RESPONSIVENESS OF SOUTH AFRICAN SEMI-COMMERCIAL FARMERS TO CLIMATE CHANGE

BY

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DEDICATION

This study is dedicated to my grandparents, Pauline (LaGininda) and David Lukhele.

DECLARATION

I declare that the content in this dissertation is my original work, not previously submitted for any other degree, and all sources are appropriately referenced.

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ABSTRACT

Agriculture is crucial for sustaining rural livelihoods and promoting economic growth. However, climate change threatens agriculture as it is directly linked to climate factors. This study assesses how semi-commercial farmers are responding to climate change. The objectives were to (1) examine the perceptions of South Africa's semi-commercial farmers on climate change; (2) assess the responsiveness of semi-commercial farmers to climate change; and (3) assess the influence of adaptation strategies on the performance of semi-commercial farmers. The data was collected through a self-administered questionnaire from 90 respondents and analysed. The demographic characteristics of the semi-commercial farmers were analysed using frequencies and descriptive statistics. In addition, a correlation analysis was conducted to determine relationships between different constructs, and multiple linear regression was used to model the relationship between variables. Most of the 90 respondents were 35 to 54 years old and had a high level of tertiary education (83.33%). The analysis of years in farming reveals a moderate experience level among participants, with 56.67% engaged in farming for 10-24 years. Rainfed agricultural practices dominated, with 57.78% relying solely on natural rainfall. Regarding access to credit, the mean score of 2.21 (standard deviation = 1.06) shows that, on average, respondents disagreed with the statements in the questionnaire about access to adequate credit, affordable lending rates, easy access to finance and alternative funding sources. Crop productivity indicated a positive correlation with soil and water conservation, and there was a positive correlation between changes in temperature and soil and water conservation. This suggests that their perception of temperature changes influences semi-commercial farmers' adaption strategies and that adopting climate strategies improves crop productivity. The study proved that soil and water conservation and crop diversification significantly predict crop productivity (performance). Recognising the positive correlation between soil and water conservation and crop diversification techniques and the perceived increased crop productivity, policymakers and agricultural extension services should prioritise and advocate for these strategies. Given the significant variations in respondents' access to credit, interventions should be tailored to the different financial needs of semi-commercial farmers. It is recommended that future research incorporate more comprehensive analyses of the development prospects of semi-commercial farmers, considering regional differences and assessing the long-term impact of adaptation strategies on actual agricultural production.

Key words: *Adaptation strategies, semi-commercial farmers, credit, climate change, performance.*

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CHAPTER 1. GENERAL INTRODUCTION

1.1 Background of the study

Climate change, identified as the main threat to agriculture, persists as the paramount global challenge necessitating collective solutions (El Bilali et al., 2020). Agriculture plays an essential role for maintaining rural livelihoods and driving economic growth in nations that are developing. It is still the primary source of income in most African countries (Yeboah et al., 2020). To sustain economic growth, it will be necessary to adopt climate change adaptation strategies that improve agricultural production. Semi-commercial farmers generate about 80% of the food consumed in underdeveloped nations, who also make up 60% of the agricultural labour force and operate 75% of all farms globally (Donatti et al., 2019). The implication is that if climate change reduces crop yield, thereby threatening food security, it will also result in increased food prices (Malhi et al., 2021). Climate change leads to environmental conditions to which businesses and other actors respond by managing new risks or taking advantage of new opportunities. Actors are exposed to the opportunities and risks connected with climate change to varying degrees (Berkhout & Dow, 2022). The current study assess how semi-commercial farmers are responding to climate change since they have different capacities and skills to respond to the new risks and opportunities it presents.

The main weather-related risks that farmers across Africa perceive and attribute to climate change are the occurrence of pests and diseases, crop failures, frequent droughts, changing rainfall patterns, soil erosion, and temperature fluctuations (Zerssa et al., 2021; Marie et al., 2020). Farmers have adopted strategies such as mixed farming, intercropping, early and late sowing, drought-resistant crop varieties, and soil and water conservation to mitigate the negative effects of climate change (Abegunde & Obi, 2022; Marie et al., 2020). Previous research has shown that labour availability, gender, farming experience, income, education level, land ownership, access to extension services, credit, and markets are important factors that influence the choice of adaptation strategies by farmers in Africa (Marie et al., 2020; Myeni & Moeletsi, 2020). However, most of these studies primarily concentrate on farmers lacking access to credit. Therefore, the current study focuses on semi-commercial farmers receiving loans for input financing and mentoring from agricultural organisations.

Climate change will worsen agricultural production in already impoverished areas and threaten food security. Climate projections indicate that climate variability will impact cropping systems and yields in numerous regions (Kogo et al., 2021). As climate change's severity and the extent of its impacts on individuals vary from one region of the world and one community to another, there will be an increase in food inequalities from the local to the global levels (Yadav et al., 2019).

This study uses the Theory of Planned Behaviour (TPB) framework to assess how South African semi-commercial farmers respond to climate change. Frameworks are useful in assisting organisations in managing change, addressing climate change issues, and developing strategies to address climate change-related challenges.

Semi-commercial farmers, also known as emerging farmers, are defined as individuals from historically underprivileged groups, primarily blacks, who sell at least some of their products and aspire to transition to a fully commercial status (Nkunjana & Zantsi, 2018). In the current study the farmers are verging on becoming commercial farmers with operations exceeding 250 hectares.

1.2 Research problem

Climate change projections indicate that extreme weather events are likely to become more frequent and severe, increasing risks to food security and agricultural productivity (Yadav, 2019). All people and organisations are affected by climate change, and consequently, businesses must adapt to remain agile. There has been limited research on the strategies of semi-commercial farmers to respond to climate change. Most of the previous research on agriculture and climate change has focused on smallholder farmers (Thinda et al., 2020; Rapholo & Diko, 2020).

Furthermore, very few studies have been conducted in southern Africa and most studies have been conducted in industrialised countries.

Due to different climatic conditions, these results cannot be extrapolated to the local environment. Local climatic conditions and climate change factors will influence how a company or business responds to climate change to remain sustainable. It is thus imperative to focus on the adverse effects that are shifting in the local context in which these semi-commercial farmers operate (Skouloudis et al., 2020; Anderson et al., 2020). As a result, new support systems must be established to help these semi-commercial farmers gain the skills and capabilities required to tackle the local impacts.

1.3 Research objectives

The study aimed at assessing the responsiveness of South African semi-commercial farmers to climate change. The context of the study and the gaps identified were critical in determining the objectives of the study. The objectives were:

- To examine the perceptions of South Africa's semi-commercial farmers on climate change.
- To assess the responsiveness of semi-commercial farmers to climate change.
- To assess the influence of adaptation strategies on the performance of semi-commercial farmers.

1.4 Research questions

The following questions were established based on the research objectives of the study.

- What are the perceptions of semi-commercial farmers about climate change?
- What are the adaptation strategies of semi-commercial farmers to climate change?

- How do adaptation strategies influence performance?

1.5 Structure of the dissertation

The dissertation will be structured in the manner depicted below.

Chapter 1: Introduction: This chapter provides the general background of the study, research questions and objectives of the study.

Chapter 2: Literature review: This chapter provides the literature review and synthesis of existing research relevant to the topic, identify gaps and provide context for the current study.

Chapter 3: Research methodology: This chapter describes the methods used to collect the data and how the data were analysed.

Chapter 4: Results and discussion: This chapter sets out what was found in the research questions or hypotheses, the analysis, and the interpretation of the results. The research findings and their significance.

