' climate resilience.

1.4 AIM OF THE STUDY

This study aims to assess the capacity of extension practitioners to support farmers for in climate change adaptation and to develop a training programme to enhance this capacity.

1.5 OBJECTIVES OF THE STUDY

1.5.1 Main objective

The study's overall objective is to investigate the capacity of EAS to support farmers in adapting to climate change in the Eastern Cape, South Africa.

1.5.2 Specific objectives

i. Determine awareness and level of understanding of extension practitioners related to climate change;
ii. Assess farmers' perceptions of the competencies of extension practitioners related to climate change;
iii. Evaluate the perceived capacity needs of extension practitioners and the inclusion of climate change concepts in their scope; and
iv. Identify channels that extension and advisory practitioners use to deliver services to farmers and factors influencing the use of these channels.

1.6 RESEARCH QUESTIONS

i. What is the level of understanding and awareness of extension practitioners related to climate change?
ii. What are farmers' perceptions of the competencies of extension practitioners related to climate change?
iii. What are the perceived capacity needs of extension practitioners and the inclusion of climate change concepts in their scope?
iv. Which communication channels are extension and advisory practitioners using to deliver services to farmers?

1.7 HYPOTHESES

The research hypotheses are as follows:

i. **Ho:**EAS in the public sector are unaware of climate changes and do not comprehend the impact of these on farmers' production in the province;
   Ha: EAS in the public sector are aware of climate changes and do comprehend the impact of these on farmers' production in the province
ii. **Ho:**Extension practitioners do not have the requisite information and knowledge about climate change to support the production of the farmers they work with;
iii. **Ha:**Extension practitioners have the requisite information and knowledge about climate change to support the production of the farmers they work with;
iv. **Ho**:Extension practitioners need training on climate-related issues to equip them with skills, knowledge, and information to enable them to support farmers; and
   Ha:Extension practitioners do not need training on climate-related issues to equip them with skills, knowledge, and information to enable them to support farmers; and
v. **Ho:** The channels to deliver services include physical farm visits and ICT tools; however, extension practitioners are rigid and inflexible in relation to options like ICT.
   Ha: The channels to deliver services include physical farm visits and ICT tools; and, extension practitioners are flexible to options like ICT.

1.8 SIGNIFICANCE OF THE STUDY

The study forms part of the objectives of the Eastern Cape Department of Agriculture (DoA), district municipalities, and local municipalities, which seek to investigate the capacity of EAS to support smallholder farmers to adapt to climate change. Despite often being farmed in adverse conditions, smallholder farming remains a bedrock for food supply and livelihoods for several rural households. EAS is at the heart of the development of smallholder agriculture. Their primary role is to facilitate knowledge and transfer of skills to farmers to change behaviour and employ the best available local adaptations that can be used to manage climate risks. The study holds significant implications for various stakeholders. For farmers, it offers valuable insights for informed decision-making, adoption of adaptive strategies, and efficient resource allocation. Extension officers benefit from identifying professional development needs, improving service delivery, and contributing to policy recommendations. Government agencies can make informed policy decisions and implement targeted interventions, while NGOs gain insights for strategic planning and community engagement. Overall, the study's significance lies in its potential to positively impact the agricultural sector's resilience and adaptation to climate change in the Eastern Cape.

1.9 THEORETICAL FRAMEWORK

This study draws its theoretical framework from two theories – namely, the Theory of Planned Behaviour (TPB) and the Organisational Learning Theory (OLT)

1.9.1 Theory of Planned Behaviour (TPB)

The TPB explains that attitudes, subjective standards, and perceived behavioural control all influence intentions, which in turn influence behaviours (Ajzen, 1991). The theory further states that the degree to which a behaviour is under the control of the individual and the extent to which perceived behavioural control is a reliable indicator of actual behavioural control will determine whether external forces directly force or prevent behaviours, regardless of the intention (Ajzen, 2005).

TPB can be applied in this study because in order to determine the capacity of extension workers, it is vital to understand their beliefs, attitudes, and intentions so that they can be influenced to drive behaviour change (extension practitioners effectively supporting farmers to adapt to

climate change). In the study, these beliefs, attitudes, and intentions were assessed through interviews and focus group discussions (FGDs), as this helps identify existing barriers to capacity and capacity development. This was done to highlight that it is possible for external factors to prevent behaviours, regardless of the intention. The study investigated whether constraints may hinder extension practitioners' capacity to facilitate a supportive and enabling environment that minimises barriers and maximises the likelihood of behaviour change.

1.9.2 Organisational Learning Theory (OLT)

According to Argote and Miron-Spektor (2011), Berta et al. (2015), and Nonaka (1994), OLT considers the social and organisational context in which new knowledge is acquired, the individual-level factors that influence learning, the macro-environmental influences on knowledge application and learning, and the influence of the characteristics of the knowledge or innovation on subsequent learning processes. Understanding the phenomenon of knowledge translation is greatly aided by this thorough theory (Berta et al., 2015).

The study's premise, using the OLT, acknowledges the need to establish a learning culture, promote information sharing, and support continuous learning to increase the capacity of extension practitioners, which can be accomplished by:

- Encouraging extension practitioners to value learning as a crucial component of their work.
- Encouraging the creation of a secure and supportive environment as well as channels to exchange information and insights.
- Encouraging practitioners to attend regular conferences, workshops, and seminars to share knowledge, insights, and best practices.

1.10 LIMITATIONS OF THE STUDY

The study was conducted only in one province, the Eastern Cape. As a result, the findings and conclusions drawn are especially pertinent to the Eastern Cape Province. They may not be as easily generalisable to the other provinces of South Africa.

The questionnaires were written in English, and some farmers were illiterate. For respondents to react, some of the questions had to be translated into their native language (IsiXhosa),

meaning farmers could not respond more quantitatively to climate change observations and adaptation strategies based on the translation.

1.11 OUTLINE OF THE STUDY

The thesis will follow an article format and is organised into eight chapters. Chapter 1 gives the study's background, problem statement, objectives, and significance of the study. The literature review related to climate change, EAS, and smallholder farmers is presented in Chapter 2. Chapter 3 provides a comprehensive overview of the methodology employed in the study. The methodology chapter is followed by four empirical chapters in which the study's objectives are addressed based on the collected and analysed data. The first objective is discussed in Chapter 4; here, awareness and level of understanding of extension practitioners related to climate change were analysed using descriptive statistics and qualitative data (which were coded thematically using content analysis). A Pearson's Chi-square ($\chi 2$) test of independence was used to assess the relationship between extension practitioners and their level of awareness and understanding of climate change. Chapter 5 addresses study objective two, which assesses farmers' perceptions of extension practitioners' competencies related to climate change. Factors influencing these perceptions were analysed using content analysis, and the binary logistic model was used to investigate factors influencing these perceptions. The third objective evaluates the capacity needs of extension practitioners from their perspective and is explored in Chapter 6. Data in this chapter were analysed using descriptive statistics and coded thematically using content analysis to examine the perceived capacity needs of extension practitioners and the inclusion of the climate change concept in their scope. The fourth objective, which relates to the channels extension and advisory practitioners use to deliver services to farmers and factors influencing the use of these channels was analysed using Pearson's Chi-square ($\chi 2$) test of independence with $\alpha = 0.005$ as a criterion for significance and the multinomial regression method in Chapter 7. The conclusions and recommendations for policy and further research are discussed in Chapter 8.

CHAPTER 2 :
LITERATURE REVIEW

2.1 INTRODUCTION

The literature review chapter is divided into three sections. In Section 2.2, the conceptual literature underpinning the study is reviewed. The review starts by defining the concepts of climate change and variability and various coping mechanisms employed by smallholder farmers to enhance climate resilience. Section 2.3 focuses on the review of literature related to smallholder farmers in developing countries, agricultural policies, constraints, opportunities for smallholder farmers in developing countries in SSA, and a particular focus on South Africa. The section contains empirical evidence on demand for agricultural extension and its impacts. Section 2.4 explores the literature on EAS, highlighting the evolution and status thereof in the context of South Africa, including the accessibility, communication channels, and the effectiveness in delivering quality services to smallholder farmers.

A comprehensive search was conducted using a range of academic databases, including Web of Science, Scopus, and Google Scholar, to conduct this literature review. The following search terms were used: “extension practitioners”, “climate change”, “capacity building”, “training”, and “knowledge”. In addition, books and academic dissertations relevant to the topic and based on methodological rigour were also used. Additional sources were identified through snowball sampling by reviewing the reference lists of the articles and conducting manual searches of key journals and books.

Material older than 10 years was included to provide a historical perspective or context for the current research, and they are contextualised in terms of relevance to the current research. However, recent literature is predominantly reviewed to highlight recent trends and to ensure relevance.

2.2 CLIMATE CHANGE

2.2.1 Definition

Climate change refers to alterations in the global climate resulting from human activities that directly or indirectly impact the composition of the Earth's atmosphere. These changes endure over extended periods, typically spanning decades or even longer durations (Council for Scientific and Industrial Research [CSIR], 2010).

According to the United Nations Framework Convention on Climate Change (UNFCCC) (UN, 1992), climate change is defined as the ongoing trend of alterations in the overall weather conditions of the Earth, attributed to a consistent increase in the planet's surface temperature, commonly known as global warming. This rise in average global temperature is primarily caused by the amplified presence of greenhouse gases (GHGs) in the atmosphere, resulting from human activities. For instance, the industrialisation processes in developed nations have contributed to substantial emissions of GHGs, such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), into the atmosphere (IPCC, 2014). These gases intensify the greenhouse effect, a natural phenomenon, by forming a layer in the atmosphere that acts as insulation, trapping heat and reducing the amount of solar radiation that escapes back into space, thereby warming the Earth. The World Meteorological Organisation (WMO, 2009) indicates that climate change represents a statistical depiction of a region's weather conditions, encompassing the mean and variability of parameters such as temperature and precipitation, over a period of at least 30 years. As per the UNFCCC (UN, 1992), evident indications of swift climate change comprise: (i) escalating average global temperatures, with the previous decade, between 2013 and 2023, registering the highest on record; (ii) elevations in the global mean sea level; (iii) alterations in average rainfall patterns, leading to increased precipitation in certain regions and aridity in others; (iv) a higher occurrence of intense rainfall and extreme weather events across most land areas; and (v) more severe and prolonged droughts, especially in tropical and subtropical regions

Scholes and Engelbrecht's (2021) review describes how the temperature rise (global warming) is predicted to pose significant environmental threats, including significant disturbance of agriculture. This means there is a high likelihood that agricultural production in Southern Africa, including staple crops and livestock, will be reduced. Their review further explains that the region is already beyond the temperature optimum for most crop and livestock production, and crop and forage production in an already dry country declines as soil moisture further decreases.

The agricultural sector remains a critical sector that is highly vulnerable to climate change due to its high dependence on and exposure to climatic variables such as precipitation, temperature, and wind (Antwi-Agyei et al., 2014). A decline in agricultural production has far-reaching implications; according to the UNFCCC (UN, 1992), certain farming activities and livelihoods may become obsolete due to higher temperatures. For example, it may become impossible to grow beans in South Africa by the middle of the century, requiring bean farmers to relocate or abandon the crop and shift to more resistant crops like yams.

According to Folke et al. (2010), limited skills and equipment for disaster management, insufficient financial resources, and weak institutional capacity contribute to Africa's vulnerability to the adverse effects of climate change. Additionally, climate change exacerbates vulnerability and reduces resilience in regions already grappling with poverty, subsistence food production, and land degradation issues (Masson-Delmotte et al., 2019). This poses a significant threat to the sustainability of food production and livelihood activities in vulnerable communities, including those in South Africa.

On the other hand, Pant (2009) highlights that agriculture itself contributes to the problem of climate change through the emission of various GHGs. Agricultural emissions originate from activities such as soil and manure management, enteric fermentation, and the consumption of fossil fuels. Agricultural soil management, for example, accounts for approximately 60% of total nitrous oxide emissions in the farming sector. To mitigate this, the use of efficient nitrogenous fertilisers can help reduce nitrous oxide emissions (Takle & Hofstrand, 2008). Ruminant animals are major methane emitters, with methane produced during enteric fermentation in their digestive process. Similarly, manure management also affects methane emissions, with the anaerobic decomposition of manure producing methane (Takle & Hofstrand, 2008). Carbon dioxide from fossil fuel consumption in agricultural production is another source of GHGs (Pant, 2009).

Climate change creates risks and opportunities globally; individuals and societies can take advantage of opportunities and reduce risks by understanding, planning, and adapting to a changing climate (Lediga, 2020).

2.2.2 Climate change adaptation policy frameworks in South Africa and the Eastern Cape

The United Nations Development Programme (UNDP, 2004) describes adaptation as a process by which individuals, communities, and countries seek to cope with the consequences of climate change, meaning that they increase their ability to cope with an uncertain future. This adaptation involves taking appropriate action and adjusting behaviours to reduce the changing climate's negative impacts (Brazier, 2015). Adaptation to climate change can be a change or modification in the agricultural farming system to minimise the adverse effects of climate change and concurrently boost or improve food production, irrespective of climate variability (IPCC, 2014). The adaptation process is not new; however, incorporating future climate risk into policymaking is. Climate change adaptation is an emerging area of policy development, particularly in relation to the agricultural sector in South Africa, as noted by the World Wildlife Fund (WWF, 2016).

In South Africa, climate change governance has evolved over time and is characterised by a complex network of executive policies, strategies, regulations, and institutions. In 2012, climate change became a crucial component of the National Development Plan (NDP) (DEA, 2012b), which serves as the overarching blueprint for the Eastern Cape Department of Economic Development, Environmental Affairs, and Tourism (DEDEAT, 2017). According to Averchenkova et al. (2019), South Africa has established one of the most comprehensive and inclusive climate governance systems observed among developing and emerging economies, and the country frequently plays a prominent role in global initiatives addressing climate change. South Africa became a party to the UNFCCC in 1997 and ratified the Kyoto Protocol in 2002. Demonstrating early commitment, South Africa was among the first developing countries and emerging economies to formulate a voluntary emissions reduction pledge for 2020 under the Copenhagen Accord in 2010. In 2011, South Africa hosted the 17th Conference of the Parties (COP 17), which led to the establishment of the Durban Platform for Enhanced Action. As part of the lead-up to the negotiations of the Paris Agreement, South Africa submitted an intended Nationally Determined Contributions (NDCs) in 2015. Throughout the past two decades, South Africa has implemented national and sectoral policies, plans, and strategies aimed at decarbonising the economy while concurrently addressing broader developmental objectives.

To comprehensively identify and address the repercussions of climate change on the economy, the South African government has formulated a range of policies, strategies, and plans, as highlighted by the WWF (2016).

Climate change adaptation, mainly in the agricultural sector, is predominantly a grassroots issue. In South Africa, the provincial, district, and local municipalities are well cognizant of the necessity for adaptation action and possess knowledge and ideas regarding appropriate measures (DEDEAT, 2017). However, there exists a disconnect between national climate change adaptation policies and the practical realities of local institutions on the ground. (Averchenkova et al., 2019).

In this study, five policy documents at a national level and one at the provincial (Eastern Cape) level were reviewed.

2.2.2.1 National Climate Change Response White Paper (NCCRWP), 2012

The NCCRWP document outlines the country's vision for effectively responding to climate change and achieving a long-term, equitable transition to a climate-resilient and low-carbon economy and society (DEA, 2012a). It encompasses two main objectives: (i) managing the inevitable impacts of climate change by implementing measures that enhance South Africa's social, economic, and environmental resilience and emergency response capacity, and (ii) making a fair contribution to global efforts aimed at stabilising GHG concentrations in the atmosphere to prevent detrimental human-induced interference with the climate system. These objectives are pursued within a timeframe that allows for sustainable economic, social, and environmental development to take place (Pant, 2009).

To respond to the need for adaptation in the agricultural sector, the NCCRWP calls for improvement in research into water, nutrient, and soil conservation technologies and techniques, as well as climate-resistant crops and livestock. It further proposes developing and enhancing early warning systems and education and awareness programmes, particularly in rural areas. Lastly, it mentions the need to manage the economic impacts of national and international climate change response measures (Scholes & Engelbrecht, 2021). On the other hand, the WWF (2016) highlights that the document does not detail the required stakeholders/institutions needed for the implementation, and it does not specify the approach that will be taken to ensure that economic risks are mitigated and opportunities seized.

2.2.2.2 National Development Plan (NDP) 2012

The NDP offers a long-term perspective. It defines a desired destination and identifies the role different sectors of society need to play to reach the goal of eliminating poverty and reducing inequality by 2030 (National Science and Technology Forum [NSTF], 2018). The key focus areas outlined in the blueprint encompass education, health, safety, economic growth, employment, skills development, infrastructure, rural development, human settlements, local government, environment, international relations, an efficient public sector, social protection, nation-building, and social cohesion The NDP recommends substantially increasing investments in water resources and irrigation infrastructure to enable climate adaptation in agriculture (DEA, 2012b). It further endorses that the Agricultural Research Council (ARC) establishes a research focus on climate change and food security (South Africa, 2012).

Although the planning and implementation of the NDP are informed by evidence-based monitoring and evaluation, the WWF (2016) highlights that the Plan fails to address crucial aspects related to the implementation of climate change responses. Firstly, it does not provide information on the funding sources for carrying out the proposed measures. Secondly, it overlooks the potential benefits of accessing agricultural insurance markets as an adaptation strategy. Furthermore, the NDP does not propose any collaboration or coordination among different departments, agencies, and stakeholders operating within the agricultural sector. Additionally, it does not acknowledge the importance of strengthening extension services, enhancing weather and climate forecasting capabilities, and improving risk management tools. Moreover, the Plan does not recognise the interconnections between climate change, trade, and agriculture. The lack of policy coherence is not limited to the agricultural sector, and there is a need to address potentially conflicting policy objectives and seek a balanced approach (Averchenkova et al., 2019). There is thus still significant work to be done to address these gaps and ensure effective policy implementation.

2.2.2.3 Agricultural Policy Action Plan (APAP) 2014

The APAP is a policy set out over a five-year period, which seeks to translate the high-level responses offered in the Integrated Growth and Development Policy for Agriculture, Forestry and Fisheries (IGDP) into tangible, concrete steps (Trade Law Centre [TRALAC], 2015). The APAP proposes several transversal interventions that complement and go beyond the specific

sectoral interventions identified and which collectively seek to strengthen the agriculture, forestry, and fisheries sectors in diverse ways. One such intervention is trade and agribusiness development (DAFF, 2015).

To promote climate adaptation in the agricultural sector, the APAP recommends climate-smart agricultural production systems and technologies (such as improved irrigation practices and techniques). It also endorses the ARC as the lead institution in the climate adaptation sphere, with support from DAFF (TRALAC, 2015). On the other hand, the policy fails to link with climate change developments. It does not address socio-economic barriers, and there is no coherent capacity-building programme for information disseminators (i.e., extension practitioners) (WWF, 2016).

2.2.2.4 Climate Change Sector Plan for Agriculture, Forestry and Fisheries (CCSPAFF) 2015

The CCSPAFF (2015), formulated by DAFF, aligns with the 2012 NDP and aims to meet the objectives of the NCCRPWP (DAFF, 2015). The fundamental strategy of the Sector Plan is climate-smart agriculture, which involves integrating land suitability, land use planning, agriculture, and forestry to maximize synergies and enhance resilience, adaptive capacity, and mitigation potential.

The key challenge for the CCSPAFF is to promptly implement cost-effective measures that will make a substantial and long-term reduction in GHG emissions and address the factors causing climate change in the agricultural sector. The CCSPAFF needs to acknowledge that delaying action will escalate the risk of adverse environmental consequences, which are likely to result in higher costs. Furthermore, it is necessary to develop scientific and technological capacities that enable innovative solutions for both mitigating and adapting to the adverse impacts of climate change (IPCC, 2016).

2.2.2.5 National Climate-Smart Agriculture Strategic Framework (NCSASF) 2018

As per the Centre for Environmental Rights (CER), the NCSASF serves as a comprehensive strategic guide, detailing climate change adaptation and mitigation strategies in the agriculture sector, as well as aquaculture, forestry, and fisheries (CER, 2015). The framework highlights

the significance of climate-smart agriculture (CSA) in addressing vulnerabilities within the agriculture sector. Various stakeholders and farmers are encouraged to play a role in promoting resource efficiency, increased productivity, and social equity through mitigation and adaptation efforts. The emphasis is on fostering effective adaptation responses and enhancing adaptive capacity to reduce vulnerability and enhance the overall resilience of South Africa's agriculture, forestry, and fisheries (AFF) systems, including their socio-economic and institutional aspects. According to the DAFF (2020), the objectives of the framework are as follows:

i. Guide various stakeholders, including government, investors, and development partners, to incorporate CSA into their AFF plans, programmes, and projects.
ii. Contribute to the increased productivity and growth of agricultural, forestry, and fisheries value chains while considering aspects such as nutrition and gender.
iii. Enhance the resilience of AFF production and food systems to climate and weather-related shocks, considering social, environmental, and economic aspects.
iv. Contribute to low-carbon development by promoting efficient resource utilisation in agriculture, agribusiness, forestry, and fishing, thus reducing national emission intensity within the AFF production and food systems.
v. Strengthen governance and institutional coordination to effectively implement the NCSASF at the national, provincial, and local levels.

The NCSASF is endorsed by South Africa's 4th Biennial Update Report (DEFF, 2020) to the UNFCCC due to the practical recommendations it contains.

2.2.2.6 Climate Change Adaptation Action Plan for the Eastern Cape Province 2017

The National Department of Environmental Affairs (DEA) has been collaborating with the mandated provincial department – namely, the Eastern Cape Department of Economic Development, Environmental Affairs, and Tourism (DEDEAT) – to support the processes underpinning an improved state of readiness to respond to climate change in the Eastern Cape. The Action Plan thus provides an updated roadmap, guiding an enhanced form of readiness to respond to climate change in the Eastern Cape by recommending sectoral programmes of action that strengthen adaptive capacity and reduce climate sensitivities and exposures (DEDEAT, 2017). In the agriculture and food security sector, the Action Plan aims to expand the capacity of extension support to address climate-related risks, especially to small-scale farmers,

incorporating climate-smart, ecosystem-based approaches. The activities based on the Action Plan include conducting workshops for various stakeholders on climate change issues and learning and exchanging programmes on best practices, with universities and research organisations being lead institutions and municipalities being support institutions (WWF, 2016).

One barrier to implementing the plan that has been noted is the lack of adequate extension capacity in climate-related information (DEFF, 2020).

2.2.3 Impacts of climate change on agricultural production

Due to the scale and sensitivity of the sector, agriculture is the industry where climate change will have the most significant economic impact.

2.2.3.1 Effects of climate change on agricultural production globally

According (IFPRI, 2009), the impacts of climate change on agriculture include the biological effects on crop yields and the impact on outcomes, including prices, production, and consumption. Similarly, climate change has an overarching impact on crop, livestock, and fisheries production and will increase the prevalence of crop pests (Campbell et al., 2016).

The biophysical impacts of climate change on agriculture result in changes in production and prices, which reverberate throughout the economic system as farmers and other market participants autonomously adjust their behaviours. These adjustments manifest as shifts in crop types, input usage, production levels, food demand, food consumption, and trade dynamics (Schmidhuber & Tubiello, 2007).

Extreme climatic events – including rising average temperatures, droughts, heatwaves, floods, wildfires, alterations in rainfall patterns and amounts, increasing atmospheric CO_2 concentrations, and heightened climatic variability – directly affect crop production. Furthermore, a temperature rise of 1˚C to 2˚C on Earth's surface is projected to reduce crop yields in tropical and sub-tropical regions due to increased evapotranspiration and reduced soil moisture availability (IPCC, 2007).

2.2.3.2 Effects of climate change on agricultural production in SSA and South Africa

Parry et al. (2007) estimate that certain areas in SSA could experience a reduction in rainfall of approximately 20%, leading to adverse effects on soil health and soil moisture, which directly impact crop yields. These conditions are likely to result in the loss of arable land due to decreased soil moisture, increased aridity, increased soil salinity, and groundwater depletion, among other factors. It is important to note that water scarcity poses a significant constraint on agricultural production, as the implementation of irrigation systems can be expensive.

According to Maponya (2013), the negative impacts of climate change on crop yields have a particularly pronounced economic impact in Africa, given that the agriculture sector contributes significantly to the GDP of many African countries. Consequently, the effects on crop production are expected to result in reduced output, increased prices of agricultural products, and significant negative impacts on people's social lives. With regards to price increases, IFPRI (2009) estimates that climate change will result in price increases of 32–37% for rice, 52–55% for maize, 94–111% for wheat, and 11–14% for soybeans.

Climatic changes have always had, and continue to exert, an impact on local agricultural production. In some parts of Africa, climate-induced sea-level rise resulting from global temperature increases already affects coastal and low-lying agricultural lands – for example in the form of increased soil salinity (Thiam et al., 2019), leading to a loss of agricultural land, loss in farmers' income, and unstable food supply systems (Chijioke et al., 2011). These findings are corroborated by a recent African Union (AU, 2022) report which indicates that crops grown across Africa are being adversely impacted by climate change.

Climate affects livestock production, both directly and indirectly. The direct effects include air temperature, humidity, wind speed, and other climate factors influencing animal performance such as growth, milk production, wool production, and reproduction (Houghton, 2001). Indirect effects are mediated through changes in feed resources; this is one of climate change's most evident and essential effects on livestock production. Feed resources can significantly impact livestock productivity, rangelands' carrying capacity, ecosystems' buffering ability and sustainability, and the distribution of livestock diseases and parasites (Thornton & Herrero, 2008).

Smith et al. (1996) explain that the impacts of climate change on livestock feed include (i) grain availability and price, (ii) decreased livestock pastures and forage crop production and quality,

(iii) changes in livestock diseases and pests, and (iv) the direct impact of weather and extreme events on animal health, growth, and reproduction. In summary, climate change impacts include decreased quality and quantity of animal feed and forage as well as the amount of water available; heat stress; biodiversity change; changes in the distribution and occurrence of livestock pests and diseases; and increased livelihood and income vulnerability, which has an impact on food security, purchasing power, and resilience (AU, 2022).

Climate change is accompanied by a range of uncertainties, including uncertainties about which areas, regions, and countries will experience its impacts and to what degree. This uncertainty can lead to a hesitant approach to implementing adaptation measures. The agricultural production in Africa and Southern Africa, particularly the developing component, is highly vulnerable and at substantial risk of being severely affected by climate change. It is imperative to engage in continuous research, education, and awareness campaigns to adapt to and combat the potential effects of climate change at local, national, and regional levels (Rust & Rust, 2013). The resilience of farmers has become increasingly crucial, and the negative impacts of climate change can be significantly mitigated through the implementation of adaptation strategies (Dinar et al., 2008; European Commission, 2021).

2.3 EXTENSION AND ADVISORY SERVICES

2.3.1 Definition

The agricultural extension does not have a fixed or precise definition. The term "extension" was initially used to describe adult education programs conducted by Cambridge and Oxford universities in England in 1867. These programs aimed to extend the research findings and knowledge generated by the universities to the local communities surrounding them (Jones & Garforth, 1997). Zwane and Kekana (2014) define agricultural extension as a non-formal educational system targeted towards adults residing in rural areas. This system is built upon pertinent content derived from agricultural, social, and communication research, which is then synthesised into a collection of concepts, principles, and operational procedures.

According to DAFF (2011), extension is a systematic process that involves working with farmers or communities to assist them in acquiring valuable and practical agricultural knowledge and skills. The primary objective is to enhance farm productivity and overall agricultural outcomes. Extension services aim to change farmers' knowledge, skills, attitudes

and skills (Kurniawan et al., 2022). Maponya and Mpandeli (2012) further define the role of extension in the agricultural sector as educational, where extension practitioners are expected to provide and disseminate information to farmers. Adesina and Forson (1995) defined agricultural extension as the most important for analysing the adoption decisions of the many sources of information available to farmers. According to Van den Ban and Hawkins (1996), extension is defined as having five different aspects – namely, (i) transferring knowledge from researchers to farmers, (ii) advising farmers in their decision-making, (iii) educating farmers to make similar decisions in the future, (iv) enabling farmers to clarify their goals and possibilities and realise them, and (v) stimulating desirable agricultural developments.

2.3.1.1 Agricultural Extension in South Africa

The South African history of extension dates to the reconstruction in 1902, when agricultural scientists were imported from England, and the missionaries first started agricultural education (Van Niekerk, 2012). However, the expertise of outsiders was futile, as they were unfamiliar with South Africa's local conditions. In response, the then Minister of Agriculture introduced six local practitioners to serve the entire country (Koch & Terblanché, 2013). The primary role of agricultural extension was to support farmers in making informed decisions that would improve their farming practices and contribute to ensuring food security in the country (Khwidzhili, 2019). In the late 1940s and early 1950s, efforts were made to establish academic training and research institutions for agricultural extension at various higher education institutions (Penzhorn, 1987). According to Koch and Terblanché (2013), the academic standing of training courses is determined by their relevant content and their ability to provide specific training tailored to particular situations or needs.

Over time, the field of agricultural extension experienced growth, leading to the establishment of the South African Society of Agricultural Extension (SASAE). The SASAE's main objectives are to promote and apply extension and rural development as a scientific discipline by fostering critical thinking, research, discussions, publications, and knowledge sharing on a national and international level. It also aims to enhance the professionalism, status, and dignity of the extension profession among the scientific community, the general public, and aspiring students (Terblanché & Koch, 2011).

In 2013, the profession of agricultural extension was officially recognised as a science by the South African Council for Natural Scientific Professions (SACNASP), allowing the SASAE to operate under the umbrella of the Natural Scientific Professions Act of 2003 (Act No. 27 of 2003) without the need for additional legislation. This recognition enabled the SASAE to continue as a voluntary association working in conjunction with SACNASP (Koch & Terblanché, 2013).The post-apartheid era (since 1994) saw drastic organisational and other changes. Present-day extension services face new professional challenges to improve service delivery to a growing and technically more divergent farming community. This trend has seen the extension service moving from a sole government mandate to a more pluralistic extension service delivery system that allows other actors (e.g., NGOs, private sector, development partners, etc.) to provide their services (Khwidzhili, 2019). Extension has immensely contributed to the livelihoods of farmers. However, Koch and Terblanché (2013) call for improvement of the academic standing of practitioners through further training at tertiary institutions and becoming involved in mentorships, continuing professional development (CPD) programmes (in both the natural as well as the supportive disciplines), and group initiatives. Experienced and knowledgeable practitioners should lead such initiatives.

2.3.2 The accessibility and role of extension service in climate adaptation

Agricultural extension is essential for bridging the gap between farmers and research in order to share information, knowledge, and innovation. As stated by the FAO (2013), agricultural extension plays a role in public communication and educational initiatives aimed at helping farmers mitigate the impacts of climate change. These activities encompass raising awareness and facilitating the exchange of knowledge regarding climate change issues; fostering the development of resilience among vulnerable individuals, communities, and regions; promoting the active involvement of all stakeholders in addressing climate change challenges; and establishing suitable frameworks for coping with and adapting to the effects of climate change. Agricultural extension plays a crucial role in initiating development because adaptations to climate change impacts require a difference in people's knowledge, attitudes, and skills (Maponya & Mpandeli, 2012).

According to the NCCRWP (DEA, 2012a), smallholder farmers require efficient and informative agricultural extension services to facilitate the process of adapting to the uncertainties posed by climate change. These services should provide up-to-date, research-based

knowledge on climate change adaptation and food security. Shaik et al. (2011) suggest that agricultural extension needs to move beyond the traditional mindset of merely transferring technology packages. Instead, it should rejuvenate its focus on knowledge transfer as a fundamental input for modern farming practices. Access to climate information has also been identified as crucial for climate change adaptation, as it increases the likelihood of implementing effective adaptation techniques (UN, 2008). Hassan and Nhemachena (2008) emphasise that exposure to extension services influences farmers' capacity to adapt to climate change. Maponya and Mpandeli (2012) further highlight the significance of climate information in increasing the effectiveness of adaptation strategies.