Chapter 5: Conclusions and recommendations: This chapter highlights the research objectives that have been achieved and how they have contributed to the overall body of knowledge. The recommendations are also presented in this chapter.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

Climate change has been demonstrated to impact agricultural production in time and space significantly, in addition to other traditional constraints (Dang et al., 2019). Climate change threatens agriculture because of its direct link to climate factors. Extreme climatic events like droughts or a shift in rainfall poses a serious threat to yields of crops (Pagliacci et al., 2020). Several modelling studies have predicted a production disparity between developed and developing countries under various climate change scenarios; yield reductions are expected in developing countries, while benefits are expected for developed countries (Anderson et al., 2020). Long-term negative effects of climate change are anticipated to include decreased water availability, land degradation, drought and desertification, crop pests and disease outbreaks (Dang et al., 2019). Implementing new and enhanced strategies to increase resilience and lessen impacts while maintaining high crop output is of vital importance (Aryal et al., 2020). Therefore, addressing the challenges presented by long-term issues in the agricultural sector is imperative.

Regional climate varies greatly from region to region, especially regarding variables related to the hydrological cycle (Kogo et al., 2021). Studies indicate that the expected variation in mean temperature will be between 0.3 °C and 0.7 °C compared to reference conditions (Sirisena et al., 2021). The temperature increase will be above average on land, and most land areas will experience more extreme heat (Hoegh-Guldberg et al., 2019). Predicted changes in southern Africa include rising temperatures and droughts and increased frequency and intensity of extreme weather events (Nhemachena et al., 2020). Both average rainfall and rainfall intensity are expected to increase in the high areas, and parts of the mid-latitudes and maximum wind speeds are expected to increase over time (Malhi et al., 2021). The high water usage by crops for evapotranspiration caused by temperature rise would undoubtedly lead to a direct loss of soil moisture. Elevated CO_2 levels are expected to boost crop yields at lower temperatures while decreasing nutritional quality (Mbow et al., 2019).

Daddi et al. (2018) reviewed the application of organisational theories to studies on climate change and found that institutional and stakeholder theories appeared to be the most commonly used. Additionally, they suggested that climate change studies should explore other management theories more thoroughly. The Theory of Planned Behaviour (TPB) was used in this study to assess the adaptation strategies and response of semi-commercial farmers in South Africa to climate change. Adaptation strategies are believed to help mitigate the negative impacts of climate change while maintaining high agricultural output or production (Pagliacci et al., 2020).

2.2 Impacts of climate change and variability

Climate variability involves variations in average condition and other climate variables at all scales, both temporally and spatially and climate change relate to an extended, significant shift in the normal condition or variability of the climate (IPCC, 2022). Climate change fundamentally alters all conditions under which agriculture is practised. Agricultural systems are affected both directly and indirectly by climate change. Direct impacts are those caused by changes in physical characteristics (e.g., temperature, water availability), while indirect impacts are those that affect production (e.g., pests, invasive species. It's noteworthy that direct impacts, which directly affect production, are much easier to predict or forecast using advanced simulations or models. Climate change projections indicate that cropping patterns and yields will be affected (Ray et al., 2019; Kogo et al., 2020) and this has been well studied for staple crops (Mbow et al., 2019). Africa's temperatures are predicted to rise, albeit with regional variations and a non-constant increase (Almazroui et al., 2020) and the hydrological conditions are also anticipated to be impacted. Africa relies on rain-fed agriculture (De Longueville et al., 2020), and rainfall is projected to decrease in the northern and southern regions of the continent while increasing in the middle regions.

Water resources must be available in sufficient quantities to cater for the rising demand for food, and water availability impacts agricultural and food security (Rasul, 2021). Agricultural output in Southern Africa is expected to fall by 15%, from 75% to 50%, potentially exacerbating food shortages throughout the region (Nhemachena et al., 2020). This will certainly translate into the loss of income for households, businesses, and communities, and ultimately affect the country's economic growth (Khan et al., 2020).

2.2.1 The projected impacts on crop yields

Crop yields are negatively impacted by climatic changes, such as increasing floods, warming temperatures, and droughts (Anderson et al., 2020). This depends entirely on the crop, the region, and the extent of parameter changes; different crops react differently to increasing temperatures, precipitation, and carbon dioxide (CO_2) fertilisation (Malhi et al., 2020). According to Mathews et al. (2018), water resources and crop yields in semi-arid countries will suffer from a slight increase in annual temperatures. Numerous studies have shown significant negative impact on the yields of staple crops in many parts of the world, and this is evident from observations of climate trends in crop productivity (Anderson et al., 2020; Carr et al., 2022). Most crops are being damaged by the increasing frequency of unusually hot nights in most areas, affecting quality and yields (Giménez et al., 2021). The results of studies comparing agricultural models show that despite uncertainties in the models' representation of the effects of rising carbon dioxide in combination with ozone and temperatures, there is consensus on the direction of yield declines for major crops (Mbow et al., 2019).

High confidence in the impact of future climate change on food production at low latitudes, with potentially ameliorated effects in northern regions IPCC (2022). However, soil quality and water availability could prevent a sustained improvement in crop yields in some high-latitude regions, even if the climate becomes more favourable there (Farooq et al., 2023). Evidence shows that farmers' yields and revenues rise with improved access to water and efficient water use (Ricciardi et al., 2020).

2.2.2 Economic and social consequences

Economic impacts on the farm and the food system, including social impacts, are directly reflected in productivity impacts. Climate change has several social and economic ramifications, such as changes in farm income, food markets, prices, economic linkage, and investment (Harvey et al., 2021). Climate change can hinder the growth of agriculture by deterring investment, and climate shocks that affect a large portion of global production or a critical region for global markets have far-reaching consequences (Ray et al., 2019).

2.2.2.1 Climate change on the farm level

Risks discourage farmers from investing in production systems, which may a detrimental impact productivity, and yield over the long term (Adnan et al., 2020). The poorest farmers are most impacted financially by different types of weather extremes (Antonelli et al., 2022). If farmers' incomes fall because of climate change, their ability to provide adequate finances for improved healthcare services for their families and quality schooling for their children will be jeopardised (Mahmood et al., 2020).

2.2.2.2 Economic impact on national scale

The macroeconomy is affected by climate change because it causes gradual warming, seasonal precipitation, and more severe and frequent weather-related events (Batten et al., 2020). The economic impact across the country could lead to higher prices for agricultural products, which could affect everyone's economic and social status, especially in countries where food costs represent a significant portion of household budgets (Janssens et al., 2020). Climate change worsens income inequality, especially among vulnerable groups and low-income earners (Dasgupta et al., 2023).

2.2.2.3 Economic impact on a global scale

The world population is estimated to grow to 9 billion people by 2050, putting additional strain on agricultural land to meet rising food demand, which is already being impacted by climate change (Arora, 2019). Because agriculture and climate change are intricately linked, severe weather events threaten food security. Climate shocks can not only disrupt the variability and vitality of markets and alter bilateral agreements, but also have profound consequences in critical regions of global food supply (Janssens et al., 2020). The impacts of climate change are widespread but becoming increasingly visible in the agriculture industry, which is critical to global food security (Mbow et al., 2020). According to Kahn et al. (2021), a sustained annual increase in global average temperature of 0.04 °C by 2100 will lead to a decline in global real GDP per capita of more than 7 % if climate change mitigation strategies are not implemented.

2.2.2.4 Volatility in food prices

Food production is declining, and costs are rising because of climate change (Kunawotor et al., 2022). Heatwaves, droughts and floods drastically reduce global agricultural yields and have a notable effect on food production globally (Özcan, 2023). It also makes overall inflation rates more volatile as food prices rise (Batten et al., 2020). Likewise, Odongo et al. (2022) found that climate change factors, such as rainfall amounts, rainfall volatility, and temperature volatility, notably influences both food and overall inflation. But, because yields may rise in some regions of the world while declining in others, the overall impact is likely to differ based on a country's geographical location and agricultural import source (Andersson et al., 2020). As a result of deregulation, food prices in free markets are projected to become more volatile (Gomez-Zavaglia et al., 2020).

2.2.3 Climate change and food security

Climate change will affect the standard of living and income of food producers and consumers. The nutritional quality of some foods, especially major cereals, will change as CO_2 levels rise. Thus, it is evident that the availability and stability of food supplies would be impacted by weather extremes (Mbow et al., 2019). South Africa's agricultural sector has experienced unpredictable rainfall and temperature changes, leading to reduced crop and livestock yields, lower farm earnings, and jeopardized food security (Ogundeji, 2022). About 70% of South Africa's population depends on agriculture for food, income, and jobs (Cammarano et al., 2020), thereby contributing significantly to both food security and the local economy. Hence, it is very apparent that food security is under risk because of these climatic changes, especially in regions where rain-fed agricultural production serves as the main source of staple food, especially in regions where rain-fed agricultural production serves as the main staple food source (Akanbi et al., 2021).

2.3 Barriers to implementing climate change adaptation strategies

Agriculture is affected by climate change, with significant economic ramifications, due to its susceptibility to climatic variables (Malhi et al., 2021). There are still numerous barriers impeding the adoption or introduction of adaptation strategies in semi-commercial farming. The following section discusses the challenges most frequently mentioned in the literature.

2.3.1 Land tenure and farm size

As climate change increasingly affects agricultural systems, farmers must adapt to shifting conditions, with their adaptation decisions and vulnerability significantly influenced by the land tenure system, particularly land tenure security (Murken & Gornott, 2022). Farmers can manage their land under the land tenure system in many developing nations, but they are frequently discouraged from investing and adding value because they do not own the land (Zerssa et al., 2021). Alemayehu and Bewket (2017) found that the perception of land tenure security is key to choosing an adaptation strategy.

The size of the farm plays an important role in deciding whether adaptation strategies should be implemented (Marie et al., 2020). Tarfa et al. (2019) found that larger farm size is associated with a significant increase in the use of soil and water conservation measures, improved crop varieties and altered planting dates. This suggests that larger farms may be able to adopt new practises because they can experiment with new practises in some areas of the farm while maintaining traditional practises in others. However, small farms may find it difficult to adopt new technologies and techniques due to their limited space.

2.3.2 Limited knowledge and information transfer

Insufficient knowledge and skills make it difficult to adapt to climate change (Olabanji et al., 2021). Ethiopia, for example, continues to have major challenges in implementing small-scale irrigation and water harvesting technology (Zerssa et al., 2021). This is because farmers are not well-informed about the advantages of small-scale irrigation, which include increased agricultural output.

Lack of knowledge about climate change and adaptation strategies and limited access to climate information are the main barriers hindering the ability of semi-commercial farmers to respond effectively to climate change (Myeni and Moeletsi, 2020). Furthermore, Lee et al. (2022) found that poor awareness among the general public and politicians, as well as inadequate communication among stakeholders, including experts and policymakers, are barriers associated with lack of awareness.

2.3.3 Food systems and enabling policies

Strategies for adaptation on farms can be greatly supported by policies at national and local levels. These adaptation strategies to be coordinated across food systems, the public sector, businesses, and civil society need to work together (Amoak et al., 2022). According to Thinda et al. (2020) policies and investment plans by the government should primarily support education, provide trainings for on-farm demonstrations, and disseminate knowledge about ways for adapting to climate change. In addition, policies that improve water rights and investment in agriculture should be supported (Deche et al., 2023).

2.4 The strategic need for change

Early investment should be made in supporting semi-commercial agriculture to ensure food security in emerging economies, where this is already a challenge (Amoak et al., 2022). Climate change is altering food and agricultural production systems, rendering decision-makers and farmers uncertain and vulnerable (Barasa et al., 2021). Accelerating knowledge transfer on institutions, practises and technologies for adaptation and mitigation requires policy-related research at all levels (Amoak et al., 2022).

Climate change undoubtedly poses a threat to food security. The situation is expected to worsen due to pressures such as population growth, economic growth, urbanisation and the frequency of extreme temperatures, droughts, and floods. This section explains how semi-commercial farmers can successfully respond to climate change.

2.4.1 Education, empowerment, and capacity building

Sharing and disseminating information on climate smart agriculture techniques and empowering officials to share their knowledge with farmers is an important avenue for the capacity building plan. This builds their resilience by promoting adaptation and mitigation, which is critical to ensuring food security. It is imperative to recognise that a number of African farmers have adopted some agricultural practises or methods that fit very well the description of climate smart agriculture (Abegunde & Obi, 2022). These include crop rotation, crop diversification, mixed cropping, and sustainable soil conservation. The decision of semi-commercial farmers to adopt appropriate climate-smart practises is mainly influenced by access to financial support (Zerssa et al., 2021).

2.4.2 Strengthening the resilience of agricultural systems

By implementing very specific measures, agricultural systems can be made more resilient (Mbow et al., 2019). Building resilient livelihoods requires the optimal use of limited resources, especially water, in productive systems. The ability to cope with water scarcity is critical to maintaining production levels as climate change alters water resources availability and precipitation patterns. Water harvesting and storage, improved irrigation techniques and cropping practises that increase soil water storage are good practices that promotes adaptation. Crop diversification guarantees that farmers can obtain food over a longer period, as different crops mature at different rates (Amoak et al., 2022). This increases the resilience of semi-commercial farms to climate variability. In addition, using crop varieties adapted to different environmental tolerances, including currently underutilised crops, is one method to mitigate the failure of a single crop. Adjustments in cropping practises, particularly planting dates, variety selection and occasional increased irrigation, as well as changes in post-harvest practises, such as the amount of grain to be dried and methods of storing post-harvest products.

2.4.3 Supporting resilient agricultural development

Investing in and developing resilient agriculture can help with adaptation. Governments and the commercial sector need to support farmers, and civil society organisations are also crucial (Mbow et al., 2019). Investment in agriculture is essential for tackling the present issue of food prices as well as for decreasing poverty and hunger in least developed countries (Fan & Rosegrant, 2008). Nugroho et al. (2021) state that developing nations should put a higher priority on investments in technology and human resources, make sure that international investors and local agricultural businesses collaborate, increase agricultural exports, and set up an economic framework that is favourable to their needs.

2.4.4 *Facilitating adaptation through institutions*

Institutions are required to manage and mitigate the risks of climate change, using appropriate measures. Invasive species, water scarcity and plant pests are just a few examples of these risks. Transboundary risks should also be considered. Natural resource management (e.g., water, land) requires collective management at local and national levels to ensure seamless adaptation (Gitz et al., 2016). To promote adaptation strategies that eventually allow producers to access the inputs needed for adaptation and sell new commodities, it is important that farmers have stronger market linkages (De Bruin et al., 2021). Food producers and policy makers are becoming increasingly sensitive to the changes that climate change is causing in the agricultural production system. Policy-related research is therefore needed at both local and national levels to accelerate knowledge exchange on institutions, practises and technologies for adaptation and mitigation. According to Talanow et al. (2021), institutional and biophysical constraints are two types of external barriers. The two most important are the different composition of the soil and the apparent lack of government backing. It is imperative that semi-commercial farmers recognise the strategic need for change and adapt. By doing this, they can guarantee continued output, generate revenue, and support economic expansion in general.

2.5 Theoretical framework

Farmers' responsiveness to climate change is influenced by various socio-economic, environmental, institutional, and economic factors (Menike & Arachchi, 2016). Their comprehension and awareness of climate change are manifested through their perceptions. Consequently, assessing farmers' climate perceptions and adoption processes requires a well-defined framework. Several theories of perception have been developed to understand better how farmers perceive and respond to climate change. The well-established psychological theoretical model known as the Theory of Planned Behaviour (TPB) has been used extensively to explain farmers' intentions and actions and was also used in the present study.