However, there are several gaps and challenges in providing climate information to farmers through extension services. One of the primary challenges is the lack of preparedness among extension organisations regarding climate change. Many extension organisations in the developing world lack awareness of climate change's impacts on agriculture. As a result, they are not adequately prepared to address climate change-related issues, such as documenting climate change scenarios at the grassroots level, mapping vulnerable regions, providing access to real-time data, synthesising and interpreting information, and facilitating decision-making processes (Shaik et al., 2011). Integrating interdisciplinary and multisectoral information into practical extension materials goes beyond the capabilities of traditional extension systems.

In summary, there is a need to enhance agricultural extension services to effectively address climate change. This involves providing timely and targeted climate information to farmers and overcoming the challenges of limited awareness, inadequate preparedness, and the integration of interdisciplinary knowledge. Kachilonda (2014) emphasises the urgent need to consider extension approaches that facilitate farmers' exchange of knowledge and information. Advisory services also deal with emerging issues, alternative solutions, conflict resolution, and nurturing emerging community learning initiatives.

2.3.3 The role of agricultural extension in agriculture production and the changing climate

Extension is viewed as a vital tool for increasing the effectiveness and efficiency of agriculture, its related activities, and other economic activities to meet the population's demands. Correspondingly, it is viewed as a tool for enhancing agricultural production. Agricultural

extension has been acknowledged as a crucial part of technology transfer because its primary goal is to increase farmers' knowledge of rural development (Bonye et al., 2012).

The role of agricultural extension encompasses several key aspects, including connecting farmers to domestic and international markets, aiding farmers in reducing vulnerability and improving livelihoods, promoting environmental conservation (Alex et al., 2001), and leading efforts in rural development and non-farm employment (Rivera, 2001). Additionally, Swanson and Samy (2016) highlight that many countries achieve food security through technology transfer for food crops and farmer capacity building in sustainable resource utilization facilitated by agricultural extension.

Across Sub-Saharan Africa, including South Africa, governments have made significant investments in agricultural extension to enhance agricultural productivity and farmers' income. There has been a notable shift towards participatory models (Duvel, 2005) in agricultural extension, where stakeholders play a more active role in the extension processes and decision-making. This approach fosters collaboration and engagement, allowing for more effective and contextually relevant solutions to agricultural challenges. Programmes for agricultural extension have been a primary means of tackling rural poverty and food insecurity because they encourage adult learning in rural areas, help farmers solve problems, and engage them in the agricultural knowledge and information systems (Danso-Abbeam et al., 2018). As a result, extension services offer knowledge favouring farm technical efficiency, revenue, and technology adoption (Anang et al., 2019).

Dunne et al. (2019) note that agriculture extension services and credit facilities are the two most helpful institutional structures for delivering knowledge on new technology and farming practices. In response to climate change, access to agriculture extension services helps farmers become more aware of how the climate changes. It makes it easier for them to learn about various management techniques that will help them adapt to those changes (Arbuckle et al., 2015). As a result, it supports farmers' ability to recognise changes in weather patterns and adjust their methods accordingly (Ramborun et al., 2019). Therefore, extension services must be adequate to develop practical climate agricultural adaptation strategies (Jha & Gupta, 2021).

2.4 SMALLHOLDER AGRICULTURE

2.4.1 Definition

The definition of smallholder farmers differs depending on the context, country, and ecological zone. The term "smallholder" is often used interchangeably with "small-scale" and "resource-poor" (Pienaar & Traub, 2015). In general, it refers to farmers with limited resources compared to others in the sector (DAFF, 2012). Another definition describes smallholder farmers as those who own small plots of land on which they cultivate subsistence crops and one or two cash crops, relying primarily on family labour. Kirsten and Van Zyl (1998) define smallholder farmers as those whose scale of operation is too small to attract the necessary services to significantly increase their productivity. The difficulty in defining the term "smallholder" is acknowledged in the literature (Lahiff & Cousins, 2005).

It is important to note that smallholder farmers vary in terms of individual characteristics, farm size, and resource distribution. Their production systems typically involve simple, outdated technologies, low returns, high seasonal labour fluctuations, and significant contributions from women (Pienaar & Traub, 2015). Smallholder farming is often labour-intensive, relying on traditional production techniques, and may lack institutional capacity and support (Louw et al., 2007). The characteristics and history of the smallholder sector's development are well-documented in the literature (Aliber & Hall, 2012).

Smallholder agriculture is increasingly recognised for its important role in many countries' economies. Governments worldwide often prioritise smallholder farming to enhance economic growth, particularly because it is part of the broader small and medium-sized enterprise sector (Louw et al., 2007). AGRA (2018) suggests that partnerships with small-scale farmers can address Africa's food security challenges. The author emphasises the importance of farmer organisations in empowering small farmers, reducing dependence on intermediaries, and providing access to storage, credit, and market price information.

Smallholder farmers face constraints that compromise their seasonal output due to limited resources (Chisasa & Makina, 2012). Van Rooyen et al. (1987) categorised the constraints faced by smallholder farmers into system constraints, allocative constraints, and environmental-demographic constraints. It is crucial to improve the productivity of smallholder farmers to ensure long-term food security. This can be achieved by promoting sustainable intensification through improved inputs and contextual factors such as enabling policy environments, good

governance, institutional and human resource capacity, investment in trade, infrastructure, finance mobilisation, farmer and community entrepreneurship, and risk management (GCARD, 2010).

2.4.1.1 Smallholder agriculture in South Africa

The agricultural sector in South Africa consists of commercial and smallholder farmers (Tregurtha et al., 2010). Pienaar and Traub (2015) explain that the smallholder sector is predominantly located in the former homeland areas, demarcated according to the 1913 and 1936 Native Land Acts, with production primarily aimed at household food security. The division between the commercial, large-scale farming sector and the struggling smallholder sector in South Africa is a result of such historical patterns of dispossession and impoverishment, which have systematically undermined historically successful land-based production systems and livelihoods (Neves et al., 2009). This division is marked by inequality in land distribution, economic assets, support services, market access, infrastructure, and income.

According to the DAFF (2012), small-scale producers can be further classified into emerging and smallholder farmers. Emerging farmers are those who sell their produce, while smallholder farmers primarily produce for household consumption.

Smallholder farmers in South Africa face various challenges that hinder their growth and ability to contribute to food security compared to commercial farmers. These challenges include limited access to land and inadequate physical and institutional infrastructure. Most smallholder farmers are located in rural areas, particularly in the former homelands, where infrastructure limitations restrict their expansion. Inadequate road networks, for instance, impede transportation of inputs and produce and hinder access to information. Additionally, smallholder farmers often lack sufficient assets, information, and access to services, limiting their participation in profitable markets (Kirsten & Van Zyl, 1998).

The NDP of South Africa has identified smallholder agriculture as a catalyst for development in rural areas, and the Plan aims to improve the livelihoods of at least 370,000 people, particularly in the former homeland regions (South Africa, 2012). The government has set targets to increase the number of smallholder producers selling their produce from 200,000 to 250,000 by 2014 and to 500,000 by 2020 (Aliber & Hall, 2012). Smallholder agriculture is seen

as the engine of rural economic growth and the primary source of livelihoods for many smallholder farmers (Komba & Muchapondwa, 2012). Globally, smallholder farmers play a vital role in food production, with estimates suggesting that they produce up to 80% of the food consumed in Asia and SSA, supporting billions of people (IFAD, 2010).

2.4.2 Smallholder farmers and climate change

Smallholder agriculture in South Africa is highly vulnerable to climate variability and change, mainly because the region is prone to extreme weather events such as floods, drought, and heat waves (Nhemachena & Hassan, 2007). Like most countries in the SSA region, these effects are exacerbated mainly by poverty, over-reliance of smallholder farmers on rain-fed agriculture, land degradation and infertile soils, poor agricultural production-related policies, and governance-related problems (Makate, 2019). Another significant effect is the lack of accessibility to information and low access to technology (Morton, 2007).

According to Maponya (2013), climate change is expected to exacerbate food insecurity and increase poverty levels among rural communities. Smallholder farmers, in particular, are directly threatened by rising temperatures, which cause heat stress on plants, reduce water availability, and lower overall productivity (Komba & Muchapondwa, 2012). The changing climate negatively affects productivity by degrading soil fertility through scorching temperatures, dry winds, erosion, wilting of plants, and poor production (DEA, 2013). The practice of mono-cropping, commonly employed by smallholder farmers, further exacerbates soil degradation (Patterson, 2015). Erratic rainfall patterns in South Africa, including droughts, result in livestock losses, water shortages, low yields, and a lack of seeds for subsequent cultivation, diminishing smallholder farmers' ability to cope with climatic changes (Lediga, 2020).

Moreover, increasing temperatures in South Africa, as highlighted by the DEA (2010), may lead to the expansion of vector and water-borne diseases such as malaria and cholera. Climate change could also trigger new and emerging epidemics and environmental toxins, posing additional challenges for smallholder farmers who lack the resources to manage or adapt to these risks.

Inadequate infrastructure further hampers smallholder farmers' adaptation to climate change. Erratic rains and floods destroy buildings, erode roads, and damage bridges, creating poor transportation infrastructure (Ngigi, 2009). Smallholder farmers, often located in remote areas,

face difficulties in accessing markets due to poor or non-existent roads. This leads to longer transportation times and higher costs, negatively impacting the quality and timely delivery of produce to markets. As a result, smallholder farmers may face lower prices or product rejection, affecting their income and livelihoods (Louw et al., 2007; Baloyi, 2010). According to Komba and Muchapondwa (2015), the adverse effects of climate change pose a great potential to result in extensive livelihood losses, especially for smallholder farmers in all countries, since they depend mainly on agriculture as their primary source of livelihood.

2.4.2.1 Climate change adaptation strategies among smallholder farmers

Historically, agriculture has demonstrated a high degree of adaptability to changing conditions, whether these changes were brought on by technological changes, economics, or resource availability (Brooks et al., 2005). Deressa et al. (2008) and the IPCC (2007) explain adaptation to climate change as a change in natural and human systems in response to climatic effects, which moderates harm or exploit beneficial opportunities. Walker (2019) defines adaptation as a continuous and evolving process to cope with climatic impacts. A study by Deressa et al. (2009) indicated that farmers perceive the climate as changing and have taken several adaptation measures to reduce the impact.

Below et al. (2010) identified a wide range of adaptation strategies utilized by farmers, amounting to approximately 104 different practices. These strategies fall under various categories, including farm management and technology, farm financial management, diversification of farm and off-farm activities, government interventions in infrastructure, health, and risk reduction, as well as knowledge management, networks, and governance.

Crop varieties and livelihood diversification emerge as significant adaptation measures commonly adopted by farmers across the continent. However, the choice of specific adaptation options varies due to diverse contextual factors, as noted by Below et al. (2012). Contextual considerations such as geographical location, climate conditions, available resources, and socio-economic factors play a crucial role in shaping farmers' adaptation decisions. This highlights the need for tailor-made and context-specific approaches to enhance the effectiveness of adaptation strategies in different regions and circumstances.This corresponds with Ojo et al. (2021), who found that farmers in South Africa consider improvements in crop variety and early-maturing crops, use of agrochemicals, diversification of livelihoods, irrigation, and reduction of

livestock to be adaptation strategies. These strategies have all been found to lessen the effects of climate change considerably and increase food security for farmers in general and smallholders in particular (Asare-Nuamah & Mandaza, 2020).

A study by Atube et al. (2021) highlighted that most of the adaptation strategies reported focused on reducing the effects of drought, which seems to be a more frequent problem than floods for farmers in the study areas. Planting different crop varieties was the most widely practised adaptation strategy.

Farmers' adaptation methods suggest that relatively inexpensive measures such as changing planting dates and diversifying crops could be used by most farmers. In contrast, those that are costly or require more capital, such as irrigation systems, are used by very few farmers (Below et al., 2012), meaning that farmers' financial capabilities influence the choice of adaptation option.

IFAD (2010) highlights that adaptation alone cannot completely mitigate all the impacts of climate change. Therefore, it is essential to focus on climate change and adaptation measures that support local communities in coping with its effects. Adaptation involves practical approaches to managing climate risks, protecting people, and building resilience among rural farming households in the region (Phuong et al., 2018). According to Smit et al. (1996), adaptation to climate change necessitates making adjustments to practices to reduce vulnerability and enhance the sustainability of economic and social activities. The African Ministerial Conference on Climate-Smart Agriculture, held in Johannesburg in 2011, emphasised the need for adaptation in the face of climate change, recognising that feeding Africa and the world at large presents a significant challenge. It was proposed that global food production must increase by 70% by 2050 to meet the needs of a projected population of over nine billion people (Giller et al., 2021).

Smallholder farmers must overcome several obstacles when deciding whether to adopt. In South Africa, these include insufficient access to credit and inadequate education and training, which have been noted in the literature as decreasing the likelihood of farmers adapting. This, in turn, has a detrimental effect on agricultural productivity and food security in rural areas (Ogundeji, 2022).

According to Ubisi (2016), the lack of support services for disseminating climate information and the high (60%) level of illiteracy among smallholder farmers present additional challenges.

Illiteracy hinders farmers' ability to read and understand climate-related information, such as weather forecasts, and stay informed about their surroundings. A lack of adaptation strategies put the well-being of smallholder farmers at risk as they struggle to cope with climate change impacts. Therefore, support systems are needed to disseminate climate change information and keep farmers updated, enabling them to respond effectively to climatic threats (IFAD, 2010).

Bryant et al. (2000) highlight the importance of how farmers perceive climate change and translate those perceptions into agricultural decisions. As farmers gradually learn about climate change, they also gain knowledge about the best techniques and adaptation options available to them (Maddison, 2007). Maddison identifies three ways in which farmers learn about adaptation options: through learning by doing, learning by copying the practices of others, and learning from instruction. These learning processes play a crucial role in enabling farmers to make informed decisions and implement effective adaptation strategies in agriculture.

As Mmbengwa (2009) emphasises, extension services have an important role to play in assisting farmers to acquire new technology, skills, innovation, and production advice. Maponya and Mpandeli (2012) recommended that the government prioritise extension services because they can significantly increase farmer awareness of changing climatic conditions and adaptation measures in agricultural production. Extension services influence the adaptation measures adopted by smallholder farmers (Ogundeji, 2022).

2.5 CAPACITY BUILDING

2.5.1 Definition

The term capacity is an elusive concept. Frequently, people confuse capacity with capabilities, but according to Hussein (2006), there is a difference between the two. Capability is defined as the knowledge, skills, and attitudes of individuals. On the other hand, the literature describes capacity as both a process and an outcome – dynamic and multidimensional. According to Goodman et al. (1998), capacity is the ability to accomplish stated objectives.

Similarly, Baser and Morgan (2008) define capacity as an organisation's collective skill and ability to achieve a particular process, either inside or outside the organisation. In all the definitions, it is essential to note that capacity exists to perform a specific action or enable performance. Hunt (2005) explains that capacity includes "hard" attributes (e.g., personal skills,

functions, structures, infrastructure, and resources) and "soft" attributes (e.g., motivations and beliefs).

According to Kaplan (2000), capacity building is one of the most frequently discussed concepts and has become central to development. INTRAC (1998) defines capacity building as any activity which increases organisations' abilities to successfully carry out or assist others to improve the lives of people experiencing poverty. Equivalently, Kuhl (2009) explains capacity building as a build-up of capabilities. In addition, Fort (1999) highlights that capacity building is multidimensional and is better described in terms of its components, strategies, dimensions, or interventions.

Capacity building is becoming an increasingly popular activity in many sectors, including natural resource management (agriculture sectors) (Photakoun, 2010). The World Bank (1997) endorses mainstreaming capacity-building activities in all its operations, and capacity building has remained high on its agenda, particularly with the vision of institutional capacity building and developing a partnership framework, which it believes is critical to successful, sound, and equitable development.

Capacity building involves collective behaviour, not simply the individual behaviour of participants. Changes in organisational behaviour may not occur for several years. Furthermore, measuring changes in organisational processes and decision making is problematic. There is a need among extension educators for a new set of simple and systematic evaluation tools that capture the impact that their programming has in producing organisational change.

2.5.2 Capacity building in extension

For agricultural extension, capacity building is defined by Eremi (2006) as the process whereby relevant stakeholders and organisations unleash, strengthen, create, adapt, and maintain capacity over time, usually to ensure sustainable agricultural growth and improve the lives of the stakeholders. According to Boyd (2004), it requires the acquisition of individual skills and institutional capacities and the development of opportunities to put these skills and networks to productive use in the transformation of the agricultural sector. Therefore, there must be proper and continuous training of extension practitioners to promote agricultural development (Androulodakis & Siardos, 1996).

Training involves the process of education and providing individuals/institutions with professional competence. Its end product is the development of innate leadership and managerial ability, intellectual understanding of the subject, the know-how of the management profession, and the ability to apply that understanding to actual management situations (Ekpere & Idowu, 1990). The need for continuous training can be attributed to the competitive change that is occurring in the world and is based on the following:

i. Rapid changes in technologies and jobs people do;
ii. Immediate and long-term skill shortage;
iii. Changes in the expectation and composition of the workforce; and
iv. Competition and market pressure for improvement in quality of products and services (Tamil Nadu Agricultural University [TNAU], 2012).

According to Eremie (2006), capacity building in agricultural extension is necessary at multiple levels. At the individual level, capacity building aims to enhance individuals' ability to identify constraints, resources, and opportunities in agriculture. Non-governmental actors also require capacity building to foster collaboration, ownership, advocacy, participation in policy debates, and negotiation with other stakeholders. At the institutional and policy level, capacity building focuses on participatory development of extension policies and strategies, efficient allocation and monitoring of public investment in extension services, relevant and effective service delivery with equitable rules and norms, networking and collaboration, and engagement with non-public-sector stakeholders.

Capacity building plays a vital role in optimising resource allocation, improving enterprise outcomes for stakeholders, enhancing farmers' access to extension services, and facilitating policy reforms. By strengthening the knowledge, skills, and capabilities of individuals, organisations, and institutions involved in agricultural extension, capacity building contributes to more efficient and effective agricultural development and extension activities. As South Africa moves towards a more decentralised, participatory, and market-driven approach, the extension system will require substantial investment and improvement in upgrading the knowledge, skills, attitude, and aspiration level of field extension personnel (Meena et al., 2010).

Current policies in South Africa do not address the reorientation and reskilling of extension services under complex conditions such as climate change (DAFF, 2011). Hence, there is a great need to keep these services up-to-date with technological advancement, especially in climate adaptation, as they play a catalytic role in adopting agricultural technologies (Adesiji, 2006).

The critical information-seeking pattern and comprehensive experience can be effectively utilised in research and extension activities by organising needs-based and skills-oriented training programmes (Meena et al., 2010). EAS need new capacities considering the evolving challenges in agriculture and the new roles, functions, and reform strategies. EAS should be able to perform a range of innovation management functions (GFRAS, 2012). The FAO corporate strategy on capacity development highlights capacity building at three levels: individuals, organisations, and enabling environment (FAO, 2012). All levels are endorsed by the New Practitioners Learning Kit (NELK) of GFRAS (2012) for capacity development in EAS.

2.5.2.1 The individual level

Capacity building at the individual level is mainly referred to as human resource development (HRD), and it is considered the most crucial element of capacity building (Biswas, 1996). It relates to the knowledge, skills (technical and managerial), and attitudes that can be addressed through facilitation, training, and competency development (FAO, 2012). The capacities required at an individual level include technical skills (practical and related to crop animal and soil science, agricultural economics, agricultural engineering, etc.). Others require functional skills (soft skills and cross-cutting), as they are used and relevant across different fields and sections. These functional skills include communication, facilitation, conflict management, leadership project management, and human relations (GFRAS, 2012).

2.5.2.2 The organisational level

This level relates to any aspect of an organisation's work (Linnell, 2003). It concerns public, private, and civil society organisations and networks of organisations in terms of i) strategic management functions, structures, and relationships; ii) operational capacity (relationships, processes, systems, procedures, sanctions, incentives, and values); iii) human and financial resources (policies, deployment, and performance); iv) knowledge and information resources; and v) infrastructure (GFRAS, 2012).

2.5.2.3 The enabling environment level

The importance of creating an enabling environment is widely endorsed. According to Frank and Smith (1999), without a supportive policy and legislative framework, organisations will not have the capacity to perform effectively, however capable the individuals within it. This level relates to i) political commitment and vision; ii) policy; iii) legal and regulatory and economic frameworks; iv) national public-sector budget allocations and processes; v) governance and power structures; vi) infrastructures; and vii) incentives and social norms.

The Tropical Agricultural Platform (TAP, 2016) has identified five interdependent capacities, also known as the 4+1 capacities, represented in Figure 2.1 below. They are pertinent to all three environmental levels to support capacity development.

i. Capacity to navigate complexity necessitates changing mindsets, attitudes, and behaviours to comprehend the more extensive agricultural innovation system.
ii. Capacity to collaborate calls for internal and external communication techniques and strategies.
iii. Capacity to reflect and learn involves bringing stakeholders together, designing and facilitating processes of critical reflection, and implementing double-loop and triple-loop learning processes, which result in action and change.
iv. Capacity to engage in strategic and political processes encourages questioning the current status quo and is a political act that is intrinsic to capacity development for transformational change.
v. Capacity to adapt and respond to realise the potential of innovation involves moving the emphasis from reactively solving problems to actively co-creating the future.

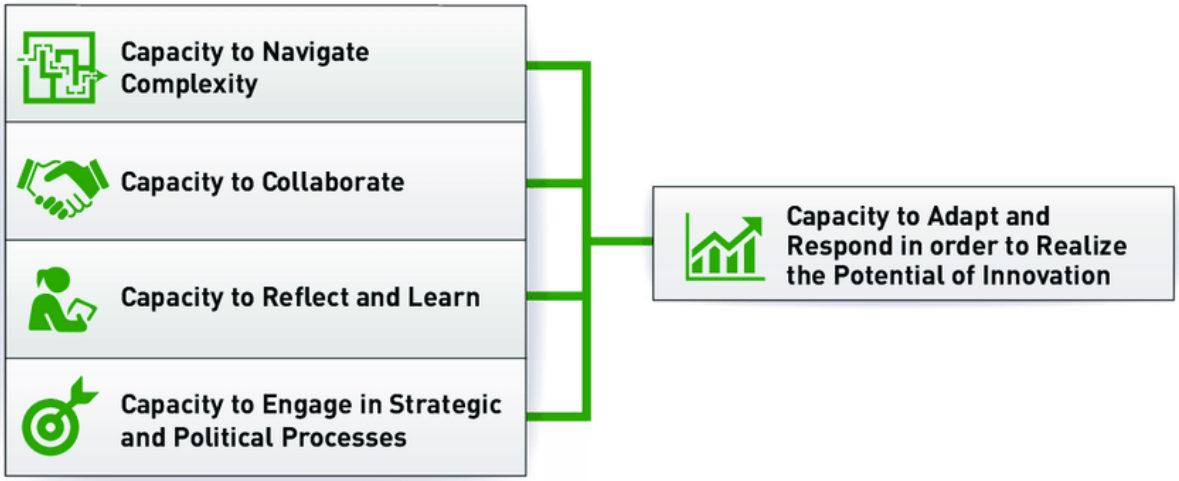


Figure 2.1: The 4+1 capacities as adapted from the Tropical Agricultural Platform
Source: TAP, 2016

2.6 CONCEPTUAL FRAMEWORK

The researcher created a conceptual framework – a visual representation of the essential concepts that anchor the study – using ideas from earlier research and theories related to the main topic. The three primary focus areas can help to improve extension practitioners' capacity to adapt and respond in supporting farmers: (i) increasing individuals' knowledge, proficiency, competence, and self-assurance; (ii) improving the organisation, procedures, and inducements within organisations and businesses; and (iii) creating an environment where actors actively interact, exchange new ideas and expertise, and collaborate (Gildemacher & Wongtschowski, 2015).

At the individual level, this study highlights that the variables age, gender, educational background, years of experience, professional body membership, and training/education all affect the capacity of practitioners to deliver climate change information to farmers successfully. The capacity of practitioners can be increased at an individual level through facilitation, training, and competency development.

At the organisational level, practitioners should be able to set up frameworks to handle institutional, legal, and regulatory challenges. Meaning institutions should encourage collaboration, learning, and processes and procedures to manage human and financial resources. The highlighted variables in the study include physical resources (ICT), organisational support (ICTs, platform), infrastructure, and knowledge and information resources.

Lastly, the institutional level involves political commitment and vision, economic frameworks, national public-sector budget allocations and processes, governance, and power structures. These factors are critical to the performance and capacity of practitioners. For example, a poorly thought-out agricultural policy would provide a hindering environment with severe ramifications for extension programmes that aim to assist farmers in adapting to climate change.

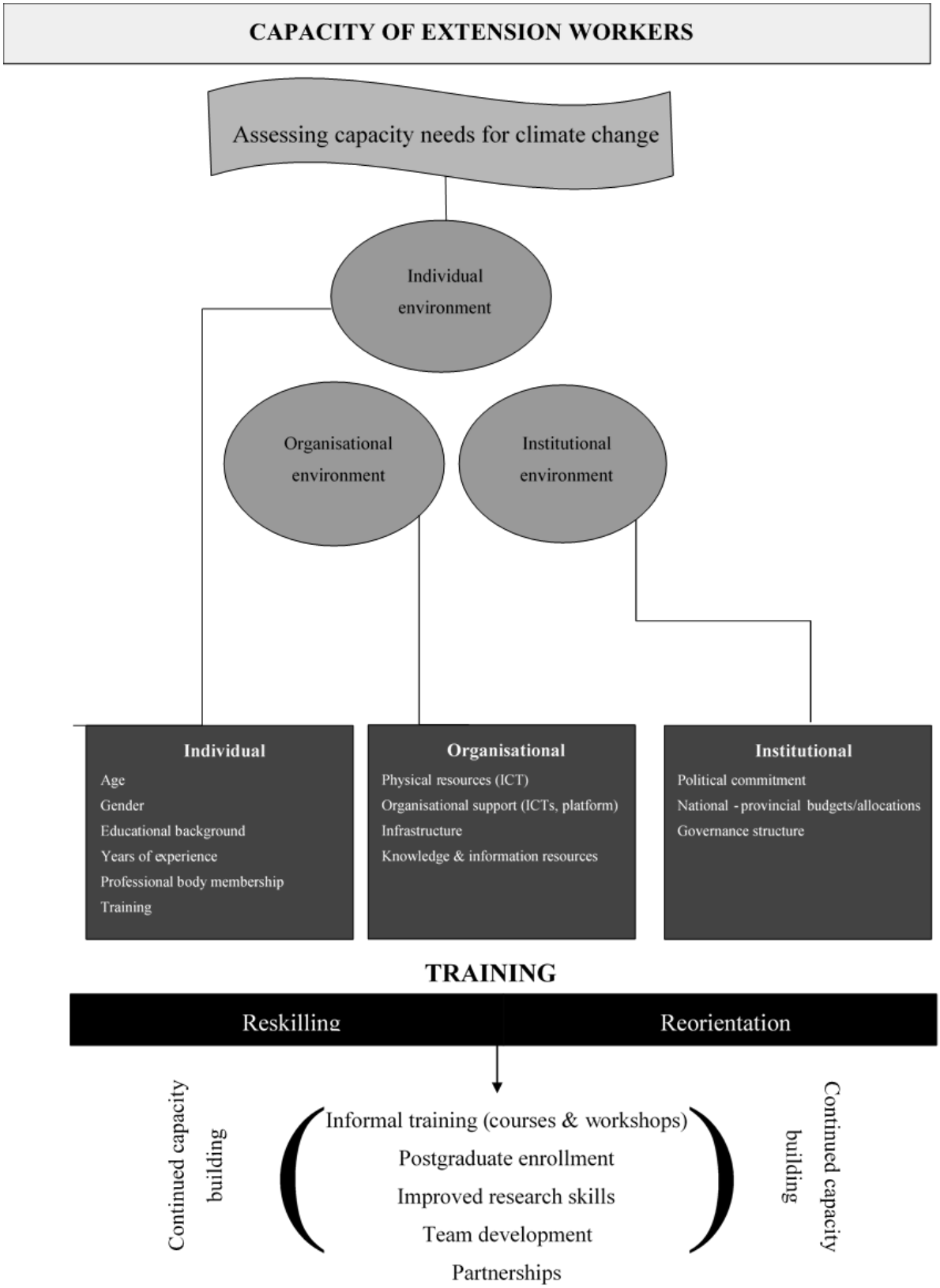


Figure 2.2: Conceptual framework
Source: Researcher, 2023

2.7 SUMMARY OF THE CHAPTER

This chapter reviewed the literature exploring the agriculture and climate change nexus to determine how the competency of agricultural extensionists can assist smallholder farmers to better adapt to climate change. The research reviewed clarifies that the effects of climate change require an adaptive response, especially with smallholder farmers, who are the backbone of the economy and contribute to food security. Based on the literature, it is also clear that agricultural extension plays a crucial role in initiating change because adaptations to climate change impacts require changes in people's knowledge, attitudes, and skills; agricultural extension can bring about this change. The literature also reflects the gaps in the capacities of extension practitioners in supporting farmers adopt to climate change. In addition, a conceptual framework for the study was presented.

CHAPTER 3 :
DESCRIPTION OF STUDY AREAS AND RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the various methods and approaches used to measure the capacity of extension practitioners. It describes the research design used to achieve this study's objectives and the rationale for this choice. The chapter describes in detail the instrument used for data collection. The methods used to analyse the data are comprehensively discussed in this Chapter. Lastly, the ethical issues involved in the research process are also discussed.

3.2 DESCRIPTION OF THE STUDY AREAS

The study was conducted in the Eastern Cape Province (Figure 3.1). The Eastern Cape is the second biggest province in South Africa, estimated at 168,966 square kilometres. The province is dominantly mountainous and forms a relatively narrow coastal plain along the Indian Ocean (Britannica, 2019). This province was established in the Xhosa homelands of the former Transkei and Ciskei in 1994, and it is the third most inhabited region in the country, with a population of 6,996,976, which makes up 12.7% of the total population (Hlomendlini, 2016; Mdoda & Obi, 2019; South African Government, 2018). The province comprises pastoral areas that derive their livelihood through agriculture, tourism, and urban and rural employment. The Eastern Cape is divided into two metropolitan municipalities (Buffalo City Metropolitan Municipality and Nelson Mandela Bay Metropolitan Municipality) and six district municipalities (Alfred Nzo, Amathole, Chris Hani, Joe Gqabi, OR Tambo, and Sarah Baartman), which are further subdivided into 31 local municipalities (South African History Online, 2019).

The climatic conditions described in the study areas, which lie between the sub-tropical climate in KwaZulu-Natal and the Mediterranean climate of the Western Cape Province, create a suitable environment for agricultural production. The province experiences a bimodal precipitation pattern, with winter precipitation occurring in the western region and summer rain in the eastern region.

The unpredictable rainfall seasons in the province lead to variations in growing times, affecting the agricultural calendar. However, the overall climatic conditions in the area are suitable for various types of agricultural activities, including crop cultivation, vegetable farming, citrus orchards, and livestock rearing, particularly cattle and sheep.

The agricultural sector in the province is predominantly comprised of smallholder farmers who rely on farming as their primary source of livelihood. These farmers generate small incomes from their farming activities. Their farming practices are primarily focused on meeting the household's food needs and producing a surplus for the market. Farming plays a crucial role in poverty alleviation and reducing food insecurity at the household level for these smallholder farmers.