2.5.1 The theory of planned behaviour

The TPB argues that an individual's actions are determined by their behavioural intent, which is influenced by their normative belief, normative belief, and control belief (Ajzen,1991). Behaviour is evaluated by behavioural belief; social acceptability is evaluated by normative belief; ease of performance is evaluated by behavioural control belief; and motivational factors influencing a specific behaviour are evaluated by behavioural intention (Nguyen & Drakou, 2021).

Agricultural debt, low income, and decreased productivity will likely make it challenging for farmers to take advantage of adaptation techniques. Though intent to adopt a specific measure is not the same as implementation, it is likely the greatest indicator (Wheeler & Bjornlund, 2013). This study used the TPB as a framework to understand better the behavioural control and the motivating factors that influence specific climate change behaviours. The application of the TPB in this research framework is consistent with its use in previous studies by Morton (2007), Wheeler et al. (2013), Owusu et al. (2015), Issa and Hamm (2017), and Belay et al. (2022), contributing to a growing body of literature that uses this theoretical approach to analyse farmers' responses to climate change.

The TPB was comprehensively analysed in three main dimensions. First, farmers' attitudes toward behaviour, subjective norms, and perceived behavioural control were examined to better understand the elements that determine their responses to climate change. Second, the study examined the relationship between perceptions of climate change and adaptation strategies. Finally, the study examined how these strategies affect crop productivity.

2.6 Conceptual framework

The study's conceptual framework includes independent and dependent variables (Figure 1). The independent variables are the adaptation strategies used by semi-commercial farmers to offset the risks of climate change, including crop diversification and soil and water conservation techniques. Performance (crop productivity) is the dependent variable.

According to Harvey et al. (2018), the percentage of farmers reporting extreme weather events and climatic stress varies by region. They indicated that many farmers reported that the agricultural production system was affected by floods, changes in rainfall patterns and severe droughts. In addition to the negative impacts of climate factors such as increased temperatures and changing rainfall patterns, social and economic issues were cited as major problems negatively impacting farmers (e.g. access to credit and markets). This vulnerability, in turn, exposes them to the impacts of climate change. These negative impacts are likely to put farmers at risk and prompt them to take appropriate measures to adapt to the negative impacts of climate and non-climate-related changes (Owusu et al., 2015).

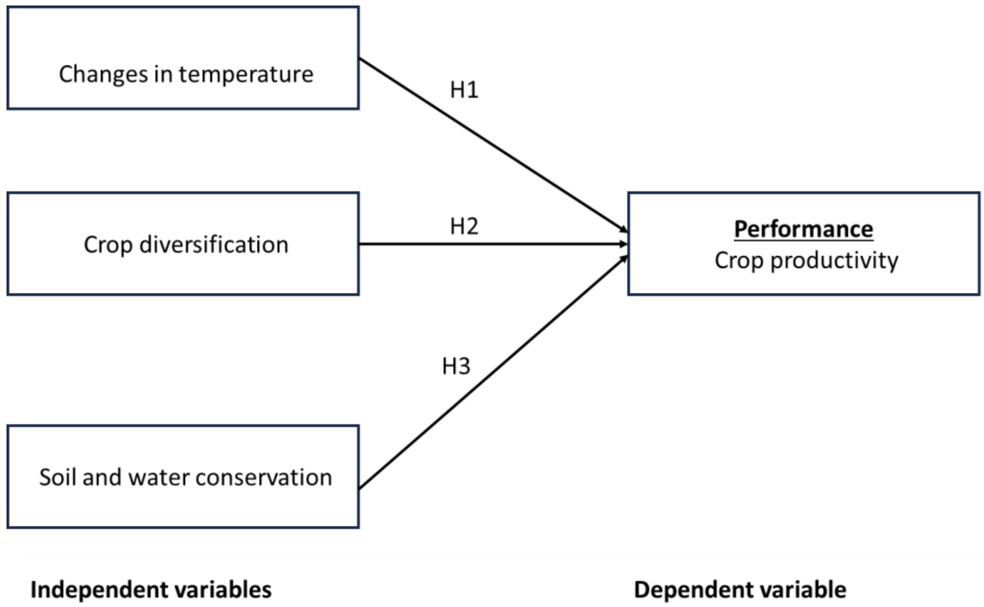

Figure 2.1: The conceptual framework.

The following hypotheses are developed from the above conceptual framework:

- *H1: Crop diversification has a positive and significant effect on crop productivity.*
- *H2: Soil and water conservation positively and significantly affect crop productivity.*
- *H3: Temperature changes have a positive and significant effect on crop productivity.*
- *H4: There is a positive correlation between crop diversification and crop productivity.*
- *H5: A positive correlation exists between soil and water conservation and crop productivity.*

The first three hypotheses (H1, H2, H3) refer to the regression model, while the last two (H4, H5) refer to the correlation analyses.

2.7 Chapter summary

The impact of climate change on agriculture requires appropriate policies that ensure food security and poverty eradication while promoting adaptation. Most African countries are the most vulnerable due to their dependence on rainfed agriculture as their main source of income. There is a need to develop adaptation strategies tailored to local climate change conditions. Many farmers have adapted to the changes caused by climate variability, such as seasonal water deficits and increased seasonal maximum temperatures. Although farmers have recognised the climate change factors, they lack knowledge on adapting their systems to extreme weather events.

CHAPTER 3. RESEARCH METHODOLOGY

3.1 Introduction

This chapter covers the applied research methodology. The chapter begins with the research approach and then discusses the research design, population, and sample. It subsequently delves into the data collection methodology, including the survey instrument, its validity and reliability, and the tools used for data processing. Additionally, ethical considerations and potential limitations that could impact the validity and reliability of the results were also examined.

3.2 Research approach

The research approach refers to the strategies and methods used to develop the research. They range from a comprehensive concept to more complicated methods of data collection, analysis, and interpretation of results. The study objectives research questions guide the researcher in choosing one of the three research methods mentioned above to identify, collect, and analyse data.

To gather data for a qualitative research technique, open-ended questions and interviews are frequently used as observational tools. An organised data collection process is employed in quantitative research to test hypotheses. The designs, which might be experimental or non-experimental, are intended to produce measurements that are accurate and trustworthy (Mohajan, 2020). Researchers employ the scientific method in quantitative methodology, which begins with a specific theory and hypotheses for the study technique. It emphasises impartiality and is especially useful when quantitative variables can be extracted from population samples (Queirós et al., 2017; Creswell, 2020). Given that the present study is structured and directed to decrease variation and concentrate on deducing a potential relationship between the variables, quantitative research was better suited for this type of study than qualitative research.

To gather data for a qualitative research technique, open-ended questions and interviews are frequently used as observational tools. In quantitative research, an organized data collection process is utilized to test hypotheses. The designs, which might be experimental or non-experimental, are intended to produce measurements that are accurate and trustworthy (Mohajan, 2020).

Researchers employ the scientific method in quantitative methodology, which begins with a specific theory and hypotheses for the study technique. It focuses on objectivity and is especially useful when it is possible to obtain quantitative measures of variables from population samples (Queirós et al., 2017; Creswell, 2020). The objectivity type of research refers to an approach where researchers strive to maintain neutrality, impartiality, and freedom from bias when conducting their investigations (Saunders et al., 2019). This involves minimizing personal beliefs, preferences, or subjective interpretations that could influence the research outcomes (Cresswell, 2020). Objectivity in research aims to ensure that findings are based on factual evidence and can be replicated by others, regardless of the researcher's perspectives or biases. For this study, quantitative research was considered more appropriate than qualitative research due to its structured approach focused on reducing variation and deducing potential relationships between variables. Additionally, considering that the study used theories and tested hypotheses, it was ideal to adopt the quantitative study.

3.3 Research design

The research design is a plan that outlines how the research will be conducted and includes detailed methods for both data collection and analysis (Creswell, 2009; Rashid et al., 2019). It also thoroughly explains the researcher's intended methodology and describes how the research questions will be addressed (Rahi, 2017). The details of the research problem to be investigated affect the study's design. A survey is a research method that allows the direct collection of information from participants using a set of predefined questions (Queirós et al. 2017). This study used a questionnaire for data collection (Appendix A). The questionnaires collected information on various aspects, including demographic data, farmers' perceptions of climate change, their response to climate change and access to credit. In addition, the survey assessed the impact of adaptation strategies on crop productivity. The collected responses furnished the essential information to evaluate farmers' responses to climate change and their perceptions and practices concerning climate change.

3.4 Population and sample

The study focused on South African Cultivar and Technology Agency (SACTA) semi-commercial farmers and semi-commercial farmers participating in development programs supported by SACTA service providers. It is important to note that SACTA does not manage the farmers; the service providers manage them on their behalf. These farmers are mainly located in the provinces of Mpumalanga, North West, Free State, Eastern Cape, KwaZulu Natal, Western Cape, Gauteng and Northern Cape. A representative sample of farmers from this community was selected using a convenience sampling method to complete a questionnaire on their response to climate change. The sample size consisted of 90 semi-commercial farmers. Convenience sampling was used, where participants were selected based on their accessibility and availability (Saunders et al., 2019). Cresswell (2020) defines convenience sampling as the selection of individuals or elements that are easily accessible or willing to participate in a study. Considering the researcher's ready access to willing participants, limited resources and time constraints, convenience sampling was deemed appropriate for the study.

3.5 Research instrument

The main goal of the instruments used for measurement is to give the researcher accurate, trustworthy, and impartial data that may be repeated in subsequent studies. The accuracy of respondents' responses and the survey's design substantially impact the trustworthiness of the survey results. Structured questionnaires were employed for the collection of data. In this type of questionnaire, respondents are presented with the same questions, ensuring that their responses can be systematically compared. The questionnaire structure has enabled the development of a regression model with performance as the dependent variable. In section A, demographic data of the participants was collected, while in section B, respondents' perceptions were recorded using statements on a five-point Likert scale, with 1 indicating strong disagreement and 5 indicating strong agreement. Table 3.1 gives a snapshot of the questionnaire used, with its respective themes. In this study, the performance construct/theme refers to crop productivity.

Table 3-1: Questionnaire snapshot.

Themes	Items	Sample questions	References
Farmers' perceptions of climate change	Temp1, Temp3.	- In recent years, I have experienced an increase in temperature - In recent years, I have experienced an increase in rainfall.	Addis & Abirdew (2021) Akanbi et al. (2021)
Responsiveness of farmers to climate change	Rainfall1, Rainfall2.	- As a farmer, I adopted high-yield crop varieties. - As a farmer, I have adopted crop rotation for soil conservation.	Atinkut & Mebrat (2016) Moges and Taye (2017)
Access to credit	CropDivers1, CropDivers3.	- I have access to adequate credit. - I have easy access to finance.	Atinkut & Mebrat (2016) Olabanji et al. (2021)
Performance (crop productivity)	Performance1, Performance3.	- Adopting disease resistance crop varieties increases crop productivity. - Adopting high-quality crop varieties increases crop productivity.	Addis and Abirdew (2021) Kassa et al. (2022)

3.6 Data collection

Since the study adopted a quantitative methodology, the questionnaire for data collection was deemed appropriate. A self-administered questionnaire was distributed electronically at a convenient time. SACTA farmers were the main study participants. The questionnaire used to collect data was considered suitable because the study used a quantitative methodology. A self-administered questionnaire was electronically disseminated at a convenient time. The main participants in the study were SACTA farmers. The questionnaire was electronically distributed and developed by Qualtrics, a survey software. The electronic questionnaire included a consent form, instructions for completing the questionnaire, and a cover letter detailing the study's objectives. The questionnaires were sent to 119 semi-commercial farmers, with 90 participants targeted for this study. The completed questionnaires were saved electronically and only accessible to the researcher through a password. The collected data was then transferred to an Excel file for statistical analysis.

3.7 Data analysis

Statistical analyses were carried out using SPSS version 29 and STATISTICA version 14.1.0. The semi-commercial farmers' demographics were analysed using frequencies and descriptive statistics. Furthermore, relationships between variables were tested using Spearman's correlation analysis, and the relationship between variables was modelled using multiple linear regression. Spearman’s statistical measure correlation was used to assess the strength and pattern of a relationship between two variables (Janse et al., 2021). For example, in this research, statistical measures were used to measure how access to credit can influence farmers' performance. Spearman's correlation evaluates the monotonic relationship between variables. Monotonic relationships describe situations where variables vary in the same direction, though not always at the same rate (Bürkner & Charpentier, 2020). The range of the Spearman's correlation coefficient, represented by ρ (rho), is -1 to +1. For each variable, a value of +1 stands for an ideal positive monotonic relationship, a value of -1 for an ideal negative monotonic relationship and a value of 0 for no monotonic relationship. The Spearman correlation is often used with ordinal data or when the relationship between the variables is not linear (Hair et al., 2017). It is a non-parametric measure that does not rely on a certain data distribution. Because this was survey data, which translates to a cross-sectional study, data was not assumed to be of any distribution.

3.8 Reliability and validity

Since multi-scale questionnaires were employed to measure constructs, it became essential to validate responses and guarantee the validity of the research instrument to reduce errors. Field (2013) indicates that validity and reliability assessment extends beyond mere error reduction, ascertaining the consistency of constructs and whether they genuinely measure what they claim.

3.8.1 Reliability

Considering that the study uses a questionnaire and focuses on qualitative aspects guided by pre-tested and adopted themes, concerns about the reliability of scales and factors are likely to arise. Hair et al. (2017) underscores the importance of testing scale reliability to ensure the credibility and generalizability of results. The researcher identified two potential threats to the questionnaire: observer and subject reliability. Subject reliability arises from factors influenced by research participants, such as farmers. Observer reliability stems from the interviewer's difficulty interpreting outcomes (Saunders et al., 2009). This study's observer reliability threat was non-existent because the survey was self-administered. To address subject reliability, the study initially proposed that respondents have enough time to complete the questionnaire, thus avoiding fatigue and ensuring reliable responses. Furthermore, the study used previously tested scales known to produce reliable outcomes and focused on asking direct, clear questions with proper wording to maintain the instrument's reliability and ensure accurate outcomes. However, a pilot study was conducted despite all these means used to address the reliability concerns.

Cronbach's alpha is a commonly used procedure. The study also used Cronbach's alpha approach to analyse an instrument's consistency, which quantifies it. The Cronbach alpha, which is between 0 and 1, is recommended to be above 0.7 (Hair et al., 2021), although some scholars argue that a coefficient above 0.6 is acceptable (Hair et al., 2017). For the study, all constructs were above 0.6, meaning that reliability concerns were eliminated as the study achieved internal consistency.

3.8.2 Validity

In the study, validity issues were carefully considered to ensure to ensure the accuracy of the constructs and the alignment of the instrument's measurements with its intended purpose. This was guided by the consistency of constructs from theories and pre-validated e consistency of constructs from theories and pre-validated indicators guided this. The researcher identified various types of validity that could affect the outcome if not addressed properly. However, based on the literature, the theories, the quantitative nature of the study and the research themes, the study proposed to examine internal and construct validity. Internal validity is assessing the extent to which a study accurately demonstrates a cause-effect relationship between variables (Saunders et al., 2019). Essentially, it assesses whether variations in the independent variables lead to changes in the dependent variables without these being influenced by external factors. In this study, this is the case when examining how access to credit affects farmer performance. To ensure internal validity, the researchers ensured that the study was effectively designed, and the constructs were used in advance, which means that biases that could influence the results were minimized. Furthermore, construct validity refers to how well a measurement instrument assesses the theoretical concept it is designed to measure (Cresswell et al., 2020). In other words, it assesses whether the instrument captures the theoretical construct it purports to represent. The variance inflation factor (VIF) approach was used in the study to determine construct validity. Hair et al. (2020) state that VIF quantifies how much the variance of a coefficient is inflated due to multicollinearity. A high VIF indicates that the variance of the coefficient estimate is inflated, suggesting that multicollinearity may be a concern. A VIF value greater than 10 is considered problematic, although some researchers may use a lower threshold (Civelek, 2018). In the study, the results did not exceed the threshold, meaning the results can be deemed valid.