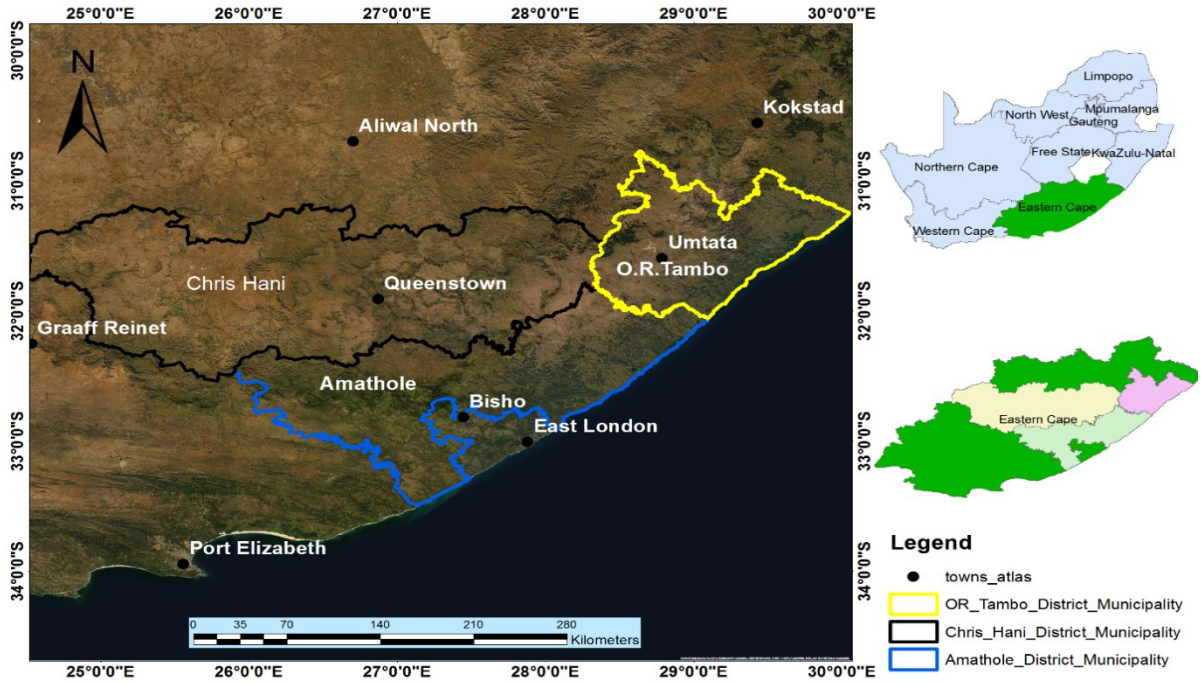


Figure 3.1: Map of the three study areas
Source: Author, 2022

3.2.1 Survey research strategy: Formal survey

A formal survey was chosen as a suitable method to collect standardised information from a selected sample of farmers. The objectives of utilising a formal survey in this study were to verify the hypotheses developed (see Chapter 1) and quantify the parameters critical for understanding the concept of competency of extension and advisory practitioners to assist farmers in adapting to climate change.

3.3 RESEARCH DESIGN

Akhtar (2016) defines research design as a theoretical blueprint of the research study; this means the research design can be described as a plan of action that includes data collection and analysis. The study used a mixed-method design, employing qualitative and quantitative methods to collect data in determining agricultural extensionists' role in building farmers' adaptive capacity to climate change. The mixed-method research design allowed the researcher to corroborate findings generated within the study (Fuentes et al., 2020). Nieswiadomy and Bailey (2018) elaborate that this design provides a broader perspective and is the most appropriate research design to answer the research questions and research problem.

Moreover, the mixed-method research design promotes more accurate inferences, improves validity, and addresses the study's multi-faceted research problem by integrating both paradigms (Doyle et al, 2009). Qualitative research was used to understand the capacity needs of extension practitioners by looking at their first-hand experience to provide meaningful data (Tewksbury, 2009). Quantitative component involved surveys to collect numerical data while the qualitative data were collected through FGDs for more in-depth information from extension practitioners in order to investigate their role in climate adaptation and their capacity needs. The quantitative research method reinforced qualitative findings and compared data gathered from the farmers.

Five strategies can be used in research, including experiments, surveys, archival analyses, history, and case studies (see Table 3.1). The two most popular strategies in social sciences are surveys and case studies. According to Crowe et al. (2011), the case study method enables thorough, in-depth examinations of complicated issues in real-world situations. The case study methodology is highly valued in business, law, and policy. The survey design makes it relatively

simple to implement study protocols, and most researchers naturally prefer to use questionnaire surveys created in the most straightforward possible manner (Odoh & Chinedum, 2014).

Table 3.1: Conditions for selecting an appropriate research strategy

Strategy	Form of a research question	Requires control over behavioural events	Focuses on contemporary events
Experiment	How, why	Yes	Yes
Survey	Who, what, where, how much, how many	No	Yes
Archival analysis	Who, what, where, how much, how many	Yes	Yes
History	How, why	No	No
Case study	How, why	No	Yes

Source: Adapted from Mathers et al., 2007

3.3.1 Sampling procedure

The study areas were three district municipalities – namely, Chris Hani, OR Tambo, and Amathole – in the Eastern Cape Province. The literature reviewed from the surveys and studies done in the Eastern Cape Province (StatsSA, 2016; DAFF etc.) and the author's experience and knowledge were critical in selecting the study areas. The selection considered district municipalities in terms of their active involvement in the agricultural production of both crops and livestock. The study established that the district municipalities experience prolonged and extreme climatic conditions with high climate variability, threatening agricultural production in the province (South African Weather Service [SAWS], 2021).

Following use of the eligibility criteria, a multistage sampling procedure was employed. The first part was choosing the district municipalities based on their active participation in both crop and livestock enterprises. The three district municipalities selected were Chris Hani, Amathole, and OR Tambo Municipalities. The second stage was the selection of three local municipalities within each district with farmers who experienced adverse climatic changes, including loss of crops and livestock due to disasters like drought and poor precipitation. Ten (10) villages were chosen purposively, assisted by records obtained from the district municipality offices in the third stage of the sampling procedure. In the final stage, the participants were randomly selected to get the desired sample size from the list of smallholder farmers registered at the DoA and

extension practitioners working in these areas. A total of 301 respondents, comprised of 126 extension practitioners and 175 smallholder farmers, were included as the study sample.

This resulted from the application of the eligibility criteria in the study, leading to the exclusion of certain participants

3.3.2 Eligibility criteria

The study objective determined the eligibility of the sampled respondents using the inclusion and exclusion methods. The two methods were used to formulate a standard that extension practitioners and farmers had to meet to be included in the study. The criteria were that the respondent must:

i. Have at least 2–10 years of experience as an extension officer or a farmer to give reliable data about weather.
ii. Practice farming as a smallholder farmer producing for marketing purposes or household consumption (in the case of farmers).
iii. Have previous or current engagement with farmers as an extension officer (in the case of extension practitioners).

The sample's eligibility criteria eliminated household and smallholder farmers farming for social status and extension practitioners with less than two years of advisory services.

3.4 METHODS OF DATA COLLECTION

3.4.1 Preparation for data collection

Before collecting data, a preliminary visit to Eastern Cape study areas was done to present the research objectives and questionnaire to the Eastern Cape DRDAR. This stage involved seeking approval from relevant authorities and the institution. Additionally, it encompassed the development and pretesting of research instruments, subsequent restructuring based on feedback from the pretest, and the training of enumerators. This approach was critical in gaining the necessary contacts, support, and information that made the study possible in the Eastern Cape.

3.4.2 Data collection instrument: Structured questionnaire

To collect primary data from respondents, the researcher employed a structured questionnaire. This method was chosen for its ability to select individuals, households, and farmers who then provided self-report responses to a series of questions (Creswell et al., 2014). The study administered two separate questionnaires, one for extension practitioners and another for farmers, and the questionnaire consisted of different sections containing both open-ended and closed-ended pre-coded questions. Each team involved in the study successfully achieved its objectives.

The data was collected at one point using semi-structured questionnaires and a structured interview guide for FGDs. This approach was used because it allowed the researcher to measure the outcome and the study participants' exposures simultaneously. The Eastern Cape DRDAR Head of Department and directors informed the extension practitioners from the three district municipalities about the study.

The interviews took place either at the farmers' residences or during their gatherings and workshops. Likewise, for extension practitioners, the interviews occurred at their workplaces or during their workshops and meetings.

In instances where participants were absent or unwilling to participate, efforts were made to reschedule interviews or engage in follow-up communication to address any concerns or obstacles to participation. Additional households were considered as replacements if the selected household remained unwilling to take part in the study.

The questionnaire was originally written in English. However, to accommodate respondents who were not proficient in English, enumerators interpreted the questions into isiXhosa during the interviews. Enumerators received training to ensure accurate data collection while interpreting the questions. Interviews with participants took place either inside or outside their homes and farms, depending on the desired level of privacy.

3.4.3 Focus group discussions (FGDs)

The objective of the FGDs was to gain a deeper understanding of the awareness and level of understanding of extension practitioners related to climate change, together with farmers' perceptions of the competencies of extension practitioners regarding climate change. In the FGDs, the researcher utilized the Participatory Ranking Technique (PRM). This approach fosters a participatory and dynamic process by involving local knowledge and perspectives. During the discussions, participants were encouraged to identify, support, or reject what they

considered most important. The PRM method allowed for peer-to-peer discussions on relevant topics, facilitating the sharing of ideas and solutions, as well as identifying obstacles to existing or potential initiatives (Potts & Kastelle, 2010). By incorporating the PRM, the FGDs provided a valuable space for inclusive and collaborative decision-making within the research process

3.4.4 Reliability and validity

The questionnaire was pre-tested on 15 farmers practising mixed farming and 10 extension practitioners in KwaZulu-Natal Province, and these results were excluded from the overall study data to ensure the validity of the data collection tool. How farmers and extension practitioners answered during pre-testing revealed consistency in responses. Lediga (2020) and Maponya (2013) investigated the impact of climate change on agriculture production and found similar results regarding the reliability and validity of the research instrument. The pre-test and consistency in responses contribute to the reliability of the questionnaire, suggesting that it produces consistent results over time. Exclusion of pre-test data, consistency in responses, and alignment with findings from related studies contribute to the validity of the questionnaire, suggesting that it measures what it intends to measure

3.5 CHOICE OF ANALYTICAL MODEL AND VARIABLES USED

An analytical model is mainly focused on quantitative analysis and utilises mathematical equations to depict the system. These equations establish relationships between parameters and variables, taking into account factors like time, space, and other relevant system parameters (Gujarati, 1992). The primary purpose of an analytical model is to understand the underlying phenomena and make predictions or evaluations regarding the system's performance and other characteristics. Different analytical models can provide insights into various aspects of the system and its environment, including performance, reliability, and perceptions (McFadden, 1978).

3.5.1 Results chapter outline

Various techniques were employed to produce empirical results to address the research questions.

3.5.1.1 Objective 1

The first objective determines the awareness and level of understanding of extension practitioners related to climate change. The results in this chapter were analysed using descriptive statistics, qualitative data were coded thematically using content analysis, and a Pearson's Chi-square ($\chi 2$) test of independence was used to assess the extension practitioners and their level of awareness and understanding of climate change.

3.5.1.2 Objective 2

The second objective assesses farmers' perceptions of the competencies of extension practitioners' related to climate change. Factors influencing these perceptions were analysed using content analysis, and the binary logistic model was used to investigate factors influencing these perceptions.

3.5.1.3 Objective 3

The third objective evaluates the capacity needs of extension practitioners from their own perspective. Data in this chapter were analysed using descriptive statistics and coded thematically using content analysis to examine the perceived capacity needs of extension practitioners and the inclusion of the climate change concept in their scope.

3.5.1.4 Objective 4

The fourth objective evaluates the channels extension and advisory practitioners use to deliver services to farmers. Factors influencing the use of these channels were analysed using a Pearson's Chi-square ($\chi 2$) test of independence with $\alpha = 0.005$ as a criterion for significance and the multinomial regression method.

3.6 ETHICAL CONSIDERATIONS

Ethical considerations were observed throughout the data and research process to protect the rights of the participants. According to De Vos et al. (2015), research ethics are a set of attitudes

from the researcher that guarantees some regard for the privacy, rights, integrity, and confidentiality of those participating in the research. They are moral principles that offer rules and behavioural expectations about the proper conduct towards participants, organisations, sponsors, etc. Richards and Schwartz (2002) explain that a researcher must adhere to ethics like informed consent and confidentiality when collecting data. The informed consent was prepared, written in English, and translated into isiXhosa for those participants who did not understand English. This allowed respondents to decide whether they wanted to be part of the study; those who agreed completedand signed the consent form. All the data for this study were collected using a questionnaire and FGDs. The privacy and confidentiality of the answers provided by respondents via these two methods are protected, for online copies data is stored in a personal computer which requires password authentication to restrict access, and the physical copies of the questionnaires are stored in a lockable office. An application for ethical clearance was made to the University of the Free State Ethical Committee as well as the Eastern Cape DRDAR to use extension practitioners and managers in the research before data collection (see Appendix A). The study was granted permission to conduct research in the province among extension practitioners and farmers (Appendix B and Appendix C).

3.7 SUMMARY

This chapter provided an overview of the research process, including what was done, the methodology employed, its purpose, and the specifics of how it was carried out. It highlights the study areas and the selection criteria. It further discusses the data collection and analysis. It is worth noting that the research methodologies used were designed to offer an understanding of and reflection on the capacity needs of extension practitioners. The subsequent chapters, presented as articles, focus on the on-data presentation and analysis responding to the objectives produced throughout the data-gathering period.

CHAPTER 4 :
CLIMATE CHANGE AWARENESS AND LEVEL OF UNDERSTANDING OF EXTENSION PRACTITIONERS IN EASTERN CAPE

4.1 INTRODUCTION

In the climate change scope, the roles of extension services include disseminating climate-related knowledge and promoting sustainable agricultural practices among farmers (Adetayo et al., 2023), furthermore they provide institutional support, technical knowledge of climate-smart practices, and facilitating farmers' needs to support agricultural production (Nnadi et al., 2013). According to Igodan (1996), they continue to ensure that farmers' practices align with the variations and changes in climatic conditions while enhancing the efficiency of making adoption decisions. Zikhali et al. (2020) note that this is accomplished by fostering access to knowledge and technologies, improving agricultural practices and skills, having the ability to innovate, and providing different rural development solutions through training programmes. A study by Donkor et al. (2016) highlights that farmers' access to extension services considerably increases the use of chemical fertilisers, demonstrating the crucial significance of agricultural extension in fostering soil development technology. This means that, in order to solve numerous issues in rural development and improve rural farmers' skills, farmers need access to extension services (Birner et al., 2009; Zakaria et al., 2013).

It is also known that farmers' decisions to alter their farming operations in response to climate change may be influenced by extension services (Abegaz & Wims, 2015). Scholes and Engelbrecht (2021) note that the excessive reliance on rain-fed agriculture, production on marginal soils, and governance-related issues leave smallholder farmers highly susceptible to climate change, leading to poor farm returns, decreased livelihood, and loss of household welfare. Therefore, access to climate information may increase the likelihood of embracing adaptation techniques.

However, concerns have been raised regarding the level of climate change awareness and understanding among extension practitioners, particularly in developing countries (Njeru, 2022). According to research, numerous front-line extension employees in Africa lack the knowledge, resources, abilities, and attitudes necessary to perform their jobs effectively

(Lindley, 2000). A study by Olorunfemi et al. (2020) in Nigeria highlighted that the extension practitioners in the area were not fully competent in climate change information and initiatives, emphasising how important it is for practitioners to have the knowledge and information required to give advisory services that can successfully provide alternatives and spark behavioural change. Similarly, in Nigeria, Ohara et al., (2023) identified a lack of capacity for disseminating climate information, particularly in producing and airing messages Simpson and Burpee (2014) also affirm that programming preparation will be necessary for practitioners to assist farmers in implementing a series of adaptive responses to new climate change problems. One of the most severe institutional issues for agricultural growth is bridging the gap between researchers, extension personnel, and farmers. Therefore, a practical extension service should be able to disseminate knowledge about new and improved technologies that address specific issues from research institutions to farmers and back to researchers and decision-makers (Bonye et al., 2012). This can help ensure agricultural systems are more productive, sustainable, and resilient, benefiting farmers and the society (World Bank, 2015).

To further justify the study, the idea of planned behaviour is considered, which contends that attitude, intention, perceived social standards, and social control all play a role in shaping how people behave. This theory results from the interaction between self-efficacy and reasoned action theories. Knowledge and awareness play a significant role in behaviour prediction because it affects sentiments of accomplishment (Ajzen, 2011). A critical assumption underlying this study is that assessing the awareness levels of practitioners regarding climate change would provide important insight into predicting whether or not they are effective in programmes that address climate change issues.

There are still considerable knowledge gaps regarding the level of awareness of practitioners related to climate change adaptation. Without conducting an empirical analysis to determine how agricultural extension practitioners could be more effective in minimising the impact of climate change on smallholder farmers, the focus has been primarily on helping farmers adjust. This paper thus aimed to evaluate the extension practitioners' level of knowledge and awareness to effectively provide climate change information to farmers in the Eastern Cape.

4.2 MATERIAL AND METHODS

The study was conducted in 3 district municipalities of the Eastern Cape Province of South Africa namely Chris Hani, OR Tambo, and Amathole as explained in Chapter 3. Data were collected using a mixed-methods approach consisting of structured questionnaires and FGDs to

gather information on agricultural extension practitioners' awareness and knowledge levels. The questionnaires entailed both open- and closed-ended questions. Open-ended questions were included in the survey to allow participants to share their unique perspectives on their understanding of climate change. In contrast, close-ended questions provided a specific range of answers for participants to select. FGDs were used to further explore practitioners' knowledge, sources of information, and whether they received any formal or informal training on climate change. The FGDs, conducted between 13 July 2022 and 30 August 2022, had 25 participants in the Chris Hani District, 42 in the Amathole District, and 32 in the OR Tambo District. FGDs were conducted once in each district, with participants organised into three groups in each session to enhance engagement. Participant selection was based on the availability of extension practitioners during their workshops or seminars

Random sampling was used to select 126 extension practitioners from across the three districts in the Eastern Cape Province. Content analysis was used to code and evaluate qualitative data from the FGDs to identify the main themes that emerged from the talks. It included transcription of the discussion and highlighting recurring themes in the responses. In some cases, answers provided in the open-ended questions were also reported verbatim. According to McNiff (2016), content analysis identifies critical ideas and topics for discussion, identifies differences and similarities across responses, and integrates themes and concepts to assist the researcher in making sense of the data gathered from respondents. The SPSS tool was used to analyse quantitative data from the questionnaire surveys (frequency counts and percentages). All the closed-ended data provided in this article were organised in frequency tables and graphs.

A Pearson's Chi-square ($\chi 2$) test of independence was also used to assess the relationship between extension practitioners and their level of awareness and understanding of climate change.

4.3 RESULTS AND DISCUSSION

This section presents results from the first objective of the study, which looks into climate change awareness and understanding of practitioners. The section is divided into two parts namely demographic characteristics of respondents and climate change awareness among practitioners.

4.3.1 Demographic characteristics of respondents

The demographic characteristics of the respondents are presented in Table 4.1. Most (34%) of the respondents had an honours degree (NQF Level 7) as their highest educational qualification, 23% had a bachelor's degree (NQF Level 6), 24% had a master's degree (NQF Level 8), and the remaining 19% had a diploma (NQF Level 5). These results corresponded with a report by DALRRD (2021), in which it is reported that 77% of practitioners have at least a four-year degree in agriculture.

Table 4.1: Extension practitioners' demographic characteristics

Variable	Frequency (n)	Percentage (%)*
Sex:		
Male	69	56.6
Female	53	43.4
Racial group:		
African/Black	116	92.1
Non-Black	4	4.84
Highest level of education:		
Diploma (NQF 5)	22	17.5
Degree (NQF 6)	26	20.6
Honours (NQF 7)	39	31.0
Masters (NQF 8)	27	21.4
Service experience:		
Less than 5 years	28	22.2
Between 5 years and 10 years	19	15.1
Between 10 years and 20 years	52	41.3
More than 20 years	20	15.9

**Note: Not all respondents answered every question, thus percentages do not always total 100%*

Source: Field Survey, 2022

As shown in Table 4.1, the results indicate that the greatest proportion (41.3%) of extension practitioners had working experience of between 10 to 20 years, 22% had less than 5 years of

experience, 15.9% had more than 20 years of experience, and 15.1% of the respondents had between 5–10 years' experience. A study by Oladele and Mabe (2010) found similar results, showing that the average length of employment for practitioners in the North West Province was 14 years. In Iran, the average was 12–17 years of work experience (Hosseini et al., 2009). This shows that work experience in the study areas is comparable to that found elsewhere.

Table 4.2. below presents statistics regarding the age of the respondents.

Table 4.2: Age of respondents

Frequency (n)	Minimum	Maximum	Mean	Std Deviation
126	24	64	41.48	9.927

Source: Field Survey, 2022

The average age of interviewed practitioners in the study areas was 41, ranging from 24 to 64 years. This is consistent with Oladele's (2015) findings, according to which the North West Province of South Africa's extension practitioners were, on average, 44.6 years old. It indicates that most of the respondents were in their middle years. This trend may have significant implications for the awareness and knowledge of extension practitioners. This age group is thought to be enthusiastic and eager to learn more about research and development issues, according to Lukhalo (2017). In comparison, older practitioners are expected to be less interested in exploring many options and would prefer conventional methods; however, based on their experience, more senior practitioners are considered to have more awareness and knowledge of climate change.

Results from the study show that a total of 81 respondents indicated that they were affiliated with a professional body. Examples of these include the SASAE, the Agricultural Economics Association of South Africa (AEASA), the SACNASP, the South African Veterinary Council (SAVC), etc. According to Davis and Terblanché (2016), agricultural advisers should be registered with a recognised professional organisation. This is to encourage trained, committed, and motivated employees with expertise in agricultural production, practical extension, and communication strategies. The association of professional bodies will also expose practitioners to several effective and efficient channels and sources of information.

4.3.2 Climate change awareness among extension practitioners

The respondents were asked to describe climate change using their own words. Based on the FGDs and practitioners' responses, they were assertive in defining and representing it based on their experience.

One of the practitioners noted that

"climate change is abnormal behaviour in the weather pattern over time. The phenomenon has created a lot of confusion among us as practitioners because, based on our observation, we do not experience heat or rainfall as expected" (Female Agricultural Adviser, FGD, Amathole District, July 2022).

The recurring theme in their definition was the change in weather patterns. Based on their description, Table 4.3 shows how the practitioners rank their understanding/knowledge of climate change. It illustrates the distribution of respondents based on their understanding of climate change.

Table 4.3: Understanding/knowledge of climate change

Variable	Frequency (n)	Percentage (%)
Excellent	7	5.8
Good	52	43.3
Average	52	45
Poor	7	5.6

Source: Field Survey, 2022

The findings indicate that most respondents had a good or average understanding of climate change (43.3% and 45%, respectively), 5.8% had excellent knowledge, and 5.6% had little understanding. The respondents' average to good knowledge of climate change suggests they have gradually gained the knowledge and awareness to understand its origins, impacts, and adaptation strategies. Ogunlade et al. (2014) noted that practitioners with knowledge of climate change would significantly enhance their competency abilities in the delivery of extension services, particularly in promoting awareness and providing suitable approaches for mitigating the impact of climate change. Before giving or creating programmes for their clients, it is suggested that practitioners should become more knowledgeable about climate change, which

is also in line with Hersman's (2004) findings, according to which the amount of information that extension practitioners supply to their clients depends on their level of expertise.

The practitioners were further asked to elaborate more on the visible effects of climate change they have noted from the farmers in the region, as illustrated in Figure 4.1.

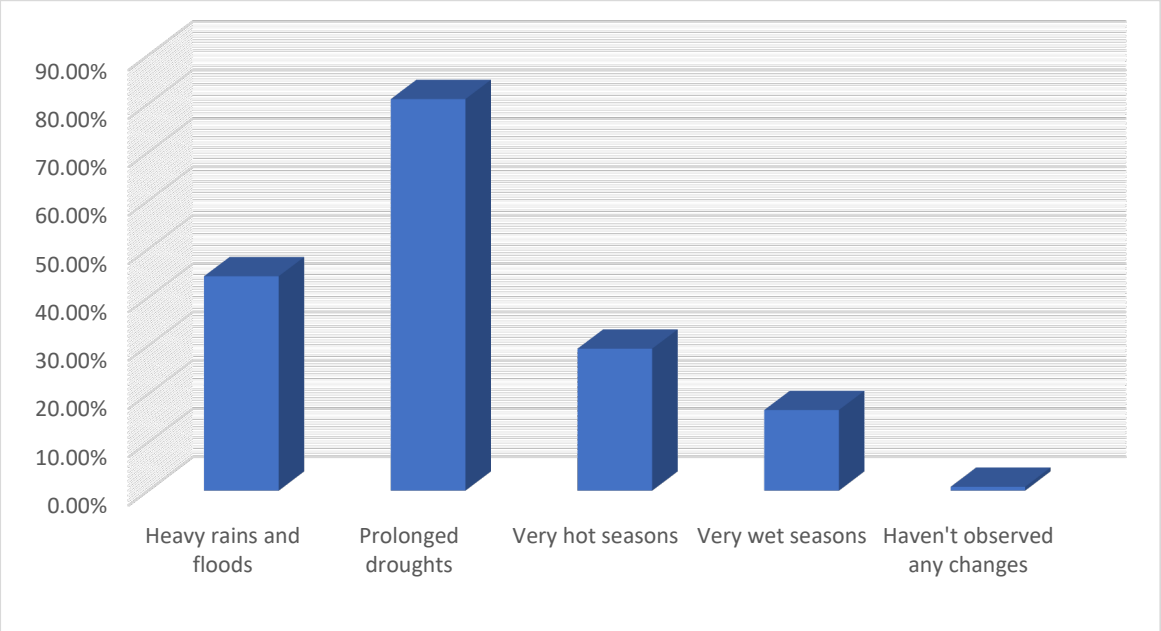


Figure 4.1: Major changes observed by extension practitioners
Source: Field Survey, 2022

Most respondents pointed out that prolonged drought was the most visible effect. The drought has had a significant impact on the region. A study by Mahlalela et al. (2020) confirmed that since 2015, a large portion of the Eastern Cape Province has been suffering from a severe drought. It has had significant socio-economic repercussions, particularly for the sizeable rural population living in poverty and for some areas where water supply services have frequently failed. In the FGD, the practitioners highlighted heavy rains and flooding as another noticeable change observed since 2019 in the region. According to South Africa's National Disaster Management Centre (NDMC) (South Africa, 2022), the heavy rains resulted in casualties, damage, many people displaced, and damage to agricultural production, resulting in the NDMC classifying the damage as a national disaster to respond to widespread flooding.

The respondents felt helpless because what they knew about seasons was not the case anymore. They report that they are clueless about what to advise the farmers, especially after they lost

their yields in the 2021/22 season. The climate changes noted by the practitioners have led to the study areas experiencing negative incidents, as presented in Figure 4.2.

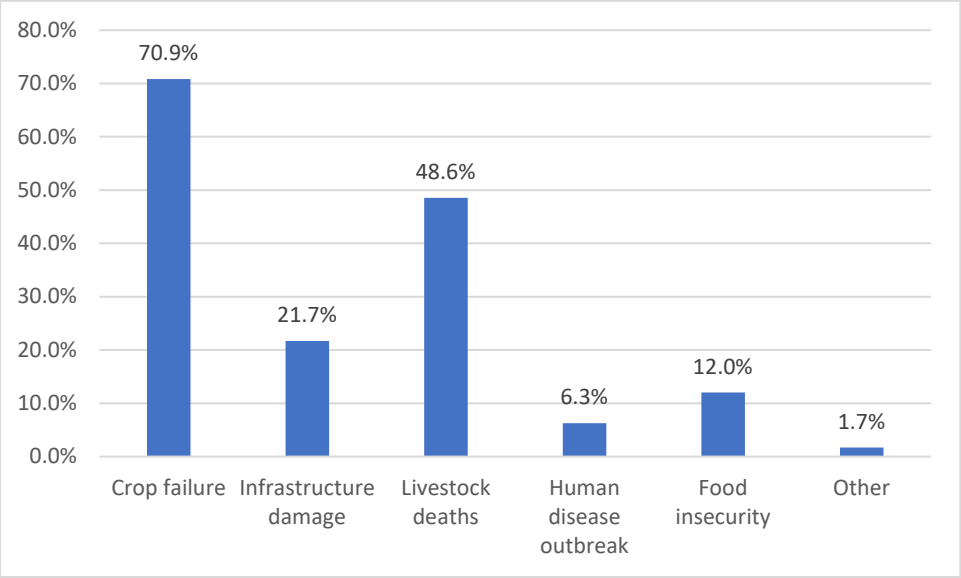


Figure 4.2: Negative incidents related to climate change experienced in the last 5-10 years
Source: Field Survey, 2022

Practitioners emphasised that farmers have mostly experienced crop failure (71%), livestock deaths (49%), damage to infrastructure (22%), and food insecurity (12%). These incidents have had significant impacts on agricultural production, which include (i) increased socio-economic problems, (ii) reduced income, (iii) increased unemployment, and (iv) reduced cultivated lands. Due to these effects, practitioners in the region continue to promote strategic adaptations like (i) CSA, (ii) conservation agriculture, (iii) and general climate change awareness.

4.3.3 Climate change training and policy awareness among extension practitioners

According to the field survey, many respondents (80.2%) have never received formal or informal climate change training. About 16% received climate change education, mainly from workshops. The results concur with a study done in Limpopo, South Africa. Zikhali et al. (2020) noted that slow mainstreaming and incorporation of climate change information is the cause of the climate information gap in extension.

The South African government has developed several policies to comprehend, recognise, and mitigate the effects of climate change on the economy (WWF, 2016). According to Blinder and Krueger (2004), governments use policy to achieve specific outcomes; extension practitioners

must be aware of adaptation policies to increase their awareness of climate change and comprehend the mandate required to assist farmers effectively. The national and local government institutions in South Africa (provincial, district, and local municipalities) know the need for adaptation action, and climate change adaptation policies have been formulated. It is critical to ensure that policies, strategies, and action plans are evidence-based, coordinated, and comprehensive. In that way, they can be easily accessible to practitioners and user-friendly. Practitioners were asked if they were familiar with any climate adaptation policies in South Africa and the Eastern Cape. The results indicate that 41.3% of the practitioners were aware of policies that address climate change in the province and country, respectively. Table 4.4 illustrates the specific policies mentioned and by how many practitioners.

Table 4.4: Extension practitioner's awareness of Climate change policies in the Eastern Cape and South Africa

Variable	Frequency (n)	Percentage (%)
National Climate Change Response White Paper (NCCRWP)	18	34.6
National Development Plan (NDP)	12	23.1
Climate Change Sector Plan for Agriculture, Forestry and Fisheries (CCSPAFF)	6	11.5
National Climate-Smart Agriculture Strategic Framework 2018	8	15.4
Climate Change Adaptation Action Plan for the Eastern Cape Province 2017	6	11.5

Source: Field Survey, 2022

Practitioners were then asked to select from a list of possible information sources that they use for climate change and adaptation to increase their knowledge and awareness of climate. These are presented in Figure 4.3.