3.9 Limitations

The research considers the views of semi-commercial farmers who have received loans from SACTA for input financing and the perceptions of participating in development programmes facilitated by SACTA service providers. As the study focuses primarily on quantitative data and does not include qualitative findings, there are limitations for people who wish to use a variety of approaches, such as interviews and case studies.

3.10 Quality assurance

The questionnaires were developed by adapting questions from earlier research in which the questionnaires had already been validated or by employing an instrument that had already been constructed, which helped to ensure the validity of the measurement instrument. Validity and dependability are closely related ideas, but they present various aspects of the measurement instrument (Sürücü & Maslakçi, 2020). For instance, a measurement instrument can be reliable without being valid, but it is more likely to be reliable if it is valid. Validity refers to an instrument's capacity to measure what it is designed to measure accurately. In contrast, reliability is the capacity of various researchers to arrive at comparable results consistently using the same experimental design or participants in a study to acquire the same measurement (Lowhorn, 2007). The study conducted a pilot study involving five respondents due to time constraints, preventing increased participation. Despite this limitation, the pilot study significantly enhanced the research quality by incorporating participant feedback to refine the questionnaire. This refinement process focused on eliminating vagueness, shortening the questionnaire duration, and enhancing coherence. As a result, the researcher was ultimately satisfied with the overall quality of the research.

3.11 Ethical considerations

Creswell (2020) defines research ethics as the codes of conduct, laws, and standards that must be adhered to before conducting research. Saunders et al. (2019) stress the importance of voluntary participation by respondents in research endeavours. In alignment with these principles and established literature, participating in this study was voluntary; no coercion was used. In addition, participants had the option or right to withdraw from the study at any time during the completion of the questionnaire. In addition, data collection was carried out only after receiving approval from the school's ethics committee (WBS/BA788404/417). Furthermore, the researcher complied with ethical standards by sending letters of introduction to organisations and individuals to request consent before data collection. The researcher maintained the confidentiality, privacy, and anonymity of participants' data by handling responses anonymously and refrained from requesting names, identity numbers, or addresses that could compromise anonymity or identify organisational affiliations. Data was securely stored in a locked Google Cloud facility and scheduled for deletion post-retention period of five years.

3.12 Chapter summary

This chapter deals with the research methodology and draws on findings from previous studies. It outlined the chosen approach, research design, and key metrics incorporated into the methodology. Given the research's quantitative nature, a survey was conducted. Additionally, the chapter discussed the adoption of convenience sampling and its appropriateness for the study. Data analysis techniques adopted for the study together with the necessary procedures were confirmed. The study utilized the Spearman correlation and performed a linear regression analysis to confirm or disregard the proposed hypotheses. Ultimately, the chapter outlined steps undertaken to enhance the study instrument's validity and reliability. It also contained a comprehensive discussion of ethics, setting out the rules of conduct for conducting the research.

CHAPTER 4. RESULTS AND DISCUSSION

This chapter presents the results and the discussion of the results. The research findings and their significance.

4.1 Frequencies and descriptive statistics of the individual questions.

Table 4.1 summarises the demographics and farming-related attributes of the participants.

Table 4-1: Frequencies of demographic characteristics.

Item	Category	Count	Percent
Age (years)	18 -34	16	17,78
	35-54	57	63,33
	55 -64	11	12,22
	Above 65	5	5,56
	Missing	1	1,11
Highest level of education	Secondary	14	15,56
	Tertiary	75	83,33
	Missing	1	1,11
Years in farming	Under 10 years	30	33,33
	10-24 years	51	56,67
	25-39 years	9	10,00
Type of agricultural practices	Rainfed only	52	57,78
	Irrigation only	4	4,44
	Rainfed and Irrigation	27	30,00
	Other	7	7,78
	Missing	0	0,00

The study involved the participation of 90 individuals. Most of the respondents (63.33%) were between the ages of 35 and 54, with 17.78% falling between the ages of 18 and 34 (Table 4.1), 12.22% between the ages of 55 and 64, and 5.56% over the age of 65. Farmers with more farming experience are more likely to adopt new farming methods, such as improved crop varieties. This is because they are better equipped to assess risks in climate change adaptation investments (Atinkut & Mebrat, 2016).

Most respondents (83.33%) have tertiary education, indicating a relatively high level of formal education among semi-commercial farmers in the study. A smaller proportion (15.56%) have secondary education, indicating a range of educational backgrounds within the surveyed group. Higher education levels are expected to boost farmers' ability to understand climate adaption strategies and increase their agricultural expertise (Abafe et al.,2022). The level of education of farmers has a greater influence on whether they use these strategies. The likelihood of implementing crop diversification rises with each additional education unit, as stated by (Destaw & Fenta, (2021). This could be because educated farmers are more aware than their counterparts of adopting new technologies.

The results on years in farming reveals that a significant portion of respondents (56.67%) has been engaged in farming for 10-24 years, indicating a moderate level of experience. Another sizable proportion (33.33%) has lower than ten years of farming experience. Only a small percentage (10.00%) has 25-39 years of farming experience. This was expected considering that most of the farmers could have left the country after independence in 1994 and due to political instability, which has led to few farmers remaining in the country. However, this number proves to be sufficient considering that technological advancements have been at rapid rise in recent years.

Most respondents (57.78%) rely on rainfed agricultural practices, indicating a significant dependence on natural rainfall for farming (Table 4.1) Similarly, Akanbi et al., 2021 stated that more than 85% of participants reported rainfed maize production, while 12% respondents relied on either limited or full irrigation. A notable proportion of respondents within the current study (30%) practices both rainfed and irrigation methods, reflecting a diversified approach to agriculture. A smaller percentage (4.44%) relies solely on irrigation, indicating a minority of respondents using controlled water supply for farming.

Tables 4.2 to 4.8 present the individual questions' frequencies, mean and standard deviation (SD). The mean values for temperature changes ranged between 3.92 (SD = 0.69) and 4.36 (SD = 0.66), indicating that respondents, on average, agreed that they did experience an increase in temperature, evaporation as well as pest and disease outbreaks in recent years (Table 4.2).

Table 4-2: Frequencies, mean and standard deviation (SD) of changes in temperature.

No	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
Temp1	In recent years, I have experienced an increase in temperature.	0	1	6	43	40	4,36	0,66
Temp2	In recent years, I have experienced an increase in evaporation.	0	3	15	48	24	4,03	0,76
Temp3	In recent years, I have experienced increased pest and disease outbreaks.	1	2	13	61	13	3,92	0,69

The mean values for changes in rainfall-related statements ranged between 3.62 (Standard deviation (SD) = 1.20) and 4.00 (SD = 0.85), indicating that respondents, on average, agreed that they did experience changes in rainfall in recent years as well as an increase in flooding and a delay in the onset of rainfall (Table 4.3).

Table 4-3: Frequencies, mean and standard deviation (SD) of changes in rainfall.

No	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
Rainfall1	In recent years, I have experienced an increase in rainfall.	5	15	12	35	23	3,62	1,20
Rainfall2	In recent years I have experienced an increase in floods	0	3	21	47	18	3,90	0,75
Rainfall3	In recent years, I have experienced a delay in the rainfall onset	2	3	11	51	23	4,00	0,85

The mean values for crop diversification ranged from 3.93 (SD = 0.78) to 4.02 (SD = 0.66). On average, respondents agreed with adopting disease-resistant, high-yield, and high-quality crop varieties as part of their farming practices (Table 4.4).