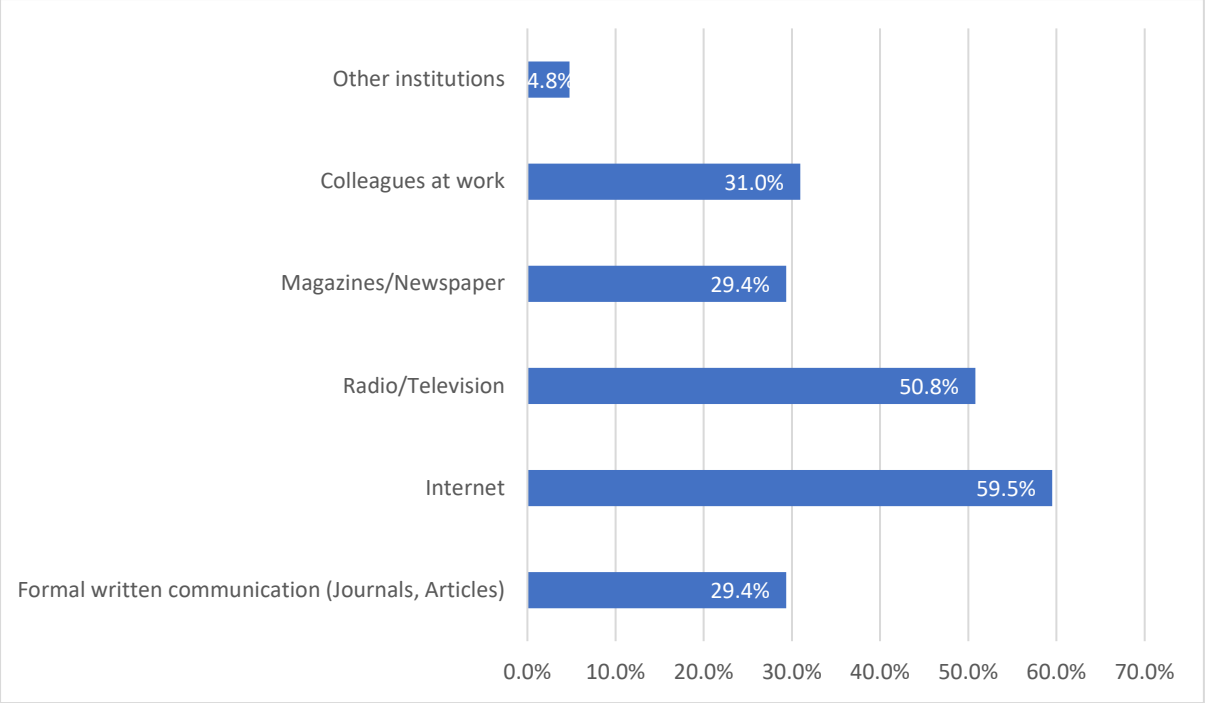


Figure 4.3: Information Source for awareness and knowledge
Source: Field Survey, 2022

Figure 4.3 shows that the internet was the most frequently mentioned source of information (59.5%), followed by radio and television (50.8%). Magazines and newspapers were cited by 29.4% of the respondents, formal written communication (scientific reports, articles, and journals) by 29.4%, and colleagues by 31% of the respondents. The analysis also showed that the majority (78%) use the South African Weather Services (SAWS) as a climate service.

Furthermore, a chi-square association test was conducted between extension practitioners' self-ranked climate change understanding and their adaptation policy familiarity and between their self-ranked climate change understanding and formal climate change education. All expected cell frequencies were more significant than five. Although more extension practitioners that were familiar with adaptation policies had an above-average understanding of climate change (self-rated) compared to those who were not familiar with adaptation policies, there was no statistically significant association, $\chi 2(1)=3,465$, $p > 0,05$. However, there was a statistically significant association between extension officers' self-rated understanding of climate change and their formal climate change education, $\chi 2(1)=6,016$, $p < 0,05$, with a small to moderate effect size, $\varphi = 0,235$. A total of 26% of extension practitioners with a formal climate change education had a self-rated climate change understanding of above average, compared to 7% whose self-rated climate change understanding of climate change was average.

These results show that familiarity with adaptation policies is not associated with self-rated climate change understanding. However, formal climate change education, typically obtained in a postgraduate degree, was associated with a self-rated climate change understanding of above average. According to Blumberga and Klavins (2010), the nature of postgraduate degrees develops “subject matter specialists” who are well-versed in modules firmly centred on climate education. In addition, Zikhali et al. (2020) highlighted that increased self-assurance comes from having more education and feeling secure in the training you received. The results are consistent with Alainati et al. (2010), who contend that education and training have a direct and advantageous relationship to on-the-job competency.

4.4 CONCLUSION

Most practitioners are aware of climate change, and there was a consensus about the impacts of climate change on the agricultural sector, the changes in weather patterns, and the frequency of extreme events. However, there are considerable knowledge gaps about climate change and adaptation due to the sources of information and informal and formal training on climate change that practitioners have. The findings further show considerable evidence of the lack of capacity-building initiatives, mainstreaming climate change education curricula, access to and knowledge of policies, and access to appropriate resources. The majority of the respondents (80.2%) never received formal or informal climate change training, and most were aware of policies that address climate change in the province and country.

Extension practitioners with a formal climate change education had a self-rated climate change understanding of above average, compared to those whose self-rated climate change understanding was average, meaning that formal climate change education was associated with a self-rated climate change understanding of above average.

The research findings underscore the importance of prioritizing climate change and adaptation in the extension system. It is essential to develop a robust strategy to address these critical areas effectively. To achieve this, there is a need to enhance practitioners' access to pertinent and up-to-date scientific resources and formal climate change education. To ensure successful implementation, future capacity-building efforts should be well-coordinated and targeted, aiming to increase awareness and knowledge levels of climate change and adaptation among practitioners. By taking these steps, the agricultural sector can better equip

itself to navigate the challenges posed by climate change and enhance its resilience for the future.

CHAPTER 5 :
FARMERS' PERCEPTIONS OF THE CAPACITY OF EXTENSION PRACTITIONERS RELATED TO CLIMATE CHANGE

5.1 INTRODUCTION

Agricultural extension is the primary delivery system for information to farmers in South Africa (Stevens & Van Heerden, 2016). It has been shown to improve farmers' agricultural knowledge and skills, disseminate new technology, and change farmers' attitudes (Khan et al., 2012). A study by Danso-Abbeam et al. (2018) in Ghana showed that farmers participating in agricultural extension programmes had increased income and enhanced welfare.

Despite the bureaucratic changes aimed at transforming the agricultural extension sector into a vibrant provider of services to all farmers, the literature suggests that the industry has regressed. According to the National Policy for Extension and Advisory Services (DAFF, 2014), EAS face several challenges in relevance, efficiency, accountability, and sustainability; this happens while the country faces socio-economic issues such as poverty, malnutrition, and food insecurity. Some scholars (DAFF, 2014; Worth, 2012; Zwane, 2016) contend that the sector is lagging, and smallholder farmers' agricultural production, income, and technology adoption are not improving (Ngemntu, 2010; Sikwela, 2013). In addition, Ajala et al. (2013) and Suleiman et al. (2021) stated that another challenge that the agricultural extension service must deal with is the high rate of illiteracy among farmers, which makes it difficult for them to understand all the concepts communicated to them and put them into practice. Also, most farmers are conservative and not always open to change.

According to Makara (2010), based on his study in Zanyokwe, extension practitioners have limited technical knowledge and tend to deliver messages that align with their agenda rather than addressing the specific needs and circumstances of farmers. Liebenberg (2015) argues that the ineffectiveness of extension services is not solely attributed to a shortage of field practitioners, but rather to the relatively low quality of their formal education and the lack of job-specific non-formal training to complement their diploma education. Additionally, factors such as lack of motivation, limited mobility, inadequate management and supervision, insufficient support, ineffective operational policies and strategies, and a poor image contribute to the problem (Makara, 2010; Van Niekerk et al., 2011). Worth (2012) further emphasises that

the absence of subject matter specialists affects the training provided, the suitability of technological packages, and effective three-way communication. The extension-officer-to-farmer ratio was reported to be very high according to Williams et al. (2008), which is one of the continued challenges facing agricultural extension services in South Africa. Research by Liebenberg (2015) shows that the DAFF has committed to ensuring enough EAS personnel on the ground to comply with the recommended extension-to-farmer ratios. The National Policy on Extension and Advisory Services in Agriculture, Forestry, and Fisheries from the DALRRD (2021) highlights that the current suggested practitioner-to-farmer ratio for subsistence and smallholder farmers is as follows: 1:400 in crop farming, 1:500 in livestock, and 1:500 in mixed agriculture.

Given the importance of the capacity of extension practitioners to improve farmer behaviour to create independent and empowered farmers (Abdullah et al., 2017), technical climate change knowledge is equally essential. A study by Mustapha et al. (2012) mentioned three ways that extension practitioners could help in supporting adaptation to climate change: (i) facilitating and implementing policies and programmes, (ii) providing information and guiding management of new methods of farming, and (iii) developing capacity. These are explored in greater depth below.

i. Facilitating and implementing policies

Extension practitioners can help disseminate climate change policy and programme information to farmers and other stakeholders (Prokopy et al., 2015). According to Davis et al. (2009), they have the ability to articulate the goals and objectives of these policies and programs, as well as the advantages of implementing them.

ii. Providing information and guiding management of new methods of farming

According to Mustapha et al. (2012), extension practitioners can train farmers to use technologies and management strategies suited to their local environments, such as utilising local cultivars of drought-resistant crop varieties. Moreover, extension agents can educate farmers on crop management practices like intercropping, sequential cropping, and no-till agriculture, which collectively enhance resilience to which all improve resistance to climate change (Davis et al., 2009).

iii. Developing capacity

USAID (2018) emphasises that extension is critical in capacity building by offering individuals and organisations technical support, education, and training to develop the abilities, knowledge,

and competencies required for sustainable development and enhancing farmer livelihoods. For the most part, extension agents lack "soft" skills like communication, farmer group building, systems thinking, knowledge management, and networking because they have historically solely received technical training (Davis et al., 2009).

For agricultural extension practitioners to help smallholders to manage and adapt to climate change effectively, it is vital to understand the capacity of the agricultural extension practitioner to fulfil this critical mandate. The capacity of extension practitioners can be seen from the quality of counselling they give to farmers (Herawati et al., 2019).

It is equally vital to understand farmers' perceptions of the services they receive from extension practitioners in climate adaptation. Perception is identifying and construing the environment and the implication of sensual motivations. Perception can happen subliminally without conscious awareness (AlGhamdi et al., 2014), meaning perceptions are interpretations; for most individuals, interpretations become their truth. Thus, perceptions are extremely powerful and essential to understanding and establishing if extension practitioners are effective and efficient when doing their job in climate adaptation according to the farmers they serve. Therefore, this study aims to investigate smallholder farmers' perceptions of the extension service practitioners' competency related to climate change. This was done by identifying farmers' views of extension practitioners' performance and determining the degree of awareness regarding climate change.

5.2 MATERIAL AND METHODS

5.5.1 Study areas and data collection

The study areas are described in Chapter 3. Data in this chapter were analysed using content analysis and a binary logistic regression model.

Data were collected in three districts in the Eastern Cape, namely Chris Hani, OR Tambo, and Amathole, using qualitative and quantitative approaches of structured questionnaires and FGDs to gather information on farmers' perceptions of the competency of agricultural extension agents related to climate change. The questionnaires entailed both open- and closed-ended questions. Open-ended questions were included in the survey to allow participants to share their perceptions of climate services in the study areas. In contrast, close-ended questions provided a predefined choice of answers for participants to select. FGDs were used to explore further the

perceptions of farmers. The FGDs had 30 participants in the Chris Hani district, 54 in the Amathole District, and 25 in the OR Tambo District between 13 July 2022 and 30 August 2022.

A total of 175 farmers were selected across the three districts in the Eastern Cape Province using random sampling. Content/thematic analysis was used to code and evaluate qualitative data from the FGDs to identify the main themes that emerged from the discussions. It included transcription and highlighting recurring themes in the responses. In some cases, answers provided in the open-ended questions were also reported verbatim. According to McNiff (2016), content analysis identifies critical ideas and topics for discussion, identifies differences and similarities across responses, and integrates themes and ideas to assist the researcher in making sense of the data gathered from respondents. Descriptive statistics was used to analyse quantitative data from the questionnaire surveys (frequency counts and percentages).

All the closed-ended data provided in this chapter were organised in frequency tables and graphs. A binary logistic model was also used to estimate determinants of smallholder farmers' perceptions.

5.5.2 Content analysis

To comprehend the written and spoken communication of the respondents unobtrusively, the researcher used content analysis. This methodology allowed the researcher to generate conclusions that could be generalised to other situations (Neuendorf, 2002). The competence relative to climate change was divided into the following themes: knowledge about climate change, climate change interventions and their impact, and the channels used to deliver extension services. The main goal was to uncover concepts and relationships that would aid in interpreting the data collected and support quantitative data. The data was then conceptualised for the objectives of the study and grouped logically into themes (Yıldırım & Şimşek, 2006). Therefore, the intended classification and construction of the common aspects through generalisation quantification was achieved (Gökçe, 2006).

5.5.3 Empirical model

In this study, the logit model was chosen to analyze the determinants of smallholder farmers' perceptions in the Eastern Cape Province. The binary logistic model is well-suited for situations

where the outcome variable is dichotomous, with values of 1 or 0, representing two choices. In this case, the outcomes were "competence of extension practitioners" (1) and "incompetence of extension practitioners" (0).

The logit model was preferred over other methods like Probit regression because it is more straightforward and flexible in interpreting results for dichotomous outcomes. It allows for the estimation of variables influencing farmers' perceptions of extension practitioners' competence about climate change.

The dependent variable, "competence of extension practitioners," was regressed against explanatory variables, including socio-economic factors. The binary logistic model can accommodate two categories in the dependent variable and address issues like heteroscedasticity and the assumption of a cumulative normal probability distribution, making it a suitable choice for this study (Joshi & Dhakal, 2021). Overall, the binary logistic model was used as it provides a robust and effective approach for analyzing perceptions of extension practitioners' competence in climate change-related matters among smallholder farmers.Let π_i it be the probability of success. Additionally, consider $X = (X_1, X_2, \ldots.. X_n)$ as a set of explanatory variables which can be discrete, continuous, or a combination of both discrete and continuous. Then, the binary logistic function π_i is given by:

$$logit\,\pi_i = log\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \cdots \ldots + \beta_n x_{i,n;} \ldots 1$$

where

$$\pi_i = \frac{exp\,(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots \ldots + \beta_n X_{i,n;})}{1 + exp\,(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots \ldots + \beta_n X_{i,n;})} = \frac{exp\,(x\prime_i \beta)}{1 + exp\,(x\prime_i \beta)} = \wedge\,(x'_i \beta) \ldots 2$$

Here, π_i denotes the probability that a sample is in a given category of the dichotomous response variable, commonly called the success probability and, clearly, $0 \leq \pi_i \leq 1$. $\Lambda(.)$ is the logistic CDF, with $\lambda(z) = e^z/ (1 + e^{-z}) = 1/ (1 + e^{-z})$, and β s represents a vector of parameters to be estimated (Joshi & Dhakal, 2021). The expression $\left(\frac{\pi_i}{1-\pi_i}\right)$ is called the odds ratio or relative risk.

5.5.3.1 Estimation and likelihood ratio test

Maximum likelihood is the preferred method to estimate β since it has better statistical properties, although we can use the least-squares approach. Consider the logistic model with the single predictor variable X given by the logistic function of:

$$\pi\,(X) = \frac{exp\,(x\prime_i\beta)}{1 + exp\,(x\prime_i\beta)} \text{……..……..3}$$

We predict finding the estimates such that plugging βˆ into the model for π(X) gives a number close to 1 for all subjects who perceive extension to be competitive relative to climate change and 0 otherwise. Econometrically, the likelihood function is given by:

$$L\,(\beta_0, \beta_1) = \prod_{i:Y_{i=1}} \pi(x_i) \prod_{i\prime:Y_{i\prime=0}} (1 - \pi(x_{i\prime})) \text{……..4}$$

The estimates βˆ are chosen to maximise this likelihood function. The logarithm is taken on both sides to calculate and use the log-likelihood function for estimation. We used the likelihood ratio to test if any subset of estimates β is zero. Suppose that p and r represent the number of β in the full model and the reduced model, respectively. The likelihood ratio test statistic is given by:

$$\Lambda* = 2\,[l(\beta^{(0)}) - l(\beta)] \text{……..…….5}$$

where l(βˆ) and l(βˆ$^{(0)}$) are the log-likelihoods of the full model and the reduced model, respectively, evaluated at the maximum likelihood estimation of that reduced, and Λ∗ ∼ χ 2 n−r; n and r being the number of parameters in full and the reduced model, respectively.

5.5.4 Description of Explanatory Variables

Table 5.1 shows the independent variables included in the binary logistic model and their measurement and expected outcome.

Table 5.1: Relationships between dependent and explanatory variables of the logit model

Explanatory variable	Measure	Expected outcome
Full-time farmer	Yes = 1 No = 0	+
Farmer experience	Categorical – less than 5 years = 1 More than 5 years, but less than 10 years = 1 More than 10 years, but less than 20 years = 2 More than 20 years = 3	+
Gender	Male = 1 Female = 0	–
Level of education	Categorical – Never been to school = 0 Grade R to Grade 8 = 1 Grade 9 to Grade 12 = 2 National Certificate/ Matric = 3 Tertiary Qualification = 4	+
Member of farm organisation	Yes = 1 No = 0	+
Land ownership	Yes = 1 No = 0	–
Access to extension	Yes = 1 No = 0	+
Dependent variable	**Measure**	
Competency of extension officers on climate change	1 = Extension officers are competent 0 = Extension officers are incompetent	

Participation of farmers was included as a variable because full-time farmers have better access to extension services and might view extension services as competent compared to part-time farmers.

Gender was used to assess its effect on the competence of extension officers relative to climate change. The tested hypothesis is that male farmers are more likely to access EAS than their female counterparts because female farmers are not seen as decision-makers in the households,

including in farming activities; thus, extension officers opt for male-headed households. This also means male farmers have a better perception of the competency of extension practitioners due to their access.

The variable's coefficient representing a member of a farm organisation was tested. This suggests that being a member of a farmer's organisation increases the possibility of having access to extension services, changing the perception of extension services and linking farmers with climate information.

Land rights through land ownership are crucial for increasing agricultural output because they encourage farmers to invest more in their land and adopt more advanced agricultural techniques. Land ownership was tested, and it was hypothesised that farmer-owned land increases farmers' chances of having access to extension and seeing the competency of farmers.

The access to extension services variable was included in the binary logistic model to assess its effect on the competence of extension officers relative to climate change. The anticipated outcome was predicted to be positive when regressed against the dependent variable because farmers that have access to extension services perceive the extension services to be competent.

5.6 RESULTS AND DISCUSSIONS

This section presents results from the topics developed based on the predefined questions. Verbatim quotes from the participants were used where necessary. The results section is divided into: 1. Demographic characteristics of respondents, 2. Farmer characteristics, 3. Farmers' knowledge of climate change, 4. Farmers' perceptions of the knowledge of extension officers on climate change, 5. Farmers' perceptions of the capacities of extension officers related to climate change, and 6. Farmers' perceptions of the capacities needs of extension officers related to climate change.

5.6.1 Demographic characteristics of respondents

Table 5.2 presents the demographic information of the respondents. The survey's findings show that women make up a majority of farmers in the study areas, with a proportion of 54% compared to 42% of their male counterparts. These results also corroborate those found by Mdoda et al. (2020) and Ndhleve et al. (2017), who also conducted studies in the Eastern Cape.

StatsSA (2012) found that households headed by women are more likely than households headed by men to engage in agriculture. Women in South Africa contribute more to increasing agricultural production by generating food than men because men move to cities to work in non-farm jobs. Regarding the racial groups, blacks comprised the majority of the farmers at 92.1 %. A study by Zantsi (2021) categorised smallholder farmers into population group, age, sex, farm location, and size, noting that with the population group, black farmers are typically linked with smallholder farming (Khapayi & Celliers, 2016; Zantsi, 2021). According to Statistics South Africa's most recent Agricultural Census, almost 95% of the country's smallholder farmers are black (StatsSA, 2017), primarily due to the legacy of apartheid, when black South Africans were barred from land ownership and agriculture (Binswanger-Mkhize et al., 2009).

With regards to respondents' level of education, only 5.7% of the respondents were illiterate, while others had completed some form of education. About 19% had gone to tertiary institutions. Results suggested that the majority of farmers could read and write. An average (49.7%) of farmers had more than 10 years of demonstrable experience. Farmers with more knowledge and education are more likely than illiterate ones to comprehend climate change and how it affects their farming activities (Mandleni & Anim, 2011).

Table 5.2: Farmers' demographic characteristics

Variable	Frequency (n)	Percentage (%)*
Sex:		
Male	74	42.3
Female	95	54.3
Racial group:		
African/ Black	169	96.6
Non-Black	0	0
Highest level of education:		
Never been to school	10	5.7
Grade R to Grade 8	62	35.4
Grade 9 to Grade 12	31	17.7
Matriculated	35	20.0
Tertiary Qualification	33	18.9
Years of experience:		
Less than 5 years	44	25.1

Between 5 years and 10 years	41	23.4
Between 10 years and 20 years	34	19.4
More than 20 years	53	30.3

**Note: Not all respondents answered every question, thus percentages do not always total 100%*

Source: Field Survey, 2022

5.6.2 Farmer characteristics

The following sections present additional farmer characteristics, such as their reason for farming, farmer organisation membership, land ownership, and farming enterprise, as shown in Table 5.3.

Table 5.3: Farm Characteristics

Variable	Frequency (n)	Percentage (%)*
Full-time farmer		
Yes	119	68
No	48	24.7
Reason for farming:		
Household consumption	30	17.1
Selling	32	18.3
Both	93	53.1
Land ownership:		
Yes	113	64.6
No	60	34.3
Farmer organisation membership:		
Yes	122	69.7
No	44	25.1

**Note: Not all respondents answered every question, thus percentages do not always total 100%*

Source: Field Survey, 2022

Results presented in Table 5.3 show that most farmers (68%) were full-time farmers; they relied entirely on it to provide for their needs. On the other hand, some respondents (24.7%) took off-farm employment or engaged in other economic activities to supplement their income.

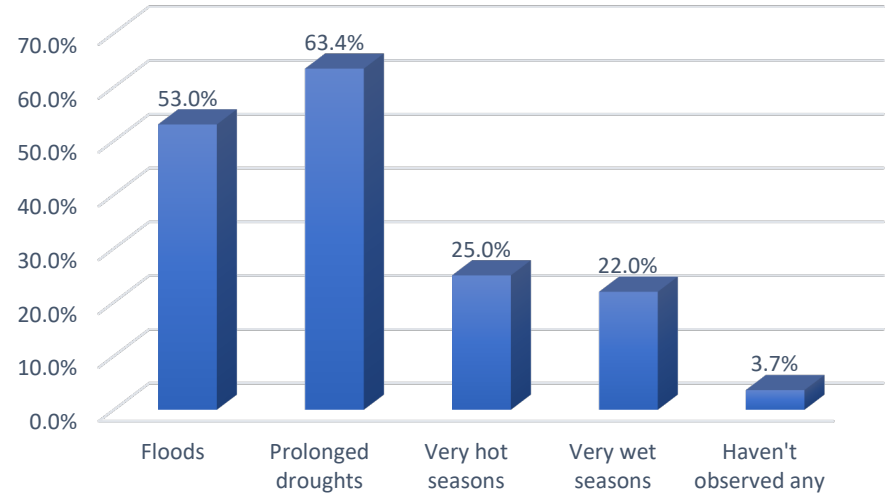
Of the survey participants, 69.7% are members/affiliated with farmer organisations. Research shows that farmer organisations, associations, cooperatives, self-help groups, and women's organisations are examples of farmer organisations, which are collective entities created to further the interests of their members (Bizikova et al., 2020). The benefit of farmers being affiliated with farmer organisations includes helping smallholder farmers to overcome the challenges they face, including access to information, lack of bargaining power, and limited resources (Bizikova et al., 2020). Farmer organisations are now essential to rural development and agricultural productivity (Bijman & Wijers, 2019). Two-thirds (64.6%) of respondents indicated that they owned land in the study areas. A study by Akinyemi and Mushunje (2019) surveyed land access in South Africa, highlighting that most households with access to land are from the provinces of the Eastern Cape, KwaZulu-Natal, and Limpopo. The farmers in the area practised crop farming (37.1%), livestock farming (22.3%), and mixed farming (36.6%). The reasons for farming were for consumption (17.1%), selling (18.3%), and a combination of both (53.1%).

The respondents were questioned about their knowledge of extension services and if they had access to them in their area. Data show that many (76%) of the respondents were aware, and only 56.6% had access to extension services. It is concerning to note that a total of 37.7% of the farmers did not have access to extension services. During the FGDs, a farmer stated that:

> *"Our occupancy is not officially registered with the Department of Agriculture because we farm on municipal or communal land. We believe this to be the reason why government extension agents are absent. Having ties to farmer organisations is the only way we receive extension assistance"* (Female Farmer, FGD, Amathole District, August 2022).

5.6.3 Farmers' knowledge of climate change

The respondents were asked about their recent observations of climate change and its effects on their community. A total of 93.7% noted that they had observed a change in climate over the years. The observed changes by farmers are presented in Figure 5.1.



**Note: Not all respondents answered every question, thus percentages do not always total 100%*

Figure 5.1: Observed changes in the climate
Source: Field Survey, 2022

Figure 5.1 shows that most respondents (63.4%) considered drought a significant event in the area. This concurs with a study in the Eastern Cape by Amoah and Simatele (2021) on food security and coping strategies of rural household livelihoods to climate change, where drought was evident. About half the respondents (53%) noted that they have also observed flooding in the study areas, which, according to Dalu et al. (2018), has been mainly caused by poor drainage and drainage clogging in the province. Other observations were very hot and very wet seasons (25% and 22%, respectively).

The impact of climate change on the local community, livelihood, and agricultural production was another question posed to respondents. It was noted that it mainly led to crop failure and livestock loss, at 70.9% and 48.6%, respectively. Another impact was the deterioration of infrastructure (21.7%). The responses of the majority of respondents thus suggest that climate change led to reduced income and increased socio-economic problems.

During the FGDs, the respondents elaborated on their experience with climate change. They agreed that their crop planting date has changed due to climate change. They have seen a relative increase in several pests during extreme weather conditions. Furthermore, most of the respondents from all the study sites believed that they receive rain later than expected. One of the participants stated:

"We farm but do not get anything from farming because of drought and recent flooding. Our food production has reduced drastically due to high temperatures. Just last year, three of my goats died because of the dryness of the grass and hunger. High temperatures severely impact our livestock. They do not get greener pastures to feed on, lose weight, and sometimes die" (Female Farmer, FGD, Chris Hani District, August 2022).

5.6.4 Farmers' perceptions of the knowledge of extension officers on climate change

Farmers were asked if they thought extension officers are aware of climate change, and almost three-quarters (72.6%) of the farmers with access to extension services highlighted that practitioners are knowledgeable about climate change. The study results further showed that participants generally agreed with the statement that extension practitioners are knowledgeable about climate change support interventions. Using a lickert scale, Figure 5.2 suggests that the majority of participants found practitioners to be knowledgeable, although a small percentage disagreed. Specifically, 14.3% of participants strongly agreed, 49.7% agreed, 17.7% were neutral, 2.9% disagreed, and 0.6% strongly disagreed.

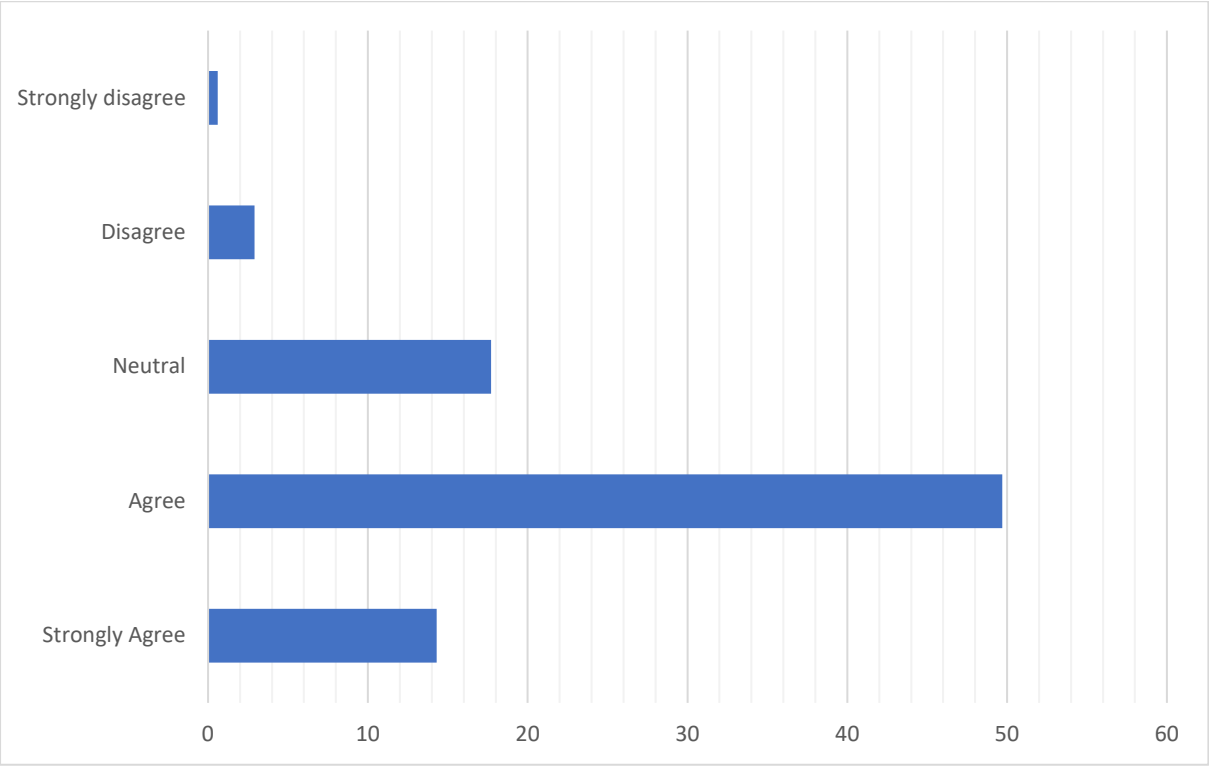


Figure 5.2: Likert scale on extension practitioners knowledge about climate change support interventions

Farmers further indicated that the information they receive makes a difference in their adaptation and production. One respondent stated:

"We lack the education to comprehend weather patterns and effective adaptation measures; we rely only on officials for information. We mainly depend on indigenous knowledge, which we have since learned is insufficient. Due to most of our time spent in the fields, we cannot receive any warnings issued via radio or television. Additionally, due to network connectivity issues in our area, we cannot utilise cell phones" (Male Farmer, FGD, OR Tambo District, July 2022).

5.6.5 Farmers' perceptions of the capacity of extension officers related to climate change

To establish the capacity of the practitioners, the three aspects proposed by Mustapha et al. (2012) were used as the basis for questions. These are (i) facilitating and implementing policies and programmes, (ii) providing information and guiding management of new methods of farming, and (iii) developing capacity.

The respondents were asked if the extension officers made them aware of climate adaptation policies in the study areas. The evidence gathered shows that the majority (64.6%) were not made aware of policies in line with climate adaptation in the country and province. Farmers should be aware of climate change adaptation policies because they can help them boost their climate resilience, manage the effects of climate change, and advance sustainable agricultural practices. Additionally, the majority of the farmers (67.5%) indicated that they have never been made aware of weather/climate services by extension practitioners. The only familiar tool to the respondents was the SAWS.

Most respondents (68%) stated that practitioners provided interventions and programmes that assist with climate change adaptation. The strategic adaptations options the practitioners recommend to farmers include: multi-cropping; crop diversity; crop rotation; changing planting dates; changing from crop farming to livestock farming or the other way round; expanding irrigation systems; change in the use of chemicals, fertilisers, and pesticides; increased water conservation and soil conservation; and using insurance. Concerningly, 45.7% of the

respondents pointed out that the practitioners do not monitor how well the advised strategies are performing.

Results show that practitioners use various channels to increase farmers' capacity, and a majority of the respondents (60.6%) indicated that these were their preferred communication channels, including face to face, mass media and farmer to farmer. To further understand the perception of farmers on the capacity of extension practitioners, a binomial logistic regression was performed to determine which independent variable/s had a statistically significant effect on the perception of extension capacity. The results are presented in Table 5.4.

Table 5.4: Factors affecting farmers' perception of extension competency

	Coefficient estimates		**Marginal effect**	
Variables	**Coff.**	**Std. Err**	**Coff.**	**Std. Err**
Gender	-1.234	0.050*	0.253	0.108
Highest level of education	0.222	0.531	0.310	0.147
Full/ part-time farmer	0.845	0.544	0.351	0.162
Farming Experience	-0.422	0.496	-0.062	0.036*
Land ownership	0.176	0.532	0.150	0.071
Member of an organisation	1.392	0.545	-0.082	.056*
Access to extension	-0.170	0.022**	0.081	0.036*
Number of observations = 175	pseudo r-squared 0.625	–2 log-likelihood 103.868	prob > chi2 = **	

Notes: ***, ** , * mean significant at 1%, 5%, and 10% levels of significance, respectively.

Source: Field Survey, 2022

Seven independent variables included in the logistic regression model were gender, education, full-/part-time farming, land ownership, experience, belonging to an organisation, and access to extension.

The pseudo r-squared was 0.625%, indicating that the model used was relatively strong to reliably predict factors affecting farmers' perception of extension competency, the explanatory variables, and the variance.

Table 5.4 shows that gender was statistically significant at a 10% level relative to farmers' perception of the competence of extension offices. This means that being a male or female farmer directly influences the opinion a farmer has on the competence of the extension officer. The marginal effects are positive, meaning the expected difference in probability of y = 1, associated with farmers' perception of the competence of practitioners, increases by 25% (0.253). This is a result of the likelihood in the interaction between extension practitioners. Idowu (2005) notes that gender is significant in the perception of extension services, and it may be due to the socio-cultural setting that delineates the male-female relationship.

For the highest education level, the coefficient estimate is not statistically significant, as shown in Table 5.4. This means the level of education does not significantly affect farmers' perceptions of extension competency. Results further show that there is a positive correlation between education level and perception as indicated by the marginal impact (0.310). A significant and positive correlation was predicted by the hypothesis based on earlier research by Khapayi and Celliers (2016), which found that farmers with low education levels depend on extension services for empowerment and getting the necessary knowledge, skills, and resources to improve their agricultural practices and livelihoods, thus these farmers have a more favourable perception of practitioners.

The study, however, showed that the variable was insignificant. While the results did not confirm the initial hypothesis, this suggests that the association between the level of education of farmers and their perception of extension services may be complex and influenced by various contextual factors.

The perception of extension competency was found to have a significant positive effect when looking at whether the farmer was farming part-time or full-time (coefficient = 0.845, p 0.05). Table 5.4 shows that a full-time farmer has a 0.351 higher chance of favourably perceiving extension expertise, according to the marginal effect. This could be because they have easy access to extension services due to their availability on the farm.

The variable farming experience has an estimated coefficient of -0.422 according to Table 5.4, and the corresponding p-value was greater than 0.05, indicating that the variable was not statistically significant in this analysis.

The coefficient estimate for farming experience had a standard error of 0.496, indicating some uncertainty in the estimation. This could be due to measurement errors or unaccounted confounding variables that might have influenced the results.

The marginal effect of farming experience is reported as -0.062. This means that, on average, a one-unit increase in farming experience is associated with a 0.062 decrease in the probability of perceiving extension competency positively. This proves that more experienced farmers may perceive extension practitioners with less urgency or reliance because they already have a certain level of farming experience and have acquired knowledge and skills over time; this concurs with Sebeho (2017).

The coefficient estimate for land ownership is not statistically significant. This implies that land ownership does not have a significant impact on farmers' perception of extension competency, as seen in Table 5.1. The positive marginal effect (0.150) shows a potential positive relationship, suggesting that owning land increases the probability of perceiving extension competency positively by 0.150 units.

The coefficient estimate for being a member of an organisation is statistically significant at the 10% level. Being a member of an organisation is linked to a higher sense of extended competency, according to the coefficient estimate (1.392). This emphasises how crucial social networks and group participation are for improving farmers' perceptions of the efficacy of extension services.

Access to extension services had a negative coefficient at -0.170 . This implies that farmers' perceptions of extension competency are correlated with their limited access to extension services. This suggests that farmers tend to have a less favourable impression of the competency of extension services when they encounter barriers in accessing extension services.

According to the coefficient estimate of -0.170, there is an association between a one-unit increase in limited access to extension services and a 0.170 reduction in the likelihood that extension expertise will be positively perceived. This offers a quantitative assessment of how farmers' perspectives are impacted by access restrictions.

5.6.6 Farmers' perceptions of the capacity needs of extension officers related to climate change

To obtain data on the capacity needs of extension practitioners, from the perceptive of the farmers, participants were asked whether extension officers needed climate change training. A total of 70.3% agreed that they do. Figure 5.3 shows the capacities practitioners need to improve to support farmers in adapting to climate change, according to the farmers.

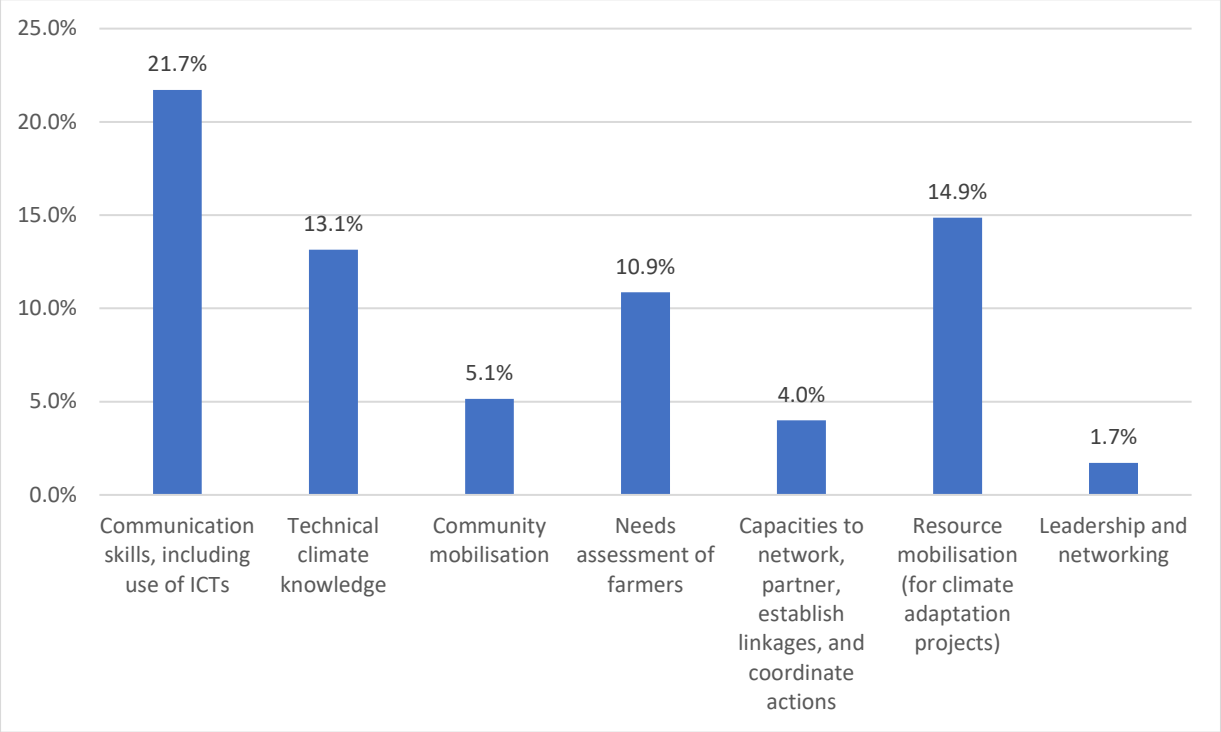


Figure 5.3: Capacity needs of extension practitioners according to farmers
Source: Field Survey, 2022

The respondents (21.7%) highlighted that communication skills are needed for extension practitioners, which extends to using ICTs. In the survey, 30.9% of farmers noted that knowledge of extensionists on using ICTs was average to poor. According to Ali et al. (2017), agricultural extension practitioners' communication abilities are crucial for boosting farmers' capacity for adaptation. Therefore, the ability of agricultural extension practitioners to communicate effectively is essential for increasing farmers' adaptability.

A total of 13.1% of respondents said that improving technical knowledge was necessary to deliver extension effectively. This indicates that agricultural extension agents should be well-

versed in relevant science about climate change. This is in agreement with Dinesh (2016), which explains that extension practitioners need training in climate change to build more resilient farmers and ensure that they can cope with the impacts of climate change. Other capacity needs highlighted by farmers include community mobilisation (5.1%), need assessment of farmers (10.9%), leadership and networking (1.7%), capacities to network and partner (4%), and resource mobilisation (14.9%).

5.7 CONCLUSION

It is widely acknowledged that climate change has become a global issue; however, there is little empirical evidence on the capacity needs of extension practitioners from the farmers' perspective. This study examined farmers' perceptions of the competencies of extension practitioners related to climate change in three districts in the Eastern Cape, South Africa. Findings from the study revealed that women constitute the majority of farmers. Most farmers in the study areas have more than 10 years of demonstrable experience. The majority of farmers were full-time practitioners whose main occupation was farming and who solely relied on it to meet their requirements, and most of survey respondents identify as members of a farmer organisation. The farmers indicated they are aware and had access to extension services.

The results show that farmers are aware of climate change and its effects. Respondents noted that observed changes have significantly impacted their livelihood, noting crop failure, livestock, and infrastructure deterioration.

The study further revealed that of the respondents from the three study sites who have access to extension services, most noted that practitioners are knowledgeable about climate change, and they receive climate change information and adaptation strategies from them. Practitioners also provide interventions and programmes, and the information farmers receive from them makes a difference in their adaptation and production. On the other hand, the majority of the respondents noted that extension practitioners did not make them aware of climate adaptation policies and tools in the country and province.

Farmers' perceptions about the capacity of extension practitioners was significantly affected by gender and farmer organisation affiliation in the study areas. This implied that farmers who are female and those who were members of farmer organisations perceived extension practitioners

to have better capacity compared to male farmers and those who were not members of farmer organisations.

Based on these results, it was also noted that practitioners in the study areas need continuous development in the climate change scope, with farmers reporting technical climate knowledge as important. It is against this background that the following recommendations are made:

1. Through the Eastern Cape DRDAR, the government should provide practitioners with regular engagement with farmers on climate change observations in their work areas.
2. The engagements should extend to continuous training, with a strong focus on communication skills and the use of ICTs, technical knowledge, community mobilisation, needs assessment of farmers, networking leadership, and resource mobilisation.
3. There needs to be a renewed focus on indigenous knowledge management and education. Indigenous knowledge systems (IKS) need to be reinvigorated, ensuring that practitioners can acknowledge the input and adaptive techniques that farmers independently employ to promote farmer engagement and overall better perception.

CHAPTER 6 :
EVALUATE THE CAPACITY NEEDS OF EXTENSION PRACTITIONERS

6.1 INTRODUCTION

The Global Forum for Rural Advisory Services (GFRAS) has presented a new vision for EAS within Agricultural Innovation Systems (AIS). This vision calls for the creation of new capacities at various levels (individual, organisational, and enabling levels) as well as an enlarged role for EAS within AIS, as stated in its position paper, The "New Extensionist" (GFRAS, 2012). The idea for the "New Extensionist" emerged from the realisation that the current EAS requires new capabilities to address the escalating issues in agricultural growth efficiently (declining water availability, increasing soil degradation, and changing and uncertain climate and markets) (AESA, 2019).

Similarly, the South African government, in the Norms and Standards set out by the DoA in 2005, highlighted that agricultural EAS are dynamic and constantly adapt to the demands of their clients and the shifting political landscape. Thus, a team of skilled, motivated, and committed employees are required for advisory and extension services (DoA, 2005).

The document further highlights that all providers of agricultural EAS must be competent in eight areas, which include client orientation and customer focus, communication, project management, knowledge management, service delivery innovation, problem-solving and analysis, honesty and integrity, and people management and empowerment. To this end, competence is critical to ensuring high standards and exemplary conduct in providing agricultural EAS.

With a focus on climate change, according to Rupan et al. (2018), the following capacities are needed by practitioners for climate adaptation:

i. Sustainably increasing productivity and enhancing adaptation through technology development and information dissemination.
ii. Building resilience through developing farmers' human and social capacity and providing support services.
iii. Supporting climate change adaptation and mitigation through facilitation and brokering.

iv. Monitoring, advocacy and policy support.

Extension services have since reformed from disseminating knowledge, skills, and technologies about producing crops, livestock, and forestry products to farmers working with them to develop new technologies while accelerating and enabling innovation processes. This change in emphasis is consistent with the requirement for site-specific analyses to determine the appropriate agricultural technology and practices required for climate change adaptation. Although distributing technology and knowledge has traditionally been the responsibility of extension practitioners, providers confront difficulties in developing and promoting climate-resilient technologies and practices. According to Simpson and Burpee (2014), two significant interrelated challenges for practitioners are figuring out what kinds of adaptive changes farmers need to make and when to make them, as well as making sure that pertinent technologies and modes of dissemination keep up with the need for constantly changing climate change adjustments. This means extension practitioners will need new capacities and skills to go through institutional changes to discover technical solutions for sustainably increasing agricultural productivity.

Building resilience through developing farmers' human and social capacity and providing support services

Farmers need to draw on local and scientific knowledge, hone their observational and experimental skills, and develop their critical thinking and problem-solving abilities to be able to make their own decisions about appropriate practices and resilient income opportunities from a menu of options to manage the uncertainties and risks associated with climate change and become more resilient. Practitioners, therefore, have to employ non-formal education and experiential learning approaches, such as farmer field schools and agricultural research institutes (Waddington et al., 2014). Davis et al. (2014) note that this would require new skills and capacities at the organisational and individual levels.

Supporting climate change adaptation and mitigation through facilitation and brokering

A "bridging" function, connecting farmers to other stakeholders and service providers, is one of the traditional functions of extension. Agricultural extension practitioners play a significant role in the AIS. According to Leeuwis et al. (2013), rural advisers can support interactions with new types of institutions related to climate change, such as insurance companies, humanitarian organisations, and meteorological services, in addition to strengthening connections between

farmers and their traditional partners (researchers, NGOs, traders, input suppliers, and credit institutions). Antwi-Agyei and Stringer (2021) highlight the need to create connections with private and public institutions that disseminate adaptation technologies and funding programmes for adaptation investments.

Extension practitioners need expertise in areas they typically lack to support innovation processes, like network building and brokering, process facilitation, and process monitoring.

Monitoring, advocacy, and policy support

In close cooperation with farmers and scientists, practitioners should take an active role in tracking the impact of climate change on agriculture and in the development of adaptation initiatives. Practitioners are uniquely positioned to highlight the results of climate-related events to policymakers and advocate for policy change and investment because they work closely with farmers and communities (Pralle, 2009). According to Antwi-Agyei and Stringer (2021) the foundation for modifying climate change adaptation techniques is monitoring and evaluation, which is also a critical tool for spotting and preventing potential maladaptation and evaluating the effectiveness of the strategies offered to farmers. Extension services can assist in educating rural communities about climate change policies, and they assist in determining the farmers' needs and their level of understanding, perception, attitude, and vulnerability to climate change.

Given the changing issues in agriculture and the new roles, functions, and reform initiatives, practitioners need new capacities to carry out various duties; they require the necessary competency to carry out the role. Hunt (2005) explains that capacity consists of both "hard" and "soft" elements, such as personal talents, functions, structures, infrastructure, and resources (e.g., motivations and beliefs). It is the knowledge, skills, behaviour, and attitude that a person can apply in the work environment, which indicates a person's ability to meet the requirements of a specific post. A formal competency required to work as an extension practitioner or agricultural adviser in South Africa is a BTech/Bachelor's/Honour's Degree in Agriculture, which can be obtained in South Africa at any of the nine universities, five universities of technology, and 12 agricultural colleges (Leibernburg, 2015).

The changing needs of farmers necessitate extension practitioners to receive comprehensive and ongoing training to support agricultural development (Androulodakis & Siardos, 1996), and effective advisory services are driven by a vital capacity (Abdullah et al., 2017). For skilled extension professionals, providing good performance is of utmost importance as is responding

to the proposed roles in capacity development. In agricultural extension, capacity development is the process by which key stakeholders and organisations mobilise, reinforce, generate, adapt, and retain capacity over time, typically to ensure sustainable agricultural expansion and increase the stakeholder quality of life. Capacity building is becoming increasingly popular across various industries, including agriculture and natural resource management. This is highlighted in the Extension Recovery Plan (2012), which proposes that extension practitioners should be reskilling and re-oriented. DAFF has developed a training programme to equip the current extension staff with the knowledge and abilities outlined in the Norms and Standards of the DoA (2005).

Mangkunegara and Waris (2015) explain that training is one of the key instruments for developing extension services. It has enormous potential for capacity development, particularly for cutting-edge technical know-how in climate change adaptation. As a result, training extension practitioners is crucial to impart the most up-to-date technical knowledge, competence, and professionalism. Short courses and internal training are used to address a portion of this. The training needs of practitioners must be continuously assessed, and in-service training implemented accordingly. However, South Africa's current policies do not focus on reskilling and reorienting extension services under challenging circumstances like climate change (DAFF, 2011). According to the Williams et al. (2008), less than 25% of extension personnel have participated in technical training programmes since joining the public sector. Very few extension staff members have access to formal skills programmes essential for providing products and services to farmers. This agrees with the findings of Zikhali et al. (2020), which showed that most practitioners have not received in-service training since joining the workforce.

Extension services, in particular, have been at the centre of the efforts taken by governments to build farmers' adaptation capacity for the impacts of climate change (Kalimba & Culas, 2020). Farmers' adoption of technology and performance increase as a result of good communication and engagement with extension practitioners who are competent in professional and technical areas (Wasihun et al., 2013). In a study by Agricultural Extension in South Asia (AESA) in 2014, the extension practitioners agreed that much more needs to be done to strengthen the capacities of practitioners to deal with rapidly evolving challenges in agriculture and there is little focus on the need to capacitate extension practitioners. Therefore,

understanding extension practitioners' capacity needs for climate change is crucial to support their capacity growth.

6.2 METHODS AND MATERIAL

The study was carried out in the Eastern Cape Province's Chris Hani, OR Tambo, and Amathole District Municipalities. A mixed-methods approach, questionnaire surveys, and FGDs were utilised to gather information on the capacity needs of extension practitioners to provide services – specifically communicate climate information – to smallholder farmers. FGDs were used to determine the need for agricultural extension capacity building, the obstacles to effective extension outcomes, and recommendations. The FGDs had 99 respondents, with 25 participants in the Chris Hani District, 42 in the Amathole District, and 32 in the OR Tambo District between 13 July 2022 and 30 August 2022.

The survey included questions about knowledge, learning needs, and demographic factors (including gender, age, racial background, level of education, years of extension service, professional organisation affiliation, and area of specialisation), with the goal of better understanding the capacity-building needs of agricultural extension practitioners to help farmers manage the risks associated with climate change. Extension practitioners were questioned regarding their knowledge of the factors causing the changing climate and the resources they use for climate information.

A total of 126 extension practitioners were selected from across the study areas using random sampling. To identify the main themes that emerged from the discussions, content analysis/ thematic analysis was used to code and evaluate qualitative data from the FGDs (Creswell, 2014). This analysis identifies critical ideas and topics for discussion, identifies differences and similarities across responses, and integrates themes and ideas to assist the researcher in making sense of the data gathered from respondents, according to McNiff (2016). The SPSS software for descriptive statistics was used to analyse quantitative data from the questionnaire surveys (frequency counts and percentages).

6.3 RESULTS AND DISCUSSION

This section presents results from the topics developed based on the predefined questions. Verbatim quotes from the participants are used where necessary. The results section is divided into 1. Demographic characteristics of respondents, 2. Capacity needs of practitioners to communicate climate change adaptation to smallholder farmers, and 3. Barriers faced by extension practitioners for successful extension services delivery for climate change adaptations.

6.3.1 Demographic characteristics of respondents

The demographic characteristics of the respondents are presented in Table 6.1. Male respondents made up 56.6% of the sample. The fact that men predominate in agricultural extension services in the Eastern Cape and South Africa may be explained by the fact that women's roles were considered insignificant and irrelevant under colonialism and apartheid, which was particularly reflected in job prospects and distribution (Zwane & Davis, 2017). However, after adopting a new constitution and holding free elections, more chances for women to follow their desired careers started to materialise (Adebayo & Worth, 2022). Despite this, there is still a significant gender gap in South Africa, as seen by the low participation of women in agricultural extension advising services (Zwane & Davis, 2017). In a DAFF (2007) report, cited by Worth (2012), the Eastern Cape had 623 extension practitioners; females constituted only 22% of that number. This significant gap and low representation of women as extension practitioners pose a risk to agricultural transformation and the overall development of the agricultural sector (Mamun-ur-Rashid et al., 2017), and it may prevent female farmers from accessing extension services (Mamun-Ur-Rashid, M., Kamruzzaman, M., & Mustafa, E. (2017). Women participation in agricultural extension services in Bangladesh: Current status, prospects and challenges. *Bangladesh Journal of Extension Education, 29*(1&2), 93–107.

-Godwin et al., 2017).

Table 6.1: Practitioners' demographic characteristics

Variable	Frequency (n)	Percentage (%)*
Sex:		
Male	69	56.6
Female	53	43.4
Racial group:		
African/ Black	116	92.1
Non-Black	4	4.84
Highest level of education:		
Grade 12 (NSC)	0	0
Diploma (NQF 5)	22	17.5
Degree (NQF 6)	26	20.6
Honours (NQF 7)	39	31.0
Masters (NQF 8)	27	21.4
Years of experience:		
Less than 5 years	28	22.2
Between 5 years and 10 years	19	15.1
Between 10 years and 20 years	52	41.3
More than 20 years	20	15.9
Professional organisation/ regulatory body membership:		
Yes	99	78.6
No	24	19.0
Other agricultural-related certificated		
Yes	22	17.5
No	82	65.1

**Note: Not all respondents answered every question, thus percentages do not always total 100%*

Source: Field Survey, 2022

Table 6.1 also shows that most respondents have an honours or a master's degree (34% and 24%, respectively), which is very high compared to other developing countries (Landini & Bianqui, 2014). This shows that practitioners in the province benefited from the Extension Recovery Plan under the retraining pillar (Mkhize, 2009). The concern, however, is that 19% of practitioners only have a diploma. This percentage is unsatisfactory, especially considering that practitioners now receive state bursaries to further their education throughout South Africa. The question is, why are they not encouraged to upgrade their credentials despite the Norms and Standards of extension in South Africa (DoA, 2005).

The years of experience of the practitioners range from 2 years to more than 20 years, with an average amount (52%) being more than 10 years but less than 20 years, as presented in Table 6.1. This supports the results from Davis and Mdee (2018) showing that the average work experience of extension practitioners is 15 years. These results are encouraging because, with years of experience, practitioners have the opportunity to build their capacity needs. A study by Zikhali et al. (2020) notes that compared to extension practitioners with less than 5 years or more than 20 years of experience, those with 6 to 15 years of work experience are more likely to have received climate change training.

6.3.2 Capacity needs of practitioners to communicate climate change adaptation to smallholder farmers

6.3.2.1 Climate change training

To develop and create effective training programmes on climate-resilient agriculture, it is essential to understand the capacity-building needs of agricultural extension practitioners. Climate change training and the requirements are presented in Table 6.2.

Table 6.2: Climate change training

Variable	Frequency (n)	Percentage (%)*
Climate change taught in the curriculum of qualification		
Yes	48	38.1
No	67	53.2
Climate change taught informally through workshops		
Yes	20	15.9
No	95	75.4
Formal training on climate with accredited certification		
Yes	8	6.3
No	107	84.9
Do you need training on climate change		
Yes	86	90.5
No	3	3.2

**Note: Not all respondents answered every question, thus percentages do not always total 100%*

Source: Field Survey, 2022

Table 6.2 shows that 38.1% of extension practitioners were taught climate change in the curriculum of their qualifications. Additionally, 15.9% received informal training through workshops, while only 6.3% received formal climate change-accredited training. Most extension practitioners (90.5%) indicated they need to have training on climate change.

6.3.2.2 Climate change knowledge and capacities of extension practitioners

The respondents were able to define climate change; they were able to note the observed changes in the study areas over the past 10 years and the impacts it has had on the livelihood and agricultural production of the farmers they serve. Table 6.3 shows the practitioners' perceived knowledge of climate change.

Table 6.3: Level of understanding of climate change

Level of understanding of climate change	Frequency (n)	Percent (%)
Excellent	7	5.6
Good	52	41.3
Average	54	42.9
Poor	7	5.6

Source: Field Survey, 2022

According to Table 6.3, the results suggest that agricultural extension practitioners still need to learn more about climate change; they corroborate those found by Ifeanyi-Obi and Ekere (2021), which show that practitioners have little knowledge of climate change-related issues. Yanfika et al. (2019) also observed that, due to their insufficient understanding of climate change, agricultural practitioners had not made enough of an attempt to mitigate it.

6.3.2.3 Capacity needs of extension practitioners

The participants were presented with skills in climate change adaptation and were asked which ones they needed to improve to increase their capacity. The results are presented in Figure 6.1, which shows the capacities practitioners need to enhance to support farmers' adaptation to climate change.

6.3.3 Communication skills

The respondents emphasised the importance of communication skills, including using ICTs for agricultural extension practitioners to carry out their duties. The need for communication skills corresponds with a study by Agunga et al. (2017), who noted gaps between communication skills needed by extension practitioners and their performance levels. The respondents in the study further highlighted that they needed training in communication to offer extension services to farmers effectively.

In the FGD, they indicated the following:

"The COVID pandemic challenged us to improve our communication with farmers for production purposes. The same strategy can be used for climate change information" (Male Agricultural Practitioner, FGD, Chris Hani District, August 2022).

"To assist farmers in addressing climate concerns, we need training on different methods of delivering climate information, as most of us are less adept at connecting with our farmers through social media and other communication methods. This concerns extends whether farmers can also comprehend and value shared via social media" (Male Agricultural Practitioner, FGD, Chris Hani District, July 2022).

i. Technical climate change knowledge

A majority (51.6%), of the practitioners, as shown in Figure 6.1, noted the need for technical skill development for efficient extension services. Climate change issues are complicated and dynamic, and most institutions of higher learning do not cover them in detail in their curriculum. As a result, there is a need for regular workshops and in-service training on climate change issues for agricultural extension practitioners. This conclusion is consistent with findings from previous studies, such as Sulaiman and Mittal (2016). A study by Anka (2016) also suggests significant climate change training needs for practitioners like weather forecasting, pest control, soil conservation skills, and programme development skills. It indicates that agricultural extension practitioners must possess solid scientific knowledge pertinent to their context.

ii. Community mobilisation

Practitioners also considered community mobilisation an essential skill. Community mobilisation is the most successful method for enhancing human capital and the ability of people, organisations, and communities to adapt to climate change. One respondent also indicated:

"With community mobilisation we also struggle with internal community politics, where certain farmers cannot and do not want to work with others due to personal reasons" (Male Agricultural Practitioner, FGD, Amathole District, August 2022).

iii. Needs assessment

Practitioners further expressed their desire to build their capacity in needs assessment (22.2%), as shown in Figure 6.1. It is the process of identifying the main issues and opportunities that

farmers face and the kinds of information they need to deliver a responsive extension service. Paladan (2021) notes that in several cases, the organisation or government at the national level establishes the training requirements for farmers without considering their unique needs and preferences. Due to this, training techniques and programmes frequently fall short of farmers' specific requirements regarding their knowledge, abilities, and interests. According to Ageogun et al. (2013), training needs analysis can identify the gap between current and necessary performance and its causes, specifics, and solutions. Individual farmers need instruction to enhance their abilities to overcome obstacles and minimise the creation of problematic situations in their farming practices.

iv. Capacities to network, partner, establish linkages, and coordinate actions and leadership

Capacities to network, partner, establish linkages, and coordinate actions and leadership were also considered important by extension practitioners. One of the traditional roles of extension is to link farmers with other stakeholders and service providers.

One respondent said the following:

"We sometimes do not have the capacity and availability to respond to the needs of the farmers. Therefore, we must connect them to other stakeholders in the value chain who can assist with those needs. This needs to further extend to climate change as well, we need to know the different stakeholders that work in climate change and create relationships so that when we cannot personally assist the farmers, we know where to direct them" (Female Agricultural Practitioner, FGD, OR Tambo District, August 2022).

v. Resource mobilisation (for climate adaptation projects)

Climate adaptation strategies require local, national, or international funding from public, private, and alternative funding sources to promote adaptation measures. Understanding the financial requirements of communities and how these financial resources might be mobilised is crucial for all practitioners. Deo and Prasad (2022) highlight that balancing adaptation and resource provision should be the goal. During the discussion, it was noted that, apart from local and national funding, most practitioners are unaware of international/developmental climate funding options like grants.

vi. Leadership and networking

Improving their capacity in leadership and networking was indicated by 19% of the practitioners, as shown in Figure 6.1. Leadership is vital in extension farming because it helps to guide and facilitate the development and implementation of extension programmes.

Networking allows professionals to build relationships with community members, stakeholders, and other organisations that can help to support and enhance their work (Provan & Lemaire 2012).

By combining effective leadership with solid networking skills, extension professionals can maximise the impact and effectiveness of their work, fostering sustainable development and positive change in the communities they serve.

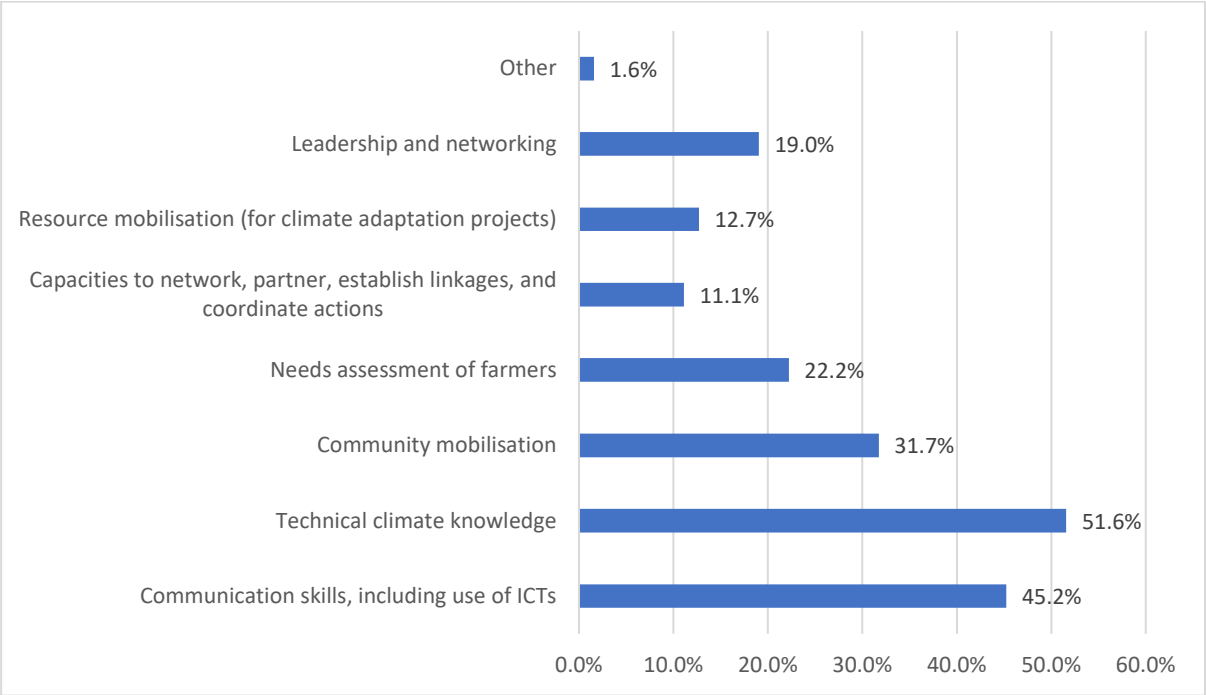


Figure 6.1: Capacity needs of extension practitioners according to practitioners
Source: Field Survey, 2022

6.3.4 Barriers practitioners face to successful extension service delivery for climate change adaptations

The practitioners were asked about the barriers they face to successful extension that can equip farmers with climate adaptation information in the three districts in the Eastern Cape. They reported several barriers, and they were thematically categorised as follows: (i) Lack of infrastructure – for example, network services for extension practitioners and farmers; (ii)

limited knowledge; (iii) insufficient funding to adopt strategies for coping with climate change; and (iv) farmers' resistance to change are among the problems.