Table 4-4: Frequencies, mean and standard deviation (SD) of crop diversification.

No	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
CropDivers1	As a farmer, I have adopted disease-resistant crop varieties.	0	7	9	55	17	3,93	0,78
CropDivers2	As a farmer, I adopted high-yield crop varieties.	0	2	12	57	18	4,02	0,66
CropDivers3	As a farmer, I have adopted high-quality crop varieties.	0	3	14	56	16	3,96	0,69

The mean values for the statements on soil and water conservation ranged from 3.70 (SD = 0.87) to 4.02 (SD = 0.79). On average, respondents agreed with the use of organic amendments for soil conservation, crop rotation for soil conservation and the use of stored water for agricultural purposes (Table 4.5).

Table 4-5: Frequencies, mean and standard deviation (SD) of soil and water conservation.

No	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
SoilWater1	As a farmer, I use organic amendments for soil conservation.	1	8	20	46	13	3,70	0,87
SoilWater2	As a farmer, I have adopted crop rotation for soil conservation.	0	7	5	54	21	4,02	0,79
SoilWater3	As a farmer, I frequently use stored water for agricultural purposes	3	9	12	46	19	3,78	1,01

The mean scores for the statements about access to credit ranged from 2.15 (SD = 1.12) to 2.44 (SD = 1.26), as shown in Table 4.6. This means that, on average, respondents disagreed that they have access to adequate credit and easy access to finance, that credit is offered at affordable interest rates and that they have access to alternative sources of finance (e.g. government grants).

Table 4-6: Frequencies, mean and standard deviation (SD) of access to credit.

No	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
AccessCredit1	I have access to adequate credit.	21	42	8	13	5	2,31	1,15
accessCredit2	Loans are offered at affordable rates.	33	31	10	8	7	2,16	1,24
AccessCredit3	I have easy access to finance.	28	36	11	9	4	2,15	1,12
accessCredit4	I have access to alternative finance sources (e.g., government grants).	25	29	11	19	5	2,44	1,26

The performance construct refers to crop productivity, which is quantitatively measured as yield per hectare (Table 4.7). The mean values for performance ranged from 3.94 (SD = 0.75) to 4.28 (SD = 0.64). These results indicate that, on average, respondents agreed that adopting disease resistance, high-yield crop varieties, high-quality crop varieties, and organic amendments for soil conservation enhances crop productivity.

Table 4-7: Frequencies, mean and standard deviation (SD) of performance.

No	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
Performance1	Adopting disease resistance crop varieties increases crop productivity.	0	2	6	46	33	4,26	0,69
Performance2	As a farmer, I adopted high-yield crop varieties.	0	1	6	48	32	4,28	0,64
Performance3	Adopting high-quality crop varieties increases crop productivity.	0	2	7	51	27	4,18	0,67
Performance4	Adopting organic amendments for soil conservation increases crop productivity.	0	3	18	47	19	3,94	0,75

4.2 Reliability

Table 4.8 shows the internal consistency and reliability of the main constructs. Values above 0.560 indicate reasonable internal consistency. The study presented Cronbach's Alpha results, which are consistent with the rule of thumb of Hair et al. (2017): Any alpha coefficients above 0.6 indicate internal consistency.

The Cronbach alpha coefficient of 0.62 indicates reasonable internal consistency for the changes in temperature construct (Table 4.8). On the hand, the low Cronbach alpha coefficient of 0.20 of changes in rainfall indicates that this construct is unreliable and will not be used in any further analyses.

The crop diversification's good internal consistency and reliability are indicated by the high Cronbach alpha coefficient (0.79). The coefficient of 0.61 reflect internal consistency and reliability for the soil and water conservation construct. Access to credit had a high Cronbach alpha coefficient (0.90) which indicate strong internal consistency and reliability (Table 4.8). Similarly, performance had a Cronbach alpha coefficient of 0.87 also indicating strong internal consistency and reliability (Table 4.8).

Table 4-8: Reliability results of the main constructs.

Construct Name	Cronbach alpha	Mean	SD
Changes in temperature	0,62	12,31	1,59
Changes in rainfall	0,20	11,54	1,77
Crop diversification	0,79	11,91	1,80
Soil and water conservation	0,61	11,44	2,01
Access to credit	0,90	9,00	4,17
Performance	0,87	16,67	2,34

The reliability analysis shows that all Cronbach’s alpha coefficients for changes in temperature, soil and water conservation, access to credit, performance and crop diversification exceed the threshold value of 0.50, which indicates comprehensive coverage and clarity of all constructs. This indicates the reliability of the questionnaire and confirms the sufficient internal consistency of the measurement scale apart from the rainfall variable.

4.3 Descriptive statistics of the construct scores

Following the reliability determination, a construct score (mean for the entire section) and descriptive statistics were obtained by grouping the questions. The mean and standard deviation of the construct score reflect respondents' perceptions regarding five key constructs, as captured through a questionnaire (Table 4.9). The rainfall variable was not included in this analysis and on further analysis since it showed a low alpha coefficient and a standardised alpha. However, the temperature variable is one of the most important drivers of climate change (Subramanian et al., 2023) and is analysed in more detail.

Table 4-9: Descriptive statistics of the construct score.

Construct Name	Mean	SD
Changes in temperature	4,10	0,53
Crop diversification	3,97	0,60
Soil and water conservation	3,84	0,68
Credit	2,21	1,06
Performance	4,17	0,59

Among the 90 participants, the mean rating for the perceived increase in temperature construct is 4.10 (SD = 0.53). Thus, on average, the participants agreed with the statements indicating that they did experience a change in temperature in recent years. The mean score for crop diversification of farming practices was 3.97 (SD = 0.60), and for soil and water conservation practices, 3.84 (SD = 0.68). This indicates a moderate level of perception with varying perceptions among the 90 respondents.

On access to credit, the mean of 2.21 (SD = 1.06) of access to credit indicates that the respondents on average disagreed with the statements that were asked in the questionnaire such as “I have access to adequate credit, Loans are offered at affordable rates, I have easy access to finance, I have access to alternative sources of finance”. Access to credit significantly improves agricultural performance by increasing the prosperity of farmers through higher yield and higher revenue to those without credit (Mkuna & Wale, 2022). There is limited access to agricultural credit farmers (Pili & Ncube, 2022; Carlsen et al., 2023). The current study also confirms that farmers have lack of access to financing. Farmers without collateral typically cannot access financial services from private sections, and their inability to use their farmland as collateral prevents them from getting funding from banks (Żmija et al., 2020; Pili & Ncube, 2022). Access to credit not only enables farmers to succeed, but also improves their ability to prepare to adapt. Teshome et al. (2021) highlighted high costs as the main barrier to purchasing essential inputs for crop diversification. This highlights the importance of resolving credit access issues to bridge farmers' financial gaps. This in turn allows them to acquire the necessary agricultural inputs and technologies, thereby improving farming performance and adaptation to climate change.

The performance construct had a high mean of 4.17 by 87 respondents, indicating a shared positive perspective seeing that respondents on average agreed with the statements (Table 4.9). The shared perception is that adaptation strategies such adopting disease-resistant crop varieties, high-yield crop varieties and high-quality crop varieties increase crop productivity (performance).

4.4 Correlation between the different constructs

Correlation analysis was performed to ascertain the direction and degree of links between various constructs. This helped with validity checks and the selection of variables for regression models.

Table 4.10 presents the spearmen correlations between the different construct scores. Spearman's correlation assesses the intensity and direction of a monotonic relationship between variables instead of a linear relationship (Tabachnick & Fidell, 2019; Gravetter & Wallnau, 2020). The degree of correlation determines the strength: a value closer to one (1) indicates a high correlation, while a value closer to zero (0) indicates a lack of correlation.

Table 4-10: Correlations between the different constructs scores.