The absence of infrastructure, notably cellular network services in rural areas, is one of the major obstacles to efficient extension delivery. Most communities are situated far from major towns or cities, and network services are still a concern, together with fluctuation/shortage of electricity supply. A respondent indicated that:

"*The constant scheduled power cuts add to the network problems we already face in rural areas. When we experience load shedding, we have network connection challenges; as such, we struggle to connect with our farmers when we call them or use WhatsApp"* (Female Agricultural Practitioner, FGD, OR Tambo District, August 2022).

Limited knowledge is another barrier faced by practitioners. Due to the complexity and obscurity of climate change, it can be challenging for smallholder farmers to recognise and comprehend how vulnerable they are to it. Agricultural practitioners must be adequately equipped to offer extension advice that farmers can understand.

A practitioners noted:

"We often struggle to comprehend climate change's complexities and how to adequately express the same to smallholder farmers. The illiterate levels of farmers also pose a challenge based on their knowledge" (Female Agricultural Practitioner, FGD, Chris Hani District, July 2022).

A key obstacle to the adoption of climate change adaptation measures is a lack of funding, as well as difficulties accessing information from the different funding sources. This problem poses a significant obstacle to the effectiveness and success of extension outcomes. Antwi-Agyei and Stringer (2021) note that even if practitioners have access to the required ICT and communication tools, they cannot ensure that their recommendations will be used because of the more significant resource issue. The same has been noted by Ebenehi et al. (2018) in earlier research, which indicates that smallholder farmers lack the resources to implement the adaptation measures advised by agricultural extension practitioners. It is worth noting that financial investment is necessary on the part of smallholder farmers for most climate change adaptation strategies.

Another noted key barrier to agricultural practitioners' efforts to assist farmers in managing climate threats is the farmers' resistance to change. The resistance of smallholder farmers to

innovations and technology intended to increase their resilience to climate change is one of the main obstacles to effective extension. A respondent highlighted that:

"Farmers occasionally prefer to continue using traditional farming methods and often attribute … climate change, like drought, to religious or traditional beliefs" (Male Agricultural Practitioner, FGD, Amathole District, August 2022).

A study by Meijer et al. (2015) reported that extrinsic and internal factors affect the behaviour, knowledge, attitudes, and perceptions of adopters of agricultural innovation and technology. Because of past climate predictions and other advances that may not have lived up to farmers' expectations, smallholder rural farmers have a general lack of confidence in science that is tied to resistance to change (Kabobah et al., 2018). Therefore, practitioners generally become disheartened when some trained farmers choose not to use the adaptation practices.

6.4 CONCLUSION

According to the findings, extension services in the study areas are male-dominated, and the majority of staff's education qualifications are an honours or master's degree. The majority of extensionists are well experienced and well-versed in the topic of climate change. However the practitioners believed they needed to properly enhance their capacity to provide extension services related to climate change. Training required is in technical knowledge and skills for communicating such information to farmers. Other capacities included community and resource mobilisation, needs assessment of farmers, networking, and leadership capacities.

The analysis further demonstrated that various obstacles outside their control prevent agricultural extension practitioners from successfully providing extension services. These obstacles cannot be overcome by capacity building and training alone. The challenges noted by extension practitioners which prevent them from successfully providing extension services are a lack of infrastructure, limited knowledge, insufficient funding, and the farmers' aversion to change due to their loyalty to traditional farming methods. Therefore, based on the findings, it is recommended that government and development partners should devote more personnel, finances, and logistical resources to agricultural extension delivery in the Eastern Cape in order to increase the agricultural productivity and climate resilience of smallholder farmers. The desired adaptation outcomes on the ground can be ensured by the continuous professional

development of extension officers through workshops and training. Further training is needed for additional soft skills like communication, leadership, and networking.

CHAPTER 7 :
CHANNELS USED BY EXTENSION AND ADVISORY PRACTITIONERS TO DELIVER SERVICES TO FARMERS AND SOURCE OF INFORMATION

7.1 INTRODUCTION

The importance of agricultural extension to agricultural development has never been challenged (Pan et al., 2018). The role of agricultural extension is crucial in developing countries, where the majority of the population is engaged in agriculture. In these countries, agricultural extension is seen as a critical tool for poverty reduction, food security, and sustainable development (Swanson & Samy, 2016). Based on the strategic functions of agricultural extension, it can be argued that an economy like South Africa's, with its significant reliance on agriculture, benefits much from a better agricultural extension system. South Africa has elaborated its agricultural research and extension systems. Therefore, a wealth of research results and a pluralistic extension systems exist.

The Technical Centre for Agricultural and Rural Cooperation (CTA, 1996) found that limited access to agricultural information is one of the most significant constraints to agricultural development. In the climate change scope, access to information about climate change is essential for developing coping and adaptation strategies. To boost agricultural output, access to agricultural information is seen as crucial to modern agricultural systems (Popoola et al., 2020). This means access to information is a countering variable contributing to increased food production (Agboola, 2000). Agricultural extension services rely on a wide range of information sources to provide farmers with up-to-date information and knowledge. These information sources include scientific research, experiential knowledge, government policies and programmes, and local knowledge and practices. Each of these sources contributes to developing and disseminating new technologies and practices that can enhance agricultural productivity and sustainability (Davis & Mdee, 2018).

The information from practitioners must be communicated to farmers through a channel of extension communication. This is transferring an idea, advice, or information to a farmer through various channels to influence their decision (Kurtzo et al., 2016). A study by Okwu et al. (2006) explains that information should be transferred from the source (practitioners) to the

recipient (farmer) with minimal or no distortions for the communication to be effective. This means the channel through which the message is sent to the farmer will most likely affect whether the message is distorted or not. Therefore, the medium used for information is as significant as the data itself.

Age et al. (2012) define communication channels as the pathways through which messages move from the sender to the recipient and vice versa. Early extension initiatives relied on direct engagement with farmers; however, technological improvements have resulted in programmes that communicate with clients through various means, both directly and indirectly (Vergot et al., 2005). There are many different ways to communicate, and they all change constantly. As a result, no single channel can be used in all cases. Many clientele, particularly the elderly, continue to rely on more conventional agricultural information channels while supplementing with emerging technologies (Boz & Ozcatalbas, 2010).

Communication channels are classified into non-interpersonal (radio, television, phone calls, posters, newspapers, internet, social media, etc.) and interpersonal (extension agent, contact/ lead farmers, friends, and family, field demonstrations, etc.) (Okwu et al., 2006). The channel's selection is influenced by the cost, availability/accessibility, suitability, nature of the message, and the farmer's expectations. In a country like South Africa, agricultural extension faces financial, infrastructural, and human resources constraints (World Bank, 2018), which translates to a poor extension-agent-to-farmer ratio. Accordingly, extension practitioners must consider and promote non-interpersonal communication channels.

The difference between the two types of communication channels is that non-interpersonal channels are essential in conveying information and creating awareness or changing perceptions. Interpersonal channels, on the other hand, are more likely to cause attitude change (Rogers, 2003). Suleiman et al. (2021) elaborate that communication channels used for dissemination have a positive relationship with behavioural modification and improved adoption rates among rural farmers.

According to Israel and Wilson (2006), understanding of extension sources and channels used is a pre-requisite for efficient educational programming because messages that go unheard or unseen cannot lead to change (also argued by Okwu & Daudu, 2011). It seems reasonable to assert that the impact of any medium in a communication situation is determined not only by the medium's kind, but also by how it is employed or used. Questions about the use and effectiveness of various communication channels in agricultural extension service delivery, as

posited by Licht and Martin (2007), need to be experimentally addressed. That involves asking the following: Which communication channels are available and used to communicate farm innovation messages to farmers? What is the percentage of farmers who use and understand these channels?

For the channels to be effective, the sources must be selected to match the client's needs and problems. Information on agriculture can be acquired from person-to-person contacts, print and electronic media, and organisational meetings (Wulandari, 2015). Agricultural extension practitioners are the primary interpersonal sources of information about the farming system, according to Harun (2001). Effective extension communication channels must constantly evaluate the impact of their communication channels to farmers. These channels must also be accompanied by communication strategies that effectively inform farmers promptly, clearly, and effectively (Suleiman et al., 2021). This is because there is still a concern that information can be delayed on the way to the farmers, giving them outdated technical details, which is not beneficial to help them overcome their difficulties.

Speed and efficiency of communication has improved over the years, and Wulandri (2015) notes that practitioners must constantly develop their information-seeking strategies to address the information demands of the farmers. Carroll et al. (2022) state that extension practitioners must keep up with new communication channels and avoid getting comfortable with effective past techniques as new communication methods, technology, and societal trends continue to emerge. Extension services face various challenges when accessing agricultural information because the use of ICTs, ethnicities, beliefs, and so forth vary according to region (Yaseen et al., 2016). Extension services must note that benefits are more likely to be realised when information is relevant to the client's needs and channels provide detailed, individualised information.

Based on the above, the following objectives were posed for this study: (i) To determine the channels used for climate change information sharing, and (ii) to determine the sources of information used by extension practitioners.

7.2 MATERIAL AND METHODS

7.2.1 Study areas and data collection

The study was conducted in the Eastern Cape Province in three district municipalities: Chris Hani, OR Tambo, and Amathole. Information on the information sources and delivery

techniques used by extension officers to provide services to smallholder farmers was gathered using a mixed-methods approach involving questionnaire surveys and FGDs.

The survey included questions about channels used to communicate climate change information and the challenges faced using the channels. The questions further investigated the effectiveness of the communication channels, the sources of information, and the support practitioners receive from the DoA (through a platform where they can discuss climate information with other extension practitioners, support in the use of ICT platforms, etc.).

Extension practitioners were questioned regarding their knowledge of ICT tools like mobile phones, GIS/GPS modelling, early warning systems, and remote sensing systems, and whether these tools improve capacity needs of extension practitioners or not.

A total of 126 extension practitioners were selected from across the three districts in the Eastern Cape Province using random sampling. The SPSS software tool for descriptive statistics was used to analyse quantitative data from the questionnaire surveys (frequency counts and percentages), and a logistic regression was run to determine which independent variables (gender, level of education, information source, platform availability, visitation) have a statistically significant effect on the dependent variables.

The model was used to model when there are more than two outcomes or the dependent variable is nominal with more than two levels (Greene, 2003). The log odds of the outcome were modelled as a linear combination of predictor variables. The choice of a given extension provider was discrete because it was chosen among other alternatives (Verbeek, 2004).

7.2.2 Empirical model

A multinomial logistic regression (MLR) model is an extension of binary logistic regression that allows for the evaluation of the probability of categorical membership with more than two outcomes. It uses maximum likelihood estimation to assess the likelihood of each category. This type of model is employed when the dependent variable is nominal and has more than two levels (Greene, 2003).

In the MLR model, the log odds of each outcome are modeled as a linear combination of predictor variables. The goal is to understand the relationship between the predictor variables and the multiple categories of the dependent variable. For example, in the context of extension

providers, the MLR model can be used to analyze the discrete choice of a given provider among several alternatives (Verbeek, 2004). This allows researchers to examine the factors that influence farmers' decisions in choosing an extension provider from a range of available options.. If P_{ij} represents the probability of choice of any given extension services provider by farmers, then the equation as adopted from Verbeek (2004) representing this will be:

$$P_{ij} = \beta_0 + \beta_1 X_1 + \cdots + \beta_k X_k + e_i$$

i, takes values (1, 2, 3, 4….), each representing the choice of the channel used to provide extension services

i = 1 In-person visit

i = 2 Mass Media

i = 3 ICT

i = 4 Farmer-to-farmer

i = 5 Community leaders

One advantage of using multinomial logistic regression (MLR) over linear regression is that it does not require careful consideration of sample size and examination for outlying cases. MLR is more robust in handling non-normality, non-linearity, and heteroscedasticity assumptions, making it suitable for categorical or non-continuous data (Greene, 2003).

However, MLR does have its own set of assumptions. One key assumption is the independence among the choices of the dependent variable. This means that the categories or levels of the dependent variable should be mutually exclusive and not correlated with each other (Verbeek, 2008).

A disadvantage of using multiple regression models, including MLR, is that the results are sensitive to the data being used. Incomplete or biased data can lead to unreliable or misleading conclusions. Additionally, correlation does not imply causation, and using regression models to infer causation without proper experimental design or controlled studies can lead to erroneous interpretations of relationships between variables.

Overall, while MLR has its advantages in handling categorical data and not requiring strict assumptions like linearity and normality, it is crucial to interpret the results cautiously, considering the appropriateness of the data and potential confounding factors when drawing conclusions.This study, however, used complete and correct primary data, thus these disadvantages were avoided.

A limitation of the MLR model is the independence of irrelevant alternatives property, which states that the ratio of the probabilities of choosing any two alternatives is independent of the attributes of any other alternative in the choice set (Verbeek, 2008). However, the model allows farmer characteristics to have different effects on the relative probabilities between any two choices.

Let P_{ij} represent the probability of choice of any given extension services provider by farmers; the equation representing this will be,

$$P_{ij} = \beta_0 + \beta_1 \ldots\ldots + \beta_k X_k + e_i \ldots\ldots (1)$$

where i takes values (1, 2, 3, 4….), each representing the choice of channel used to provide extension services (In-person visits = 1, Mass Media = 2, ICT = 3, Farmer-to-farmer = 4). β are parameters to be estimated, X_1 are factors affecting the use of different channels to delivers services to farmers, and e_i is a randomised error. With j alternative choices, the probability of choosing communication channel j is given as suggested by:

$$Prob\ (Y_i = j) = \frac{e_{z_j}}{\sum_{k=0}^{j} e_{z_k}} \ldots\ldots (2)$$

where Z_j is a choice and Z_k is an alternative that could be chosen (Greene, 2003). The model estimates are used to determine the probability of using different communication channels for extension services' j factors that affect how X relates to the choice of Y with several alternative choices. The log odds ratio is computed as follows:

$$ln\left(\frac{P_{ij}}{P_{ij}}\right) = a + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + e_i \ldots\ldots (3)$$

P_{ij} and P_{ik} are probabilities that extension officer i will choose a given channel to deliver services and alternative channel, respectively. $ln\frac{P_{ij}}{P_{ij}}$ is a natural log of the probability of choice J relative to probability choice k; a is a constant; β is a vector that reflects the impact of changes

in X on the probability of choosing a given outlet; e is the error term that is independent. The parameter estimates in a multinomial logistic regression (MLR) model indicate the direction of the effect that each independent variable has on the dependent (response) variable. However, these estimates do not provide information about the actual magnitude of change or probabilities.

To assess the probabilities and measure the expected change in the probability of a particular choice being made, researchers use marginal effects or marginal probabilities. Marginal effects are functions of the probability itself and are calculated based on the probabilities of the different choices in the dependent variable.

The marginal effects represent the expected change in the probability of a specific choice occurring when there is a unit change in an independent variable, while keeping all other variables at their means (Greene, 2000). They provide insights into how each independent variable influences the likelihood of making a particular choice$\delta = \frac{\partial P_i}{\partial X_i} = pi\left(B_j - \sum_{k=0}^{j} P_k \beta_k\right) = P_i\left(\beta_j - \beta\right)$…… (4)

The MLR model was as follows;

$yi = ln\frac{P_i}{P_j} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots\ldots\ldots \beta_n X_n + e_i$ …….. (5)

where Yi = different communication channels extension officers use to provide services, β = coefficient vectors of independent variables and X_i, where i = 1, 2, 10 are explanatory variables and e_i = randomised error term.

7.2.3 Description of explanatory variables

Table 7.1 shows the list of independent variables that were included in the multinomial regression model, as well as their measurement and expected relationship to the choice of extension services.

Table 7.1: Relationships between dependent and explanatory variables of MLR

Dependent variable	Measure	
Communication channels used by extension officers to deliver services to farmers	In-person farm visits – 1 (extension officers physically visit the farmers) Mass media – 2 (extension officers use radio, tv and print to service farmers) ICT – 3 (extension officers use WhatsApp and smart gadgets to communicate services with farmers) Farmer-to-farmer extension – 4 (extension officers train farmers to provide extension services to other farmers) Community leaders – 5 (extension officers communicate information through councillors, chiefs, etc.)	
Explanatory variable	**How it is measured**	**Expected outcome**
Gender	Dummy - Male = 1; Female = 0	
Level of education	Categorical – National Senior Certificate/ Grade 12 = 0; Diploma = 1; Degree = 2; Honours = 3; Master's = 4	+
Source of information	Formal written communication (Journals, Articles) = 0; Internet = 1; Radio/Television = 2; Magazine/Newspaper (Farmers weekly) = 3; Colleagues = 4	+
Platform availability	No = 0; Yes = 1	–
Frequency of farmer visits	Weekly = 0; Monthly = 1; Quarterly = 2; Bi-yearly =3, Yearly = 4, When an incident occurs =5	+

The gender variable was included in the MLR model to examine the effect being a male or female has on an extension practitioner's choice of channels to deliver services to farmers. The coefficient for gender was predicted to be positive when tested against the dependent variable. Female practitioners are more likely to use ICT to communicate services to farmers and as a source of information.

Education was included in the MLR model to assess the effect varied education levels have on extension practitioners' choice of channels to deliver services to farmers. The coefficient for the level of education was predicted to be positive when regressed against the dependent variable. The tested hypothesis was that practitioners are more likely to use ICT and mass media to extend information to farmers because higher levels of education allow flexibility and use of varied methods to communicate with farmers (Reimers & Klasen, 2013). Similarly, they are most likely to use ICT and mass media as their source of information.

Source of information was included in the MLR model to assess its effect on practitioners' choice of channels to deliver services to farmers. The tested theory was that extension practitioners who use varied sources of information also explore communication channels.

Platform/forum availability, where extension workers discuss climate change, was included in the MLR model to assess its effect on practitioners' communication channel. The tested theory was that the availability of facilities like a WhatsApp group at work, where officials can discuss climate change, increases the probability of practitioners access and use of varied communication channels.

The last variable included in the model was the frequency of contact. This was to assess its effect on extension practitioners' choice of delivery channels. The coefficient for the frequency of contact response was predicted to be positive when tested against the dependent variable. This follows the hypothesis that the schedule of the practitioners determines the choice of the channel used; that is to say, the official may choose to use ICT rather than an in-person visit to communicate extension if they have a busier schedule.

7.3 RESULTS AND DISCUSSION

This section presents results from the topics developed based on the predefined questions. The results section is divided into 1) Demographic characteristics of respondents, 2) Communication channels used by extension, and 3) Sources of information.

7.3.1 Demographic characteristics of respondents

Results from the survey show that a majority of the respondents are male. The male respondents made up 56.6% of the sample. A study by Lahahi et al. (1999) encouraged an increase in the recruitment of female extension practitioners, noting that women farmers who had female extension practitioners reported having better adoption of suggested technologies and practices and technical knowledge of such techniques. Witinok-Hube et al. (2021) highlighted that it was not only female farmers, but a plurality of farmers (women and men) also reported wanting more women extension practitioners to serve them and their communities; this is because of the satisfaction with the quality of the practitioners' services, and credibility. The distribution of race is presented in Figure 7.1. African/Black people make up 95% of the practitioners in the research, followed by Non-blacks, with a breakdown of Caucasian/White people (3%), and then Indian and Coloured people (1% each). This supports a study conducted in South Africa by Lukhalo (2017).

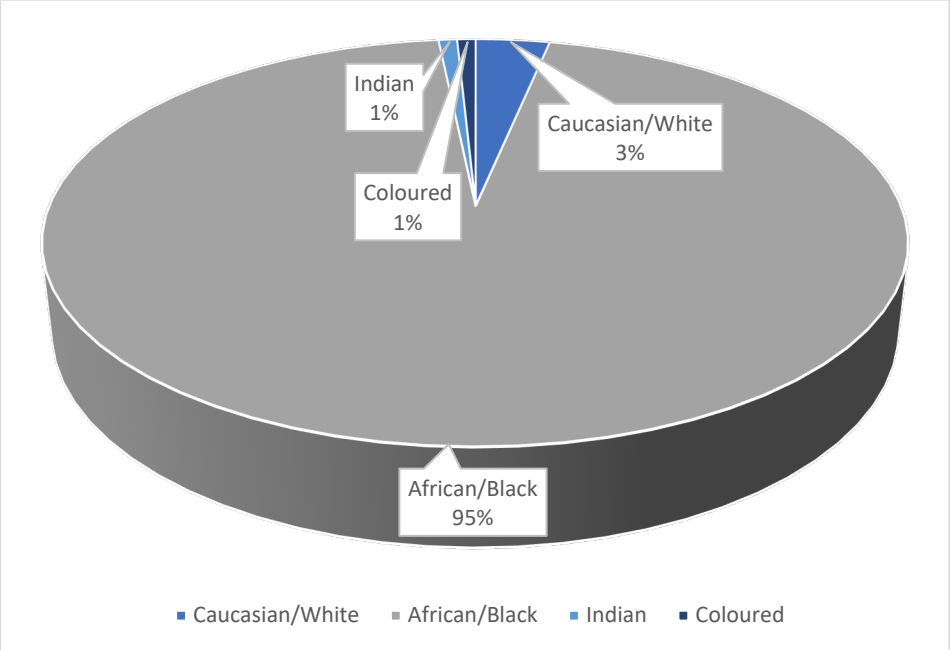


Figure 7.1: Race distribution of extension practitioners
Source: Field Survey, 2022

The results also show that 52.4% (31% honours degree, 21.4% master's degree) of the respondents comply with the Norms and Standards of Extension and Advisory Services (DoA, 2005). The Norms and Standards encourage practitioners to be well-trained, motivated, and

highly skilled. They further prescribe that all practitioners in South Africa should have a four-year bachelor's degree as a minimum qualification requirement (DoA, 2005).

The age of the respondents ranged between 24 to 64 years, with a mean age of 41 years old. Lukhalo (2017) also notes that the majority of practitioners in South Africa fall in the age group of 36–45 years. This may positively affect the channels and sources of information used because younger practitioners are anticipated to have higher knowledge levels of the different media and sources and utilisation of them.

Extension practitioners are expected to have a wide range of skills to respond to the needs of the farmers throughout the value chain. The Eastern Cape Province is a significant participant in several commodities, and practitioners with different specialisations are vital. Figure 7.2 shows the commodities practitioners specialise in.

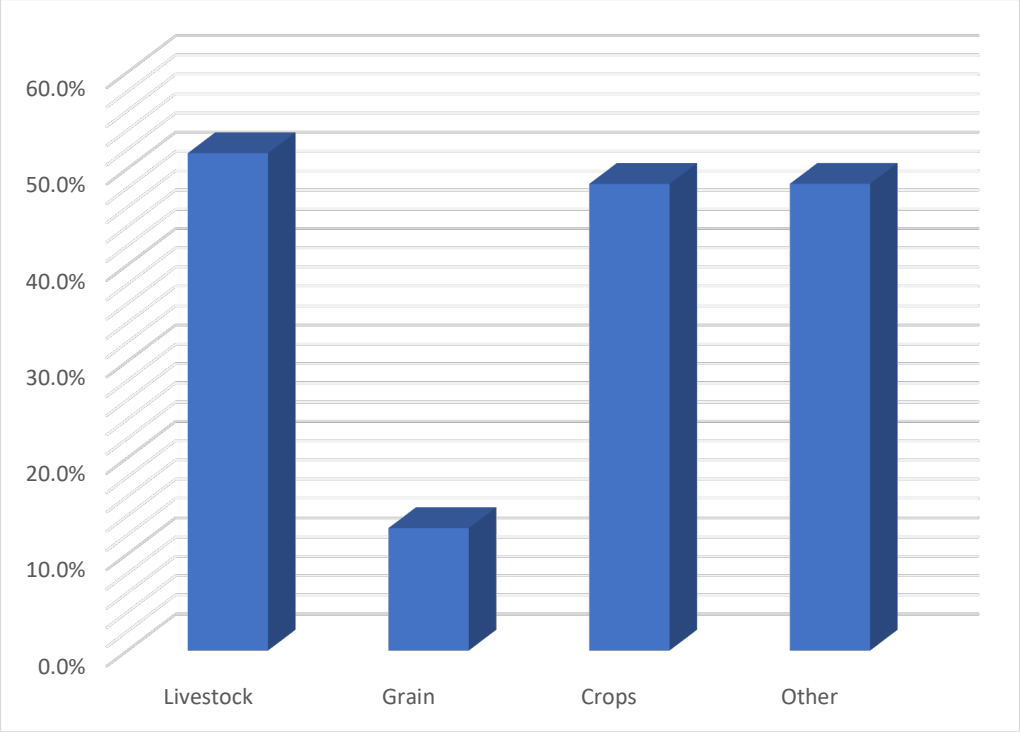


Figure 7.2: Area of specialisation of practitioners
Source: Field Survey, 2022

Having a specialisation in a particular area of agriculture, such as crop science, animal science, or grain, can help extension practitioners provide more targeted and practical support to farmers in the study areas, and it can assist practitioners in responding more effectively to the diverse and complex needs of farmers.

7.3.2 Communication channels used by extension practitioners

Respondents were asked to indicate their communication channels for extension services. Table 7.2 summarises the results, and it shows that practitioners in the study areas use in-person visits, mass media, ICTs, farmer-to-farmer extension, community leaders, and other communication channels.

Table 7.2: Communication channels

Communication channel	Frequency (n)	Percentage (%)
In-person visit	76	60.3%
Mass media	15	11.9%
ICT	25	19.8%
Farmer-to-farmer extension	75	59.5%
Community leaders	47	37.3%
Other	7	5.6%

Source: Field survey, 2022

The findings as shown in Table 7.2 show that in-person visits (60.3%), farmer-to-farmer extension (59.5%), and community leaders (37.3%) were the main communication channels in the study areas. This proves that practitioners in the region prefer to use interpersonal extension. This could be due to several reasons, as noted during the survey. Extension practitioners indicated that accessibility, the nature of the message, and the farmers' expectations impacted their preferred channel choice. Sobalaje and Adigun (2013) note that the accessibility of a channel is essential in determining its use. This is consistent with Zikhali et al. (2021), whose study showed that it is easier to convey agricultural extension services, especially climate change information, when doing so face-to-face. This is because it allows practitioners to assess whether farmers understand and gives them a chance to address any misunderstandings or questions quickly.

The respondents were asked whether their communication channels were effective, using a scale from 1–10, with 1 being not effective and 10 being effective. Most (56.8%) of the respondents chose ratings between 7 and 10, indicating that their choice of communication channels is

practical. However, because they are now experiencing significant difficulties with interpersonal communication channels, the participants mentioned that they would prefer to investigate non-interpersonal channels (mass media and ICTs).

Figure 7.3 below shows challenges experienced by practitioners with the current extension channels.

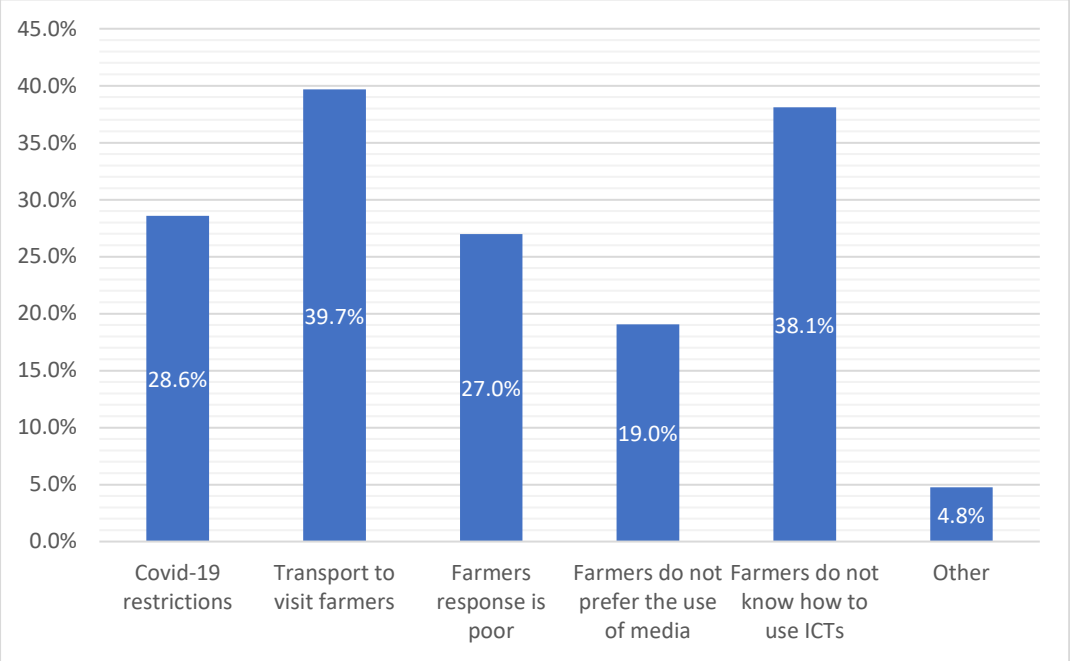


Figure 7.3: Challenges with current extension services channels
Source: Field Survey, 2022

The study was conducted when COVID-19 limitations were still in place in South Africa. This meant that the interpersonal routes usually employed by practitioners presented difficulties. Extension workers in South Africa were recognised as essential workers during the COVID-19 pandemic due to the critical services they provided to communities; however, 28% of the respondents highlighted that they still struggled with accessing farmers due to COVID-19 restrictions.

The DoA's continued struggles with transportation for farmer visits were emphasised by 39.7% of the practitioners in the study areas, as shown in Figure 7.3. These struggles are due to the limited number of vehicles available and the administrative procedures necessary to obtain

them. Practitioners highlighted that there is a problem with farmers' response rates and, overall, the farmers are either unable to utilise or prefer not to use mass media and ICTs.

The research noted that the frequency of farmer visits was not statistically significant; however, participants who only used interpersonal channels of communication conducted more frequent visits than those who used both interpersonal and non-interpersonal. This could be that participants who have diverse means of communicating feel that they do need to visit the farmers as frequently. In contrast, those using only interpersonal communication regard more frequent farmer visits as important.

To investigate further, a logistic regression was performed to determine which independent variable/s had a statistically significant effect on communication channels. Independent variables included gender, age, level of education, information source, platform availability, and visitation. All assumptions were met, therefore the results were interpreted and showed that the logistic regression model was statistically significant, with $\chi 2(6) = 18{,}593$, $p = 0{,}005$. The model explained 28% (Nagelkerke R2) of the variance in communication channels and correctly classified 71% of cases. The results are presented in Table 7.3.

Table 7.3: Factors affecting the use of communication channels

	Coefficient estimates		Marginal effect	
Variables	**Coff.**	**Std. Err**	**Coff.**	**Std. Err**
Gender	0.384	0.543	-0.980	0.519
Age	-0.410	0.561	-0.287	0.263
Highest level of education	-0.797	0.564	0.257	0.287
Information sources	3.084	1.081	-0.027	.007**
Discussion forum	0.276	0.587	0.014**	0.011**
Frequency of farmer visits	-0.170	0.022**	0.081	0.036*
Number of observations = 12	pseudo r-squared 0.625	–2 log-likelihood 103.868	Prob > chi2 = **	

Notes: ***, ** , * mean significant at 1%, 5%, and 10% levels of significance, respectively.
ns = not statistically significant

Six independent variables included in the logistic are gender, age, highest level of education, information sources, availability of discussion fora, and frequency of visits. The pseudo r-squared was 0.625%, indicating that the model used was relatively strong to reliably predict factors affecting the use of communication channels, the explanatory variables, and the variance.

The coefficient estimate for gender was 0.384 ($p > 0.05$), as shown in Table 7.2, which indicates that being a female increases one's propensity to use communication channels. However, the marginal effect of -0.980 suggests that being female is associated with a lower likelihood of utilising communication channels. This disparity between the estimated coefficient and marginal effect raises the possibility of interactions between gender and other unexplained factors, calling for more research.

However, studies that have looked into how communication preferences and communication methods vary by gender suggest that, compared to males, women typically participate in more frequent and varied communication, including communication channels. Karatsoli and

Nathanail (2020) assert that women are more likely than men to reach out for information offered by social media and to use varied communication channels.

According to Table 7.2, the age variable shows that using communication channels is less frequent for older people, according to the negative coefficient estimate of -0.410 ($p > 0.05$). The marginal effect of -0.287 (p 0.05) further suggests that using communication channels is less likely as people get older, which supports this finding. These results indicate that younger people are more responsive to and comfortable with different communication mediums. This is confirmed by Wilkins et al. (2018) and Lukhalo (2017), who highlight that younger practitioners are projected to have more awareness of the various communication channels and information sources and to use them more.

The marginal effect for the variable "level of education of extension practitioners" was positive at 0.257 ($p < 0.05$), indicating that an increase in the highest level of education leads to a higher probability of using communication channels. Oladele (2015) reports that extension practitioners with more education better understand how ICTs and other communication channels are used in agricultural research and extension activities.

Information sources were statistically significant relative to communication channels. This means a total of 87% of participants whose communication channel included physical interaction and media used more than one source of information compared to 57% of participants whose communication channel included only physical interaction (they had a 30% higher use of a single information source), as presented in Table 7.3. The positive coefficient estimate of 3.084 ($p < 0.05$) suggests that information sources significantly influence communication channel usage. According to Abukari et al. (2021), the use of communication channels depends on the accessibility, availability, and cost of using that channel.

The coefficient estimate for the variable frequency of visits is -0.170, and it is statistically non-significant ($p > 0.05$). This suggests that there is a negative association between the frequency of farmer visits and the use of communication channels, which implies that as the frequency of farmer visits increases, the probability of using communication channels decreases.

Lastly, the use of discussion fora as a variable appears to have a favourable impact on the use of communication channels, according to the positive coefficient estimate of 0.276 ($p > 0.05$). The marginal effect of 0.014 (p 0.01), which indicates that the likelihood of using communication channels rises with the use of discussion boards, supports this finding. These

findings underline platforms' importance in encouraging user interaction and information sharing.

7.3.3 Sources of information

Table 7.4 shows sources of information on climate change for practitioners in the study areas. The internet is ranked as the top source of information at 59.5%, followed by radio, colleagues at work, formal written communication, magazines/newspaper, and others.

The analysis of climate change information sources indicated that practitioners primarily use the internet, radio, and colleagues at work as sources of information in the study areas. It is worth noting that the availability and accessibility of pertinent and valuable information about climate change significantly impact the readily available information about climate adaptation. As such, with the rapid development of ICT, the internet is becoming a more common instrument for people to use for information sourcing (Deshpande et al., 2014). Another school of thought contends that the internet offers a level playing field for ideas, which traditional media do not. It gives organisations more chances to reach a wider audience with their messages (Popoola et al., 2020), and it opens many doors for those who might not otherwise have access to information (Gavin, 2008). Over the years, mobile phones and associated applications have been utilised effectively in several African nations to gather weather-related data and general agricultural information. Mobile phones are acknowledged as a crucial medium for information (Aker & Fafchamps, 2015). This emphasises how vital mobile phones and the internet are to obtain information.

Table 7.4: Information sources for practitioners

Variables	Frequency (n)	Percentage (%)
Formal written communication (Journals, Articles)	37	29.4%
Internet	75	59.5%
Radio/Television	64	50.8%
Magazines/Newspaper (Farmers weekly)	37	29.4%
Colleagues at work	39	31.0%
Other institutions	6	4.8%

Source: Field Survey, 2022

Radio and television were ranked second in this study as a source of climate change information for practitioners. Radio was reviewed by Olajide (2011) and found to be significantly less expensive than other information sources. The study further emphasised its numerous unique advantages, making it a highly utilised and preferred information source among extension practitioners (Olajide, 2011). The inference is that radio and television, in this context, play a significant role in society. By raising public knowledge of particular issues and influencing people's interests, attitudes, and, ultimately, governmental legislation, the media plays an essential role in bringing about change (Murphy, 2015). It is the most effective and quickest way to spread information and significantly impact how people perceive climate change (Popoola et al., 2020).

In this study, practitioners highlighted using the weather section of radio and television news reports, primarily the SAWS, which was their most crucial and trustworthy source of information on climate change. According to Gavin (2008), this could be because, for most people, watching television is still the most effective way to learn about science and the environment.

Personal interaction with colleagues at work is another source of information used in the study areas, as noted by 31% of respondents (see Table 7.4). Participants indicated that personal interaction with co-workers leads to information sharing. The participants fully encouraged this and highlighted that it allows for information sharing and participatory and collaborative interactions. They also encouraged the development of a platform/forum to discuss climate information with other extension practitioners.

Formal written communication (journals, articles) and magazines/newspaper ranked last, at 29.4% each, for providing participants with climate change information. The high costs of formal and informal communication methods are attributed to the low numbers utilising them. To support agricultural growth, particularly in tackling climate change challenges, there is a dire need to encourage a strong interest in the use of formal and informal information.

7.4 CONCLUSION

Enough evidence exists that increased climate inconsistencies will seriously hinder agricultural production. Smallholder farmers are particularly challenged by the need to adapt to and/or cope with changing climatic circumstances, as they are more disadvantaged for various reasons – one of which is their lack of access to agricultural information. Both the number and ability of extension practitioners to educate rural farmers about climate change issues and assist with appropriate coping and adaptation responses are limited. As such, the sources of information and channels practitioners use are vital in ensuring farmers' adaptation. This research investigated the sources of information and channels used in extension in the Eastern Cape.

Results revealed that extension practitioners in the region mostly used interpersonal communication channels. Moreover, the availability, accessibility, resources, and facilities required to use a specific communication channel all had an impact on the choice of channels. It was concluded that practitioners were experiencing challenges with their current channels and exploring interpersonal mediums.

Sources of information distribution are considered vital as they successfully link people to information they might otherwise be unaware of. As a result, people's reliance on information sources is growing. In this study, those information sources are seen as essential to helping practitioners learn more about climate change so that they can assist smallholder farmers to satisfy their adaptation needs. The analysis of the information sources used in this study on climate change found that the study areas' top information sources were the internet, radio and television, and colleagues. These sources were discovered to be more successful than the public at disseminating information about climate change.

This study suggests stepping up the use of mass media and written communication as sources of information in the study areas in order to increase awareness, knowledge, and skills related to climate change. Also, it is necessary to raise the educational level of extension practitioners

by acquiring more qualifications in related fields so that they comply with the DoA's (2005) Norms and Standards. Lastly, the study suggests that adequate policies and sufficient provision of sources and channels for information should be used to improve the extension practitioners' readiness, which is a composite of access, availability, accessibility, and competency.

CHAPTER 8 :
SUMMARY, CONCLUSIONS, AND RECOMMENDATION POLICY IMPLICATIONS AND AREAS FOR FURTHER RESEARCH

8.1 INTRODUCTION

This chapter summarises the research findings, briefly discusses the implications, conclusions, and recommendations of the study. The summary of the results includes input from qualitative and quantitative approaches employed in the descriptive and empirical analysis.

This research was done to understand better the capacity of extension practitioners in supporting farmers to adapt to climate change in the Eastern Cape, South Africa. Furthermore, the study also aimed to provide insight and empirical evidence on the climate change awareness and level of understanding of extension practitioners, farmers' perceptions of the capacity of extension practitioners in relation to climate change, the capacity needs of extension practitioners, and channels used by extension and advisory practitioners to deliver services to farmers and as sources of information. The research hypotheses stated that extension practitioners lack sufficient awareness of climatic changes and fail to grasp the significance of these for farmers' production in the province. It was also hypothesised that extension practitioners lack the necessary information on and understanding of climate change to effectively support the farmers they work with. Additionally, the hypotheses suggested that physical farm visits serve as the primary method of delivering services, while alternative options, such as ICT, are met with resistance due to the inflexibility of extension practitioners.

8.2 CONCLUSIONS

The first objective investigated climate change awareness and level of understanding of extension practitioners in the study areas. The findings shows that extension practitioners are aware of climate change, and the impacts on agriculture. However, there are notable knowledge gaps regarding climate change and adaptation, which are due to the limited sources of information as well as the training on climate change that practitioners have. The research also noted that there is a need of capacity-building initiatives, with a focus on climate change and policies.

Overall, the findings of this study suggest that in order to raise the levels of awareness and understanding, capacity-building initiatives with a focus on climate change and adaptation must be implemented, and additional work needs to be done to increase practitioners' access to current, relevant scientific information and informal climate change education.

The second objective of the study assessed the farmers' perceptions of the capacity of extension practitioners related to climate change. Farmers highlighted that they have access to extension services. They reported that they are aware of climate change, and the phenomenon has dramatically harmed their way of life, with notable crop failure, livestock loss, and infrastructural destruction. The results show that farmers get information about climate change from extension practitioners, along with suggestions for adaptation, interventions, and programmes. Based on this, farmers emphasised the necessity for continued advancement in the field of climate change for practitioners. It was concluded that practitioners need ongoing training, and the following recommendations were made: i) the government should regularly engage practitioners in discussions about climate change observations in their fields of expertise, ii) these engagements should include ongoing training, and iii) there should be a renewed emphasis on indigenous knowledge management and education (i.e., IKS).

The third objective evaluated the capacity needs of extension practitioners. Based on empirical findings, practitioners need to improve their ability to offer extension services connected to climate change. Technical knowledge and communication skills to convey information to farmers are required. Additional skills include networking, leadership abilities, community and resource mobilisation, and farmer needs assessment.

The investigation also showed that agricultural extension practitioners could not successfully provide extension services because of several factors outside their control. It is therefore advised that government and development partners invest more resources into agricultural extension delivery in the study areas to boost agricultural productivity and climate resilience of smallholder farmers.

The fourth objective investigated the channels of communication and sources of information used by extension practitioners. The results noted that practitioners tended to use interpersonal communication channels compared to interpersonal media. Also, the choice of channels was influenced by the accessibility, availability, resources, and facilities needed to use a particular communication channel.

The analysis of the information sources employed in this study on climate change revealed that the internet, radio and television, and colleagues were the top information sources in the study areas. They were shown to be more effective at spreading knowledge about climate change than the general public. This study recommends increasing the use of written communication as a source of information and mass media as communication channels in the study areas. Additionally, the educational levels of practitioners must be raised by assisting them to obtain more credentials and qualifications. The study concludes that availability, accessibility, and sufficient provision of sources of and channels for information should be maintained by practitioners.

8.3 RECOMMENDATIONS

This work comes at a crucial time, when the world is looking at ways to build resilient food systems. Farmers depend on extension practitioners for information, and these research findings highlight the need to prioritise climate change and adaptation while establishing a sound strategy for extension services. Within this context, the following steps are recommended based on the study's results and conclusions:

1. More effort should be made to increase extension practitioners' access to current, pertinent scientific information and formal climate change education. These considerations serve as the basis for the following advice: (i) The government should give practitioners opportunities for regular engagement in making observations about climate change their work areas, and (ii) practitioners should be encouraged to use written communication as a source of information and use mass media as communication channel in the study areas.
2. There should be engagements that include ongoing training, emphasising communication skills and the use of ICTs, as well as technical know-how, community mobilisation, farmer needs assessment, networking leadership, resource mobilisation, and policies that affect their line of work.
3. A renewed emphasis needs to be placed on indigenous knowledge management and education (i.e., IKS). This will ensure that the information and adaptive methods farmers independently use can be acknowledged by practitioners.
4. This study recommends governments and development partners invest more personal, financial, and logistical resources into agricultural extension delivery in the Eastern Cape

in order to boost the agricultural productivity and climate resilience of smallholder farmers.

5. In order for extension practitioners to comply with the DoA's (2005) Norms and Standards, it is also advised that practitioners enhance their educational level by getting more credentials in related subjects. The study concludes that in order to increase the preparedness of the extension officer, which is a composite of access, availability, accessibility, and competency, proper policies and sufficient provision of sources and channels for information should be used.

8.4 AREAS FOR FURTHER RESEARCH

This study investigated the capacity of extension practitioners in supporting farmers to adapt to climate change in the Eastern Cape, South Africa. The findings of the study raised new questions which, if further researched, can provide more insights to improve the effectiveness of extension services in addressing climate change. Accordingly, the following further research is recommended:

1. Assessment of existing extension programmes: There is a need to continuously evaluate existing extension programmes to determine the extent to which they address climate change adaptation. This assessment can help identify gaps and opportunities for improving extension services in addressing climate change.
2. Capacity-building needs assessment: A comprehensive needs assessment can help identify extension practitioners' specific capacity-building needs in regards to climate change adaptation. This assessment can inform the development of tailored capacity-building programmes relevant to the particular needs of extension practitioners.
3. Knowledge and information management: Extension practitioners need to have access to up-to-date and relevant information on climate change adaptation and mitigation. Exploring the most effective ways of managing and disseminating climate change information to extension practitioners and farmers is necessary.
4. Partnerships and networks: Collaboration and partnerships among extension practitioners, researchers, and other stakeholders can enhance the capacity of extension practitioners in addressing climate change. There is a need to explore the most effective ways of establishing and strengthening partnerships and networks that can support extension practitioners in delivering effective climate change services.

5. Innovative extension approaches: Traditional extension approaches may not be effective in addressing the complex challenges of climate change. There is a need to explore innovative approaches, such as the use of ICTs and participatory extension methods, that can enhance the capacity of extension practitioners in relation to climate change adaptation and mitigation.

8.5 THESIS DISSEMINATION

The adoption of the suggestions in this thesis can be used as a foundation for potential confirmation or rejection of the study's findings. The empirical results of this thesis will be presented at academic conferences and will be submitted to peer-reviewed journals for publication. The thesis will be digitally and physically archived at the University of the Free State (UFS) library. The findings will be disseminated to the farmers and extension practitioners in the study region. A climate change and agriculture training programme will also be presented to practitioners in the study areas. The proposal for this programme is included in Appendix K.

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APPENDIX A: ETHICS CLEARANCE LETTER

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

GENERAL/HUMAN RESEARCH ETHICS COMMITTEE (GHREC)

02-Jun-2022

Dear Mrs Anathi Makamane

Application Approved

Research Project Title:
CAPACITY OF EXTENSION AND ADVISORY SERVICES IN SUPPORTING FARMERS TO ADAPT TO CLIMATE CHANGE IN THE EASTERN CAPE, SOUTH AFRICA

Ethical Clearance number:
UFS-HSD2022/0482/22

We are pleased to inform you that your application for ethical clearance has been approved. Your ethical clearance is valid for twelve (12) months from the date of issue. We request that any changes that may take place during the course of your study/research project be submitted to the ethics office to ensure ethical transparency. furthermore, you are requested to submit the final report of your study/research project to the ethics office. Should you require more time to complete this research, please apply for an extension. Thank you for submitting your proposal for ethical clearance; we wish you the best of luck and success with your research.

Yours sincerely

Dr Adri Du Plessis
Chairperson: General/Human Research Ethics Committee

Dr Adri du Plessis
Digitally signed by Dr Adri du Plessis
Date: 2022.06.03 07:44:11 +02'00'

205 Nelson Mandela Drive
Park West
Bloemfontein 9301
South Africa

P.O. Box 339
Bloemfontein 9300
Tel: +27 (0)51 401 9337
duplessisA@ufs.ac.za
www.ufs.ac.za

APPENDIX B: PERMISSION LETTER TO CONDUCT RESEARCH

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS
NATURAL AND AGRICULTURAL SCIENCES
SUSTAINABLE FOOD SYSTEMS AND DEVELOPMENT

Department for Sustainable Food Systems and Development
P.O. Box 339, BLOEMFONTEIN 9300
☎ 051 401 2163
msa@ufs.ac.za

Department of Rural Development and Agrarian Reform (Eastern Cape)

01/06/2022

Dear Sir/Madam,

Re: Permission to conduct research

My name is Anathi Siphesihle Makamane, a doctoral student from the Department for Sustainable Food Systems and Development, University of the Free State. My research is titled: Capacity of extension and advisory services in supporting farmers to adapt to climate change in the Eastern Cape, South Africa.

I hereby request permission to conduct the study in the following district municipality: Chris Hani, Joe Gqabi, OR Tambo and Amathole. My respondents will include agricultural advisory services (extension agents and extension managers) and smallholder farmers involved in crop and livestock enterprises. I would also appreciate the support and collaboration with extension officials responsible for the respective areas to assist me with answering the questionnaire about them and the mobilisation of farmers for focus group discussion.

I certify that the research participants will not be advantaged or disadvantaged in any way. They will be reassured that they can withdraw their participation during this project without any penalty. There are no foreseeable risks in participating in this study, and the participants will not be paid for this study.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Thank you in advance for your time and consideration

Yours sincerely,

Anathi Makamane, 2010143242
silwanaas@ufs.ac.za

Dr Jan Swanepoel (Supervisor)
SwanepoelJW@ufs.ac.za

APPENDIX C: APPROVAL LETTER TO CONDUCT RESEARCH

rural development
& agrarian reform
Department:
Rural Development & Agrarian Reform
PROVINCE OF THE EASTERN CAPE

OFFICE OF THE CHIEF DIRECTOR: FARMER SUPPORT AND DEVELOPMENT:
8th Floor Dukumbana Building · Independence Avenue · Private Bag X0040 · BHISHO, 5606 · REPUBLIC OF SOUTH AFRICA.
Tel: +27 (0)40 602 5153/ 5130 · **Fax:** +27 0862310599 · Cell: 082
E-mail: Hamilton.ntsabo@drdar.gov.za/nomthandazo.bhengu@drdar.gov.za www.drdar.gov.za

Our Reference:		Your Reference:	

4 July 2022

Ms U Makamane
Dept. of Sustainable Food Systems and Development
University of Free State
P.O. Box 339
BLOEMFONTEIN 9300

Dear Ms Makamane

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH EASTERN CAPE

Your correspondence on the above matter bears reference

The Department of Rural Development and Agrarian Reform (DRDAR) of the Province of the Eastern Cape has no objection in granting you permission to conduct the interviews with our Extension and Advisory Services personnel as detailed in your request letter.

We look forward in anticipation to the outcomes of this very important study.

DATE: 06.07.2022

HM NTSABO
CHIEF DIRECTOR: DISTRCIT CORDINATION

Cc: *Ms N Bongco : Regional Director: Amathole*
Dr Z Ntondini: Regional Director: Chris Hani
Mr. Z Madyibi: Regional Director: OR Tambo

APPENDIX D: FARMER CONSENT FORM

RESEARCH STUDY INFORMATION LEAFLET AND CONSENT FORM

DATE

MARCH 2022

TITLE OF THE RESEARCH PROJECT

CAPACITY OF EXTENSION AND ADVISORY SERVICES IN SUPPORTING FARMERS TO ADAPT TO CLIMATE CHANGE IN THE EASTERN CAPE, SOUTH AFRICA

PRINCIPLE INVESTIGATOR / RESEARCHER(S) NAME(S) AND CONTACT NUMBER(S):

ANATHI SIPHESIHLE MAKAMANEANATHI SIPHESIHLE MAKAMANEANATHI SIPHESIHLE MAKAMANEANATHI SIPHESIHLE MAKAMANE 201014324220101432422010143242201014324 +27719911759 +27719911759 +27719911759 +27719911759

FACULTY AND DEPARTMENT:

NATURAL AND AGRICULTURAL SCIENCESNATURAL AND AGRICULTURAL SCIENCESNATURAL AND AGRICULTURAL SCIENCESNATURAL AND AGRICULTURAL SCIENCES

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DEVELOPMENTDEPARTMENT OF SUSTAINABLE FOOD SYSTEMS AND DEVELOPMENTDEPARTMENT OF SUSTAINABLE FOOD SYSTEMS AND DEVELOPMENT

STUDY LEADER(S) NAME AND CONTACT NUMBER:

DR. JAN W SWANEPOEL (UFS staff member)DR. JAN W SWANEPOEL (UFS staff member)DR. JAN W SWANEPOEL (UFS staff member)DR. JAN W SWANEPOEL (UFS staff member)

+27784577655+27784577655+27784577655+27784577655

DR. OLWETHU LOKI

+27794203251

WHAT IS THE AIM / PURPOSE OF THE STUDY?

The study aims to investigate the capacity of extension and advisory services in supporting farmers to adapt to climate change in the Eastern Cape, South Africa.

WHO IS DOING THE RESEARCH?

I, Anathi Siphesihle Makamane, will be conducting the research as part of my doctoral thesis in Sustainable Agriculture at the Department for Sustainable Food Systems and Development, University of the Free State.

HAS THE STUDY RECEIVED ETHICAL APPROVAL?

This study has received approval from the Research Ethics Committee of UFS. A copy of the approval letter can be obtained from the researcher.

Approval number: UFS-HSD2022/0482/22UFS-HSD2022/0482/22UFS-HSD2022/0482/22UFS-HSD2022/0482/22

WHY ARE YOU INVITED TO TAKE PART IN THIS RESEARCH PROJECT?

You were selected to participate in the study as you are farmer in the area. Contact details of participants were obtained from the Department, and convenience sampling was used. You were selected to participate in the study as you are farmer in the area. Contact details of participants were obtained from the Department, and convenience sampling was used. Contact details of participants were obtained from the Department, and convenience sampling was used. You were selected to participate in the study as you are farmer in the area. Contact details of participants were obtained from the Department, and convenience sampling was used. You were selected to participate in the study as you are farmer in the area.

WHAT IS THE NATURE OF PARTICIPATION IN THIS STUDY?

The participants (farmers) will participate in surveys and focus groups discussions. The questionnaire will take about 30 minutes to complete, and the focus group will be 60- 90 minutes.

CAN THE PARTICIPANT WITHDRAW FROM THE STUDY?

Being in this study is voluntary, and you are under no obligation to consent to participation. The participants will be told about the purpose of the study; their input and availability will be explained before they fill out the questionnaire. If you decide to withdraw from the study at any point, you are free to do so without giving a reason.

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

The research outcomes will be documented and available for reference for similar studies and policy recommendations on extension practitioners' capacity needs. This will be done while protecting the confidentiality of the participants. The research outcomes will be documented and

available for reference for similar studies and policy recommendations on extension practitioners' capacity needs. This will be done while protecting the confidentiality of the participants. s will be documented and available for reference for similar studies and policy recommendations on extension practitioners' capacity needs. This will be done while protecting the confidentiality of the participants. The research outcomes will be documented and available for reference for similar studies and policy recommendations on extension practitioners' capacity needs. This will be done while protecting the confidentiality of the participants. The research outcome

WHAT IS THE ANTICIPATED INCONVENIENCE OF TAKING PART IN THIS STUDY?

Farmers might lose out on the productivity time due to the time spent in the interview. I will also travel to the farmer's comfort zone to complete the questionnaire and minimise travel costs. They might also find it difficult to travel to a central point for the discussion boards; however, I will target when they meet for their meetings and farmers day. The sessions will not require physical work or labour such as trials, and therefore no risks to health or injuries are anticipated to happen.

WILL WHAT I SAY BE KEPT CONFIDENTIAL?

During the study, your identity will not be recorded, and at no point will your answers connect back to you. Participants will be briefed clearly and made to thoroughly understand the purpose and the guarantee of their identification to remain kept for the study use. In this case, codes or numbers will be used, and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. The answers may be used in the research report, journal articles, and conference presentation; within these publications and presentations, the participant's anonymity will be protected, no identification of the participants will be made. Only the University will use their data if need to make a future reference. During FGDs, I will constantly encourage all participants to treat the information confidentially, and I will advise you not to disclose sensitive personal information in the focus group.

HOW WILL THE INFORMATION BE STORED AND ULTIMATELY DESTROYED?

The researcher will store hard copies of your answers for five years in a locked cupboard/filing cabinet at the University of the Free State. Electronic information will be stored on a password-protected computer for future research or academic purposes. Future use of the stored data will be subject to further Research Ethics Review and approval. After the stated period of 5years data (hardcopy and electronic) will be destroyed by deleting, ensuring that there is no record available. The participant does not run the risk of any harm, and the questions are structured in a way that avoids discrimination or any form of misconduct that can result from the study, which safeguard the participant.

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

Participants will be informed before signing consent form about the benefits of the study and that there will be NO payment or incentives for participating in this study Participants will be informed before signing consent form about the benefits of the study and that there will be NO payment or incentives for participating in this study.

HOW WILL THE PARTICIPANT BE INFORMED OF THE FINDINGS / RESULTS OF THE STUDY?

If you would like to be informed of the final research findings, please contact Anathi Makamane on 0719911759 or 0514013893 or email address at asilwana16@gmail.com The findings are accessible for 6 months after approval by the University of the Free State. Participants can request information via WhatsApp, but not Facebook, Twitter, or other social media platforms. Should you require any further information or want to contact the researcher about any aspect of this study, please get in touch with Anathi Makamane at the abovementioned contact details, including email address. Should you have concerns about the way in which the research has been conducted, you may contact Dr Jan Swanepoel, 0784577655 (contact details), SwanepoelJW@ufs.ac.za (email).

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

CONSENT TO PARTICIPATE IN THIS STUDY

I, the undersigned,

_____ (*participant's full names to be included*), (the "**Participant**")

confirm that I voluntarily agree to participate in the research

I, the undersigned Participant, further confirm that–

the Researcher has explained the nature, procedure, potential benefits and anticipated inconvenience of my participation in the Study;

1. I have read (or had explained to me) and understood the Study as explained in the attached information sheet;
2. I have had sufficient opportunity to ask questions and am prepared to participate in the Study;
3. I understand that my participation in the Study is entirely voluntary and that I am free to withdraw at any time without penalty (if applicable);
4. I voluntarily provide the UFS and the Researcher with my personal information and consent to the UFS and the Researcher collecting, disclosing and processing my personal information in order to conduct the Study and any related activities in relation thereto;
5. I hereby acknowledge and confirm that I understand the purpose for which the UFS and the Researcher may collect, store, use, delete, destroy, outsource, transfer or otherwise process, as the context and circumstances may require and as contemplated in terms of POPIA, my personal information as set out herein;

6. I am aware that the findings of the Study will be anonymously processed into a research report, journal publications and/or conference proceedings and that my personal information will be aggregated and deidentified at such stage;
7. I also give the UFS permission to share, without notification, the collected data with other researchers at the UFS or other higher education institutions. This permission is dependent on the same principles of ethical research practices, anonymity/ confidentiality, safekeeping of information, and other issues listed above applying.

APPENDIX E: EXTENSION PRACTITIONERS CONSENT FORM

RESEARCH STUDY INFORMATION LEAFLET AND CONSENT FORM

DATE

MARCH 2022

TITLE OF THE RESEARCH PROJECT

CAPACITY OF EXTENSION AND ADVISORY SERVICES IN SUPPORTING FARMERS TO ADAPT TO CLIMATE CHANGE IN THE EASTERN CAPE, SOUTH AFRICA

PRINCIPLE INVESTIGATOR / RESEARCHER(S) NAME(S) AND CONTACT NUMBER(S):

ANATHI SIPHESIHLE MAKAMANEANATHI SIPHESIHLE MAKAMANEANATHI SIPHESIHLE MAKAMANEANATHI SIPHESIHLE MAKAMANE 2010143242201014324220101432422010143242 +27719911759 +27719911759 +27719911759 +27719911759

FACULTY AND DEPARTMENT:

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STUDY LEADER(S) NAME AND CONTACT NUMBER:

DR. JAN W SWANEPOEL DR. JAN W SWANEPOEL DR. JAN W SWANEPOEL DR. JAN W SWANEPOEL

+27784577655+27784577655+27784577655+27784577655

DR. OLWETHU LOKI

+27794203251

WHAT IS THE AIM / PURPOSE OF THE STUDY?

The study aims to investigate the capacity of extension and advisory services in supporting farmers to adapt to climate change in the Eastern Cape, South Africa.

WHO IS DOING THE RESEARCH?

I, Anathi Siphesihle Makamane, will be conducting the research as part of my doctoral thesis in Sustainable Agriculture at the Department for Sustainable Food Systems and Development, University of the Free State.

HAS THE STUDY RECEIVED ETHICAL APPROVAL?

This study has received approval from the Research Ethics Committee of UFS. A copy of the approval letter can be obtained from the researcher.

Approval number: UFS-HSD2022/0482/22UFS-HSD2022/0482/22UFS-HSD2022/0482/22UFS-HSD2022/0482/22

WHY ARE YOU INVITED TO TAKE PART IN THIS RESEARCH PROJECT?

You were selected to participate in the study as you are appointed by the Department of Rural Development and Agrarian Reform in the Eastern Cape to establish the capacity needs of extension practitioners. Contact details of participants were obtained from the Department, and convenience sampling was used.

WHAT IS THE NATURE OF PARTICIPATION IN THIS STUDY?

The participants (extension practitioners) will participate in surveys and focus groups discussions. The questionnaire will take about 30 minutes to complete, and the focus group will be 60- 90 minutes.

CAN THE PARTICIPANT WITHDRAW FROM THE STUDY?

Being in this study is voluntary, and you are under no obligation to consent to participation. The participants will be told about the purpose of the study; their input and availability will be explained before they fill out the questionnaire. If you decide to withdraw from the study at any point, you are free to do so without giving a reason.

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

The research outcomes will be documented and available for reference for similar studies and policy recommendations on extension practitioners capacity needs. This will be done while protecting the confidentiality of the participants.

WHAT IS THE ANTICIPATED INCONVENIENCE OF TAKING PART IN THIS STUDY?

Extension practitioners might lose out on the productivity time due to the time spent in the interview. I will also travel to their offices to complete the questionnaire and to minimise travel costs. They might also find it difficult to travel to a central point for the discussion boards; however, I will target times when they meet for their meetings and symposiums. The sessions will not require physical work or labour such as trials, and therefore no risks to health or injuries are anticipated to happen.

WILL WHAT I SAY BE KEPT CONFIDENTIAL?

During the study, your identity will not be recorded, and at no point will your answers connect back to you. Participants will be briefed clearly and made to thoroughly understand the purpose and the guarantee of their identification to remain kept for the study use. In this case, codes or numbers will be used, and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. The answers may be used in the research report, journal articles, and conference presentation; within these publications and presentations, the participant's anonymity will be protected, no identification of the participants will be made. Only the University will use their data if need to make a future reference. During FGDs, I will constantly encourage all participants to treat the information confidentially, and I will advise you not to disclose sensitive personal information in the focus group.

HOW WILL THE INFORMATION BE STORED AND ULTIMATELY DESTROYED?

The researcher will store hard copies of your answers for five years in a locked cupboard/filing cabinet at the University of the Free State. Electronic information will be stored on a password-protected computer for future research or academic purposes. Future use of the stored data will be subject to further Research Ethics Review and approval. After the stated period of 5years data (hardcopy and electronic) will be destroyed by deleting, ensuring that there is no record available. The participant does not run the risk of any harm, and the questions are structured in a way that avoids discrimination or any form of misconduct that can result from the study, which safeguard the participant.

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

Participants will be informed before signing consent form about the benefits of the study and that there will be NO payment or incentives for participating in this study.

HOW WILL THE PARTICIPANT BE INFORMED OF THE FINDINGS / RESULTS OF THE STUDY?

If you would like to be informed of the final research findings, please contact Anathi Makamane on 0719911759 or 0514013893 or email address at asilwana16@gmail.com The findings are accessible for 6 months after approval by the University of the Free State. Participants can request information via WhatsApp, but not Facebook, Twitter, or other social media platforms. Should you require any further information or want to contact the researcher about any aspect of this study, please get in touch with Anathi Makamane at the abovementioned contact details, including email address. Should you have concerns about the way in which the research has been conducted, you may contact Dr Jan Swanepoel, 0784577655 (contact details), SwanepoelJW@ufs.ac.za (email).

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

CONSENT TO PARTICIPATE IN THIS STUDY

I, the undersigned,

_____ (*participant's full names to be included*), (the "**Participant**")

confirm that I voluntarily agree to participate in the research study

I, the undersigned Participant, further confirm that–

1. the Researcher has explained the nature, procedure, potential benefits and anticipated inconvenience of my participation in the Study;
2. I have read (or had explained to me) and understood the Study as explained in the attached information sheet;

3. I have had sufficient opportunity to ask questions and am prepared to participate in the Study;
4. I understand that my participation in the Study is entirely voluntary and that I am free to withdraw at any time without penalty (if applicable);
5. I voluntarily provide the UFS and the Researcher with my personal information and consent to the UFS and the Researcher collecting, disclosing and processing my personal information in order to conduct the Study and any related activities in relation thereto;
6. I hereby acknowledge and confirm that I understand the purpose for which the UFS and the Researcher may collect, store, use, delete, destroy, outsource, transfer or otherwise process, as the context and circumstances may require and as contemplated in terms of POPIA, my personal information as set out herein;
7. I am aware that the findings of the Study will be anonymously processed into a research report, journal publications and/or conference proceedings and that my personal information will be aggregated and deidentified at such stage;
8. I also give the UFS permission to share, without notification, the collected data with other researchers at the UFS or other higher education institutions. This permission is dependent on the same principles of ethical research practices, anonymity/ confidentiality, safekeeping of information, and other issues listed above applying.

APPENDIX F: FARMER QUESTIONNAIRE

evasys	Capacity of Extension and Advisory Services in Supporting Farmers to Adapt to Climate	evasys
University of the Free State	Anathi Siphesihle Makamane	
Department for Sustainable Food Systems and Development	Supervisors: Dr JW Swanepoel and Dr O Loki	

Mark as shown: ☐☒☐☐☐ Please use a ball-point pen or a thin felt tip. This form will be processed automatically.
Correction: ☐■☐☒☐ Please follow the examples shown on the left hand side to help optimize the reading results.

1. INSTRUCTIONS

Topic: Capacity of Extension and Advisory Services in Supporting Farmers to Adapt to Climate Change in the Eastern Cape, South Africa

This questionnaire is prepared to collect data that will be used in the study of the above subject. Your name is not required and you are assured that information collected here will be treated confidentially.

Please supply the information required by choosing the appropriate code and insert it in the box/column/space of your choice.

Do not mark against each statement more than once.

1.1 Interview no

1.2 Province

1.3 District municipality

1.4 Local municipality

1.5 Village

1.6 Date

2. DEMOGRAPHIC INFORMATION

2.1 Respondent gender
☐ Male ☐ Female

2.2 Respondent racial group
☐ Caucasian/White ☐ African/Black ☐ Indian
☐ Coloured ☐ Other

2.3 Respondent highest education level:
☐ Never been to school ☐ Grade R to Grade 8 ☐ Grade 9 to Grade 12
☐ Matriculated ☐ Tertiary Qualification

2.4 Are you a full-time or part-time farmer?
☐ Full time ☐ Part time

2.5 If you are a part-time farmer, do you have an external source of income?
☐ Yes ☐ No

2.6 If yes to question 2.5, what is your external source of income?
☐ Disability grant ☐ Old age grant ☐ Salary and wages
☐ Remittance ☐ Other

2.7 How long have you been a farmer?
☐ Less than 5 years ☐ More than 5 years, but less than 10 years ☐ More than 10 years, but less than 20 years
☐ More than 20 years

2. DEMOGRAPHIC INFORMATION [Continue]

2.8 What farming enterprise are you involved in or practicing?
☐ Crop production ☐ Livestock production ☐ Mixed farming

2.9 What is the reason (goal) for your involvement in farming?
☐ Household consumption ☐ Selling (markets) ☐ Both
☐ Other

2.10 Do you own the land you are farming on?
☐ Yes ☐ No

2.11 If no to question 2.10, how did you acquire the land?
☐ Lease ☐ Renting ☐ Communal
☐ Inherited ☐ Other

2.12 If other to question 2.11, please specify:

2.13 Are you apart of any farmers organisations?
☐ Yes ☐ No

2.14 If yes to question 2.13, which farmer organisations do you belong to?

2.15 Have you gained any professional development (climate change related) from these organisations?
☐ Yes ☐ No

2.16 If yes to question 2.15, what professional development (climate change related) have you gained from the organisations?

2.17 If no to question 3.8, why do you think that?

3. FARMERS PERCEPTIONS OF THE COMPETENCIES OF EXTENSION OFFICERS ON CLIMATE CHANGE

3.1 Are you aware of extension services in your area?
☐ Yes ☐ No

3.2 Do you have access to extension services?
☐ Yes ☐ No

3.3 Climate change has become a prominent global issue in recent media, international, and national policy processes, have you observed any changes in climate?
☐ Yes ☐ No

3.4 If yes to question 3.3, which of the major changes in climate change have you observed in your community over the last 10 years?
☐ Floods ☐ Prolonged droughts ☐ Very hot seasons
☐ Very wet seasons ☐ Haven't observed any changes

3.5 Elaborate more on the visible effects of climate change have you noted from your region?

3.6 What is the main impact of these changes on the local community?
☐ Crop failure ☐ Infrastructure ☐ Livestock deaths
☐ Human disease outbreak ☐ Food insecurity ☐ Other

3. FARMERS PERCEPTIONS OF THE COMPETENCIES OF EXTENSION OFFICERS ON CLIMATE CHANGE [Continue]

3.7 What impacts has climate had on your livelihood and agricultural production?

☐ Increased socio-economic problems ☐ Reduced income ☐ Increased unemployment
☐ Reduced cultivated lands ☐ Other

3.8 Do you think extension officers are aware of climate change?

☐ Yes ☐ No

3.9 If no to question 3.8, why do you think that?

3.10 Extension officers are knowledgeable about climate change support interventions

☐ Strongly disagree ☐ Disagree ☐ Neutral
☐ Agree ☐ Strongly agree

3.11 Do extension workers provide interventions/ programmes that assist with climate change adaptation?

☐ Yes ☐ No

3.12 Does the information you get make any difference in your production?

☐ Yes ☐ No

3.13 What strategic adaptations options do the extensionist recommend to you?

☐ Plant different crops (multi-cropping) ☐ Crop diversity ☐ Crop rotation
☐ Change planting dates ☐ Change from crop farming to livestock farming or the other way round ☐ Change to mixed farming (planting crops and livestock together)
☐ Change from farming to non-farming ☐ Increase irrigation system ☐ Change the use of chemicals, fertilizers, and pesticides
☐ Increase water conservation ☐ Soil conservation ☐ Use insurance
☐ Other

3.14 List other examples of climate change interventions that extensionist recommend to you?

3.15 Does your extensionist make you aware of climate adaptation policies in South Africa and the Eastern Cape?

☐ Yes ☐ No

3.16 If yes to question 3.13, which ones has the extensionist made you aware of?

☐ National Climate Change Response White Paper (NCCRWP) ☐ National Development Plan (NDP) ☐ Climate Change Sector Plan For Agriculture, Forestry and Fisheries (CCSPAFF)
☐ National Climate Smart Agriculture Strategic Framework 2018 ☐ Climate Change Adaptation Action Plan for the Eastern Cape Province 2017 ☐ Other

3.17 Which of the following weather/ climate service for agriculture has your extensionist made you aware of?

☐ South African Weather Service (SAWS) ☐ Weather forecasts and "Seasonal Climate Watch ☐ DALRRD: National Agro-meteorological Committee (NAC) Advisory
☐ National, Provincial and District Disaster Management Centres ☐ ARC: Umlindi ☐ AgriSA
☐ CSIR: Advanced Fire Information System (AFIS) ☐ SAEON: South African Risk and Vulnerability Atlas (SARVA) ☐ CSIR: GreenBook (online tool)
☐ DEFF: National Climate Change Information System (NCCIS) (online tool)

3.18 Does the information you get from extension officers about the climate change support interventions makes a different in your production?

☐ Yes ☐ No

3. FARMERS PERCEPTIONS OF THE COMPETENCIES OF EXTENSION OFFICERS ON CLIMATE CHANGE [Continue]

3.19 What channels do extension officers use to communicate and deliver climate change related services to you?

- ☐ Radio
- ☐ Television
- ☐ Newsletter
- ☐ Email
- ☐ SMS/MMS
- ☐ Mobile apps
- ☐ Other farmers
- ☐ Researchers
- ☐ Charity organisations
- ☐ Community leaders
- ☐ Suppliers sales rep

3.20 Are these your preferred communication channels?

- ☐ Yes
- ☐ No

3.21 If no to question 3.20, what channel of communication do you prefer and why?

3.22 Do extensionists monitor if you are adapting to climate change?

- ☐ Yes
- ☐ No

3.23 How do you rate the knowledge of extensionists on the use of ICTs to share climate information with you?

- ☐ Very good
- ☐ Good
- ☐ Fair
- ☐ Poor
- ☐ Very poor

3.24 Which of the following ICT tools does the extensionist use for climate information?

- ☐ Mobile phone apps
- ☐ GIS, GPS modelling
- ☐ Smart systems sensor networks
- ☐ Early warning systems weather management
- ☐ Remote sensing systems

3.25 Do extensionist need climate change training?

- ☐ Yes
- ☐ No

3.26 Which of the following capacities does your extensionist have to support your adaptation to climate change?

- ☐ Communication skills including use of ICTs
- ☐ Technical climate knowledge
- ☐ Community mobilization
- ☐ Need Assessment of farmers
- ☐ Capacities to network, partner, establish linkages and coordinate actions
- ☐ Resource mobilization (for climate adaption projects)
- ☐ Leadership and networking

3.27 Which of the following capacities does your extensionist need to improve to support you adapt to climate change?

- ☐ Communication skills including use of ICTs
- ☐ Technical climate knowledge
- ☐ Community mobilization
- ☐ Need Assessment of farmers
- ☐ Capacities to network, partner, establish linkages and coordinate actions
- ☐ Resource mobilization (for climate adaption projects)
- ☐ Leadership and networking

Thank you for your time and participation

APPENDIX G: EXTENSION PRACTITIONERS QUESTIONNAIRE

evasys	Capacity of Extension and Advisory Services in Supporting Farmers to Adapt to Climate	evasys
University of the Free State	Anathi Siphesihle Makamane	
Department for Sustainable Food Systems and Development	Supervisors: Dr JW Swanepoel and Dr O Loki	

Mark as shown: ☐☒☐☐☐ Please use a ball-point pen or a thin felt tip. This form will be processed automatically.
Correction: ☐■☐☒☐ Please follow the examples shown on the left hand side to help optimize the reading results.

1. INSTRUCTIONS

Topic: Capacity of Extension and Advisory Services in Supporting Farmers to Adapt to Climate Change in the Eastern Cape, South Africa.

This questionnaire is prepared to collect data that will be used in the study of the above subject. Your name is not required and you are assured that information collected here will be treated confidentially.

Please supply the information required by choosing the appropriate code and insert it in the box/column/space of your choice.

Do not mark against each statement more than once.

1.1 Interview no

1.2 Province

1.3 District municipality

1.4 Local municipality

1.5 Village

1.6 Date

2. DEMOGRAPHIC INFORMATION OF EXTENSION MANAGER

2.1 Respondent gender
☐ Male ☐ Female

2.2 Age of respondent

2.3 Respondent racial group
☐ Caucasian/White ☐ African/Black ☐ Indian
☐ Coloured ☐ Other

2.4 What is the highest level of education you have completed?
☐ National Senior Certificate/Grade 12 ☐ Diploma (NQF Level 5) ☐ Degree (NQF Level 6)
☐ Honours (NQF Level 7) ☐ Masters (NQF Level 8)

2.5 How long have you been working as an extension officer?
☐ Less than 5 years ☐ More than 5 years, but less than 10 years ☐ More than 10 years, but less than 20 years
☐ More than 20 years

2.6 Are you registered in any professional organization/ regulatory body (e.g. SASAE/ SACNASP)?
☐ Yes ☐ No

2. DEMOGRAPHIC INFORMATION OF EXTENSION MANAGER [Continue]

2.7 If yes to question 2.5, what professional body are you registered with?

2.8 Have you gained any professional development (climate change related) from these organisations?
☐ Yes ☐ No

2.9 If yes to question 2.7, what professional development (climate change related) have you gained from the organisations?

2.10 Do you have other agricultural-related certification (e.g. Artificial Insemination, climate change in agriculture)?
☐ Yes ☐ No

2.11 If yes to question 2.9, what other agricultural-related certification do you have?

2.12 What is your level of occupation?
☐ Senior Management ☐ Manager ☐ Supervisor/Coordinator
☐ Extension worker

2.13 What is your area of specialization?
☐ Livestock ☐ Grain ☐ Crops
☐ Other

3. CLIMATE CHANGE AWARENESS

3.1 In your own words, how would you describe climate change?

3.2 How would you rank your current understanding/knowledge on climate change?
☐ Excellent ☐ Good ☐ Average
☐ Poor

3.3 What major changes in have you observed in the areas you provide extension services over the last 10 years?
☐ Heavy rains and floods ☐ Prolonged droughts ☐ Very hot seasons
☐ Very wet seasons ☐ Haven't observed any changes

3.4 Elaborate more on the visible effects of climate change you have noted from the farmers in your region:

3.5 Which of the following incidences have you experienced in the last 5-10 years in the areas you work in?
☐ Crop failure ☐ Infrastructure ☐ Livestock deaths
☐ Livestock and crop disease ☐ Food insecurity of farmers ☐ Other

3.6 What impacts has climate had on livelihood and agricultural production of your farmers?
☐ Increased socio-economic problems ☐ Reduced income ☐ Increased unemployment
☐ Reduced cultivated lands ☐ Other

3. CLIMATE CHANGE AWARENESS [Continue]

3.7 Based on your understanding of climate change, what strategic adaptations options do you recommend to farmers?

- ☐ Plant different crops (multi-cropping)
- ☐ Crop diversity
- ☐ Crop rotation
- ☐ Change planting dates
- ☐ Change from crop farming to livestock farming or the other way round
- ☐ Change to mixed farming (planting crops and livestock together)
- ☐ Change from farming to non-farming
- ☐ Increase irrigation system
- ☐ Change the use of chemicals, fertilizers and pesticides
- ☐ Increase water conservation
- ☐ Soil conservation
- ☐ Use insurance

3.8 What promotes the climate change strategic adaptations?

3.9 Are you familiar with any climate adaptation policies in South Africa and the Eastern Cape?

- ☐ Yes
- ☐ No

3.10 If yes to question 3.8, which policies are you aware of?

- ☐ National Climate Change Response White Paper (NCCRWP)
- ☐ National Development Plan (NDP)
- ☐ Climate Change Sector Plan For Agriculture, Forestry and Fisheries (CCSPAFF)
- ☐ National Climate Smart Agriculture Strategic Framework 2018
- ☐ Climate Change Adaptation Action Plan for the Eastern Cape Province 2017

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

- ☐ Formal written communication (Journals, Articles)
- ☐ Internet
- ☐ Radio/Television
- ☐ Magazines/Newspaper (Farmers weekly)
- ☐ Colleagues
- ☐ Other

3.12 Have you ever received formal climate change education?

- ☐ Yes
- ☐ No

3.13 If yes to question 3.10, please provide the institution/organisations names and type of education received:

3.14 If you acquired education through informal training; e.g. workshops and conferences proceeding, elaborate more:

3.15 Which of the following weather/ climate service for agriculture are you aware of?

- ☐ South African Weather Service (SAWS)
- ☐ Weather forecasts and "Seasonal Climate Watch"
- ☐ DALRRD: National Agro-meteorological Committee (NAC) Advisory
- ☐ National, Provincial and District Disaster Management Centres
- ☐ ARC: Umlindi
- ☐ AgriSA
- ☐ CSIR: Advanced Fire Information System (AFIS)
- ☐ SAEON: South African Risk and Vulnerability Atlas (SARVA)
- ☐ CSIR: GreenBook (online tool)
- ☐ DEFF: National Climate Change Information System (NCCIS) (online tool)

3. CLIMATE CHANGE AWARENESS [Continue]

3.16 Which of the following weather/ climate service for agriculture do you use?

- ☐ South African Weather Service (SAWS)
- ☐ Weather forecasts and "Seasonal Climate Watch"
- ☐ DALRRD: National Agro-meteorological Committee (NAC) Advisory
- ☐ National, Provincial and District Disaster Management Centres
- ☐ ARC: Umlindi
- ☐ AgriSA
- ☐ CSIR: Advanced Fire Information System (AFIS)
- ☐ SAEON: South African Risk and Vulnerability Atlas (SARVA)
- ☐ CSIR: GreenBook (online tool)
- ☐ DEFF: National Climate Change Information System (NCCIS) (online tool)

4. SOURCES OF INFORMATION AND COMMUNICATION CHANNELS USED BY EXTENSION

4.1 What channel/s do you use to communicate and deliver climate change related information?

- ☐ In person visit
- ☐ Mass media
- ☐ ICT
- ☐ Farmer to farmer extension
- ☐ Community leaders
- ☐ Other

4.2 If other to question 4.1, please specify:

4.3 Please list the reasons for using this channel:

4.4 How frequently do you contact or visit farmers for climate related information?

- ☐ Everyday
- ☐ Weekly
- ☐ Monthly
- ☐ Quarterly
- ☐ Bi-yearly
- ☐ Yearly
- ☐ When there is an incident

4.5 On a scale of 1 - 10, how effective are your communication channels in communicating climate information? Not effective ☐☐☐☐☐☐☐☐☐☐ Extremely effective

4.6 How do you measure the effectiveness of your channels?

4.7 What challenges do you have with the current extension services channels?

- ☐ Covid-19 restrictions
- ☐ Transport to visit farmers
- ☐ Farmers response is poor
- ☐ Farmers do not prefer the use of media
- ☐ Farmers do not know how to use ICTs
- ☐ Other

4.8 Where do you get information about climate change?

- ☐ Formal written communication (Journals, Articles)
- ☐ Internet
- ☐ Radio/Television
- ☐ Magazines/Newspaper (Farmers weekly)
- ☐ Colleagues at work
- ☐ Other institutions

4.9 On a scale of 1 - 10, how accurate are your sources of information? Not accurate ☐☐☐☐☐☐☐☐☐☐ Extremely accurate

4.10 Do you verify the information you receive from the above sources before you share it with farmers?

- ☐ Yes
- ☐ No

4.11 Is there an available platform/ forum where you can discuss climate information with other extension workers/farmers?

- ☐ Yes
- ☐ No

4. SOURCES OF INFORMATION AND COMMUNICATION CHANNELS USED BY EXTENSION [Continue]

4.12 If yes to question 4.40, how does it work and who shares the information (explain)?

4.13 Is the platform useful?

☐ Yes ☐ No

4.14 What improvements can be made to the platform?

4.15 If the platform is not useful, can it be considered beneficial?

☐ Yes ☐ No

4.16 Does the office promote the use ICT platforms to communicate with the farmers (e.g. Whatsapp, email)?

☐ Yes ☐ No

4.17 If yes to question 4.16, how?

4.18 Does the office provide support for the use of ICT platforms (e.g. data)?

☐ Yes ☐ No

4.19 If yes to question 4.18, how?

4.20 How do you rate your knowledge on the use of ICTs when sharing climate information with farmers?

☐ Very good ☐ Good ☐ Fair
☐ Poor ☐ Very poor

4.21 Which of the following ICT tools are you aware of?

☐ Mobile phone apps ☐ GIS, GPS Modelling ☐ Smart systems sensor networks
☐ Early warning systems weather management ☐ Remote sensing systems

4.22 Which of the following ICT tools do you use for climate information?

☐ Mobile phone apps ☐ GIS, GPS Modelling ☐ Smart systems sensor networks
☐ Early warning systems weather management ☐ Remote sensing systems

4.23 Which platform would you like to see the extension agents use more with the farmers?

4.24 Does the use of ICT improve the capacity needs of extension workers (explain)?

5. PERCEIVED CAPACITY NEEDS OF EXTENSION OFFICERS AND THE INCLUSION OF THE CLIMATE CHANGE CONCEPT IN THEIR SCOPE OF WORK

5. PERCEIVED CAPACITY NEEDS OF EXTENSION OFFICERS AND THE INCLUSION OF THE CLIMATE CHANGE CONCEPT IN THEIR SCOPE OF WORK [Continue]

5.1 Climate change was taught in the curriculum of your qualification?
☐ Yes ☐ No

5.2 Have you ever received any formal training covering climate change (accredited certification)?
☐ Yes ☐ No

5.3 Have you ever received informal climate change training (workshop)?
☐ Yes ☐ No

5.4 If yes to question 5.3, who was the service provider?

5.5 If no to question 5.3, do you need training on climate change?
☐ Yes ☐ No

5.6 What other areas/ subject/topic related to climate do you need training on?

5.7 Which of the following capacities do you have to support farmers adaptation to climate change?
☐ Communication skills including use of ICTs ☐ Technical climate knowledge ☐ Community mobilization
☐ Need Assessment of farmers ☐ Capacities to network, partner, establish linkages and coordinate actions ☐ Resource mobilization (for climate adaption projects)
☐ Leadership and networking ☐ Other

5.8 Which of the following capacities do you need to improve to support farmers adapt to climate change?
☐ Communication skills including use of ICTs ☐ Technical climate knowledge ☐ Community mobilization
☐ Need Assessment of farmers ☐ Capacities to network, partner, establish linkages and coordinate actions ☐ Resource mobilization (for climate adaption projects)
☐ Leadership and networking ☐ Other

5.9 What barriers do you face that affect successful advisory services in climate adaptation?

5.10 What kind of support do you get from your organisation/manager to promote climate adaptation in agricultural production?

5.11 Do you think the inclusion of climate change in the school curriculum/ departmental trainings would benefit upcoming extension and advisory officers (explain)?

Thank you for your time and participation

APPENDIX H: FARMER FOCUS GROUP DISCUSSION

Focus group discussion for Farmers

Topic: Capacity of extension and advisory services in supporting farmers to adapt to climate change in the Eastern Cape, South Africa

This questionnaire is prepared to collect data that will be used in the study of the above subject. Your name is not required and you are assured that information collected here will be treated confidentially.

Researcher: Anathi Siphesihle Makamane

Supervisors: Dr JW Swanepoel

Dr O Loki

Thank you for agreeing to participate. We are very interested to hear your valuable opinion capacity of extension and advisory services in supporting farmers to adapt to climate change in the Eastern Cape, South Africa

- The purpose of this study is to investigate the capacity of extension and advisory services in supporting farmers to adapt to climate change in the Eastern Cape, South Africa.
- In the questionnaire your name will not be recorded, anywhere and no one will be able to connect you to the answers you give.

- Being in this study is voluntary, and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.
- If you have any questions, now or after you have completed the questionnaire, you can contact the researcher or any enumerators, or you can call the University of Free State.

1. Introductory session

- Introduction of the researcher and team of enumerators.
- Introduction of the study, the main objective, and anticipated outcomes what will be done with this information?
- Explain the role of the farmers and conduct during the interview and discussion process.

2. Explanation of the process
    - In this research, we are doing both questionnaires and FGDs. The reason for using both tools is that we can get more in-depth information from a smaller group of people in focus groups. This allows us to understand the context behind the answers given in the written questionnaire and helps us explore topics in more detail than we can do in a written questionnaire.
    - Focus group will last for 60- 90 minutes.
3. Ground rules
    - Everyone should participate. Don't be afraid to voice your opinion
    - Information provided in the focus group must be kept confidential.

4. Materials focus groups

- Sign-in sheet
- 1 recording device
- Questionnaire
- Consent forms (one copy for participants, one copy for the team)
- Pads and Pencils for each participant

5. Questions: Capacity of extension practitioners

a) Do you have access to extension services in your area?
b) When I say the word climate change, what comes to mind?
c) What changes have you observed due to climate change?
d) Is your extension officer knowledgeable about climate change support interventions ?
e) Does your practitioners employ any climate change programmes/ interventions?
f) Does the information you get make any difference in your production?
g) Does the extension practitioners make use of ICT? And yes, which ICT tools?
h) Does the extension officer need training on climate change?
i) Does the extension officer have the capacity to assist you to adapt to climate change?
j) What barriers do practitioners face for successful advisory services in climate adaptation?
k) Should the government provide support to practitioners to assist you in promoting climate adaptation in agricultural production
l) Do you have any last comment?

That concludes our focus group. Thank you for your time and sharing your opinions with us

APPENDIX I: EXTENSION PRACTITIONERS GROUP DISCUSSION

Questionnaire for Extension practitioners

Topic: Capacity of extension and advisory services in supporting farmers to adapt to climate change in the Eastern Cape, South Africa

This questionnaire is prepared to collect data that will be used in the study of the above subject. Your name is not required and you are assured that information collected here will be treated confidentially.

Researcher: Anathi Siphesihle Makamane

Supervisors: Dr JW Swanepoel

Dr O Loki

Thank you for agreeing to participate. We are very interested to hear your valuable opinion capacity of extension and advisory services in supporting farmers to adapt to climate change in the Eastern Cape, South Africa

- The purpose of this study is to investigate the capacity of extension and advisory services in supporting farmers to adapt to climate change in the Eastern Cape, South Africa.
- In the questionnaire your name will not be recorded, anywhere and no one will be able to connect you to the answers you give.

- Being in this study is voluntary, and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.
- If you have any questions, now or after you have completed the questionnaire, you can contact the researcher or any enumerators, or you can call the University of Free State.

6. Introductory session

- Introduction of the researcher and team of enumerators.
- Introduction of the study, the main objective, and anticipated outcomes what will be done with this information?
- Explain the role of the farmers and conduct during the interview and discussion process.

7. Explanation of the process
    - In this research, we are doing both questionnaires and FGDs. The reason for using both tools is that we can get more in-depth information from a smaller group of people in focus groups. This allows us to understand the context behind the answers given in the written questionnaire and helps us explore topics in more detail than we can do in a written questionnaire.
    - Focus group will last for 60- 90 minutes.
8. Ground rules
    - Everyone should participate. Don't be afraid to voice your opinion
    - Information provided in the focus group must be kept confidential.

9. Materials focus groups

- Sign-in sheet
- 1 recording device
- Questionnaire
- Consent forms (one copy for participants, one copy for the team)
- Pads and Pencils for each participant

10. Questions: Capacity of extension practitioners

m) When I say the word climate change, what comes to mind?
n) What changes have you observed due to climate change?
o) What impacts have you observed caused by climate change?
p) What climate change programmes do you employ with your farmers
q) Is there an available platform/ forum where you discuss climate information with other extension practitioners / farmers?
r) Does the office promote the use of ICT?
s) Which ICT platform are you using to promote climate adaptation?
t) Does the use of ICT improve the capacity needs of extension practitioners?
u) Have you ever received climate change training?
v) Do you need constant training on climate change adaptation?
w) What capacities do you have to support farmers adapt to climate?
x) What barriers do you face that affect successful advisory services in climate adaptation?
y) What kind of support do you get/ need from your organisation/ manager get to promote climate adaptation in agricultural production
z) Do you have any last comment?

That concludes our focus group. Thank you for your time and sharing your opinions with us

APPENDIX K: CLIMATE CHANGE AND AGRICULTURE TRAINING PROGRAMME – CHRIS HANI DISTRICT

PROJECT PROPOSAL Climate Change Adaptation in Agriculture: Strengthening Capacity of agricultural practitioners - Chris Hani District			
PROJECT MANAGERS:	MS ANATHI MAKAMANE PROF JAN SWANEPOEL DR OLWETHU LOKI	LOCATION:	CHRIS HANI DISTRICT, EASTERN CAPE
STAKEHOLDERS	UNIVERSITY OF THE FREE STATE UNIVERSITY OF PRETORIA EASTERN CAPE DEPARTMENT OF AGRICULTURE WESTERN CAPE DEPARTMENT OF AGRICULTURE AUDA-NEPAD AERES UNIVERSITY OF APPLIED SCIENCE SOLIDARAD FANRPAN ARC	PROJECT DURATION:	3 MONTHS
CONTACT DETAILS:	0514013893 0514013571		

	0794203251		

1. PROJECT BACKGROUND AND MOTIVATION

1.1 Project Title:

Climate Change Adaptation in Agriculture: Strengthening Capacity of agricultural practitioners Chris Hani District, South Africa

1.2 Project Overview:

Overview: Findings in the study with practitioners in the Eastern Cape show considerable evidence of the lack of capacity-building initiatives, mainstreaming of climate change education, access to and awareness of policies, and access to relevant resources. The research points out the need to prioritise climate change and adaptation and establish a solid strategy in the extension system.

Therefore, this online training programme aims to provide extension practitioners with a comprehensive understanding of climate change impacts on agriculture and equip them with strategies for adapting to the changing climate. The course will cover a range of topics including climate change science, impacts on agriculture, adaptation strategies, and policy and governance for adaptation in the agriculture sector.

Upon completion of this programme, participants will be able to:

Understand the science of climate change and its impacts on agriculture

Identify potential risks and vulnerabilities in agricultural systems due to climate change

Develop strategies for adaptation to climate change in agriculture

Understand the role of policy and governance in promoting climate change adaptation in agriculture

Apply knowledge and skills gained to develop and implement climate change adaptation plans for agricultural systems.

Programme Outline:

Module 1: Introduction to Climate Change and Agriculture (max 45 minutes presentation)

- Overview of climate change science
- Climate change impacts agricultural production
- Climate adaptation in agriculture

Module 2: Assessing Risks and Vulnerabilities in Agricultural Systems (max 45 minutes presentation)

Identifying risks and vulnerabilities in agricultural systems

Approaches to assessing and monitoring climate change impacts

Module 3: Adapting to Climate Change in Agriculture (max 60 minutes presentation)

- Strategies for adapting to climate change in agricultural systems
- Climate-smart agriculture practices
- Building resilience in agricultural systems

Sustainable land management practices

Water conservation and management practices

Crop selection and diversification

Integrated pest management

Climate-smart livestock management practices

Module 4: Climate-Smart Agricultural Technologies

-

Module 5: Policy and Governance for Climate Change Adaptation in Agriculture (max 45 minutes presentation)

- National and provincial policy frameworks for climate change adaptation in agriculture
- Governance approaches to promoting climate change adaptation in agriculture
- Financing climate change adaptation in the agriculture sector

Module 6: Supporting Farmers in Developing Climate Change Adaptation Plans for Agricultural Systems (max 45 minutes presentation)

- Integrating climate change considerations into agricultural planning
- Supporting farmers in developing and implementing climate change adaptation plans
- Monitoring and evaluating climate change adaptation in agricultural systems

Module 7: ARC Umlindi Tool (max 30 minutes presentation)

Methodology:

This online course will be delivered through self-paced learning modules. Each module will include readings, video recordings, and reflections by participants. Subject matter experts in climate change adaptation and agriculture will facilitate the course.

Target Audience:

This course is designed for agricultural extension practitioners who are interested in understanding and addressing the challenges of climate change in agricultural systems and want to take action to mitigate its effects and adapt to a changing climate.

Duration:

The course will be self-paced, taking 8 hours to complete.

Assessment and Certification:

You will be assessed through reflections in each module on the knowledge and skills gained through the course to develop a climate change adaptation plan for an agricultural system. Participants who complete the training programme and programme evaluation will receive a certificate.

Conclusion:

This online training course provides extension practitioners with a comprehensive and practical approach to climate change adaptation in agriculture, equipping them with the knowledge and skills needed to support farmers in developing and implementing effective adaptation strategies in agricultural systems. By completing this course, extension officers will be better equipped to support farmers in adapting to the changing climate and promoting food security and livelihoods in their communities.

APPENDIX K: LANGUAGE EDITING CERTIFICATE

Esley van der Berg
e.vanderberg@live.co.za
+27 (0)63 437 1858
https://esleyvdb.wixsite.com/editingandresearch

Esley vd B
Editing | Research Support

27 July 2023

To whom it may concern,

It is hereby confirmed that the thesis document described below has undergone language editing, formatting, and reference checking by myself, Esley van der Berg. I am an independent contractor who provides editing and research support services.

Student name:	Anathi Siphesihle Makamane
Student number:	2010143242
Institution:	University of the Free State
Thesis title:	CAPACITY OF EXTENSION AND ADVISORY SERVICES IN SUPPORTING FARMERS TO ADAPT TO CLIMATE CHANGE IN THE EASTERN CAPE, SOUTH AFRICA

Conventions utilised:

Language conventions:	English – United Kingdom
Reference formatting:	APA

For further enquiries, please feel to contact me at e.vanderberg@live.co.za

Kind regards,

EvdBerg

Esley van der Berg