Construct name		Temperature	Crop diversification	Soil and water conservation	Credit	Performance
Changes in temperature	Correlation Coefficient	1,00	0,19	**0,39***	-0,03	**0,30***
	Sig.		0,08	0,00	0,79	0,00
Crop Diversification	Correlation Coefficient	0,19	1,00	**0,52***	0,08	**0,51***
	Sig.	0,08		0,00	0,47	0,00
Soil and water conservation	Correlation Coefficient	**0,39***	**0,52***	1,00	0,13	**0,58***
	Sig.	0,00	0,00		0,23	0,00
Credit	Correlation Coefficient	-0,03	0,08	0,13	1,00	0,13
	Sig.	0,79	0,47	0,23		0,24
Performance	Correlation Coefficient	**0,30***	**0,51***	**0,58***	0,13	1,00
	Sig.	0,00	0,00	0,00	0,24	

*Correlations are significant at the 0.05 level (2-tailed).

It is important to mention that P values will be reported for completeness but will not be interpreted due to using an available sample instead of a random sample. This approach aligns with Spearman's correlation principle as it does not assume that the data follow a specific distribution, making it suitable for non-normally distributed data (Pallant, 2021).

Temperature is positively correlated with one of the adaptation strategies applied by semi-commercial farmers which is soil and water conservation (corr. = 0,39*) and performance (corr. = 0,30*). Soil and water conservation demonstrated a positive correlation with performance (corr. = 0,58*). This clearly suggests that temperature changes influence the strategies used by semi-commercial farmers, and that adopting climate strategies improves crop productivity (performance). Similarly, Mairura et al. (2021) found a relationship between farmers' perceptions and the use of strategies for adaptation. They also established a stronger relationship between perceptions of climate change and soil and water conservation than crop diversification strategies.

Access to credit, however, had a very low correlation with performance (corr = 0.126). According to Ojo et al. (2021), access to finance encourages farmers and the implementation of adaptation strategies. A study conducted by Atinkut and Mebrat (2016) found that access to credit significantly impacts soil and water conservation practices and crop diversification practices. Mairura et al. (2021) have shown that access to finance hurts farmers' willingness to use improved crop varieties. This contradicts the expected moderating effect between climate change perceptions and adaptation strategies.

4.5 Regression model

Tables 4.11 and 4.12 present the regression models fitted to the data with performance as a dependent variable. The initial model encompasses temperature, crop diversification techniques, soil and water conservation techniques, and access to credit as independent variables. In contrast, the second model includes only crop diversification, soil and water conservation techniques and temperature as independent variables. The regression model assesses respondents' perceptions of responsiveness to climate change, specifically focusing on the variable performance (crop productivity) as dependent.

The R-squared value of the model is 0.407, which means that about 40.7% of the variance of the performance variable is described by the predictors. According to Hair et al. (2022), the R-squared metric defines the degree of variability of the dependent variable and how the independent variables describe it. While a higher R-squared value frequently suggests a better fit of the model to the data, the researchers highlight that its interpretation depends on the level of detail of the study. However, the study used the rule of thumb to explain variations with the close association, where the R-square explains the effect of the dependent variable on independent variables. Additionally, it is important to mention that access to credit variables can be omitted from the model based on the correlation results, which indicated low correlations. It was included here to verify if it is a significant predictor of Performance.

The regression coefficients represent the predicted relationship among the predictors and the dependent variable. Crop diversification techniques (Beta =

0.334) and soil and water conservation techniques (Beta = 0.287) contributed statistically to the model. Access to credit (Beta = 0.076) is statistically insignificant in the model, as expected, given the low correlation between this and dependent variables.

Collinearity diagnostics provide information on probable multicollinearity. In regression analysis, multicollinearity happens when two or more predictor variables have a significant correlation with one another (Hair et al., 2020). The computation of the regression coefficients and the model's interpretation may be complicated by this high correlation.

Multicollinearity becomes a problem when the relationship between the predicted variables is so strong that it leads to inconsistent estimates of the regression coefficients. This may lead to incorrect interpretations of the data and make it challenging to ascertain the distinct contribution of each predictor variable to the outcome variable (Gelman & Hill, 2021). Several scholars have identified different ways to handle multicollinearity, such as principal component analysis (PCA), condition indices, and variance inflation factors (Hair et al., 2020; Cresswell, 2020; Pallant, 2021). The study performed the VIF to help examine if there are issues of multicollinearity.

The variance inflation factor indicates low collinearity among the predictor variables (Table 4.11). The regression model results reflect that crop diversification measures and soil and water conservation techniques significantly predict perceived increased productivity (performance). As previously mentioned, access to credit is not a significant predictor of perceived performance, but it can be excluded from the regression model based on the correlation results.

Table 4-11: Standardised coefficients of the constructs.

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1,05	0,46		2,26	0,03		
	Changes in temperature	0,19	0,10	0,17	1,89	0,06	0,85	1,17
	Crop diversification	0,33	0,10	0,33	3,31	0,00	0,71	1,41
	Soil and water conservation	0,25	0,09	0,29	2,79	0,01	0,68	1,46
	Credit	0,04	0,05	0,08	0,87	0,39	0,95	1,05
a. Dependent Variable: Performance (Crop productivity)								

Table 4.12 shows the regression model without the access to credit variable. The second model showed that the predictors describe 40.2% of the variation in the dependent variable. According to the coefficients, crop diversification has the largest standardised coefficient (beta = 0.341) (see Table 4.12).

Table 4-12: Standardised coefficients (without credit as variable).

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1,12	0,45		2,47	0,02		
	Changes in temperature	0,18	0,10	0,16	1,78	0,08	0,87	1,15
	Crop Diversification	0,33	0,10	0,34	3,40	0,00	0,72	1,40
	Soil & water conservation	0,26	0,09	0,30	2,94	0,00	0,70	1,44
a. Dependent Variable: Performance (Crop productivity)								

The collinearity diagnostic indicates a moderate degree of multicollinearity across the predictors, with VIF values less than 2, indicating acceptable collinearity (Table 4.12). Overall, the model results shows that two independent variables, soil and water conservation and crop diversification techniques proofed to be significant predictors of "Performance" at a 0.05 significance level. Similarly, in regression model crop diversification serves as a key indicator of agricultural production (Liu et al., 2022). The regression model that excludes the variable access to credit provides a more robust and interpretable explanation of the variables that influence perceived increased productivity. It increases the predictive power of the model while meeting statistical significance and theoretical expectations.

4.6 Summary of the main findings

This study aimed to assess the responsiveness of semi-commercial farmers to climate change. The main questions related to (1) What are the perceptions of semi-commercial farmers about climate change, (2) What are the strategies of semi-commercial farmers to climate change, and (3) How do adaptation strategies influence performance? The main results for these research questions were as follows: (1) respondents agreed that climate change exists, with a particularly strong consensus regarding the delayed onset of rainfall, evaporation, temperature changes, and impact on pest and disease outbreaks; (2) they perceived crop diversification strategies such as the adopting of disease-resistant crop varieties, high-yielding crop varieties, high-quality crop varieties; the also perceived soil and water conservation techniques such as the use of stored water for agricultural purposes, adopting crop rotations for soil conservation and organic amendments and (3) both crop diversification, soil and water conservation practices were found to be significant predictors of performance (crop productivity), highlighting their strong influence on farmers' perspectives on increased crop productivity. Consistent with the study objectives, the hypotheses tests performed helped strengthen the study's conclusions. Table 4.13 summarizes the results of the hypotheses.

Table 4-13: A summary of hypotheses results.

Hypothesis	Relationship	Remarks
H1	Crop diversification has a significant effect on crop productivity.	Supported
H2	Soil and water conservation has a significant effect on crop productivity.	Supported
H3	Temperature changes have a significant effect on crop productivity.	Not supported
H4	There is a positive correlation between crop diversification and crop productivity.	Supported
H5	There is a positive correlation between soil and water conservation and crop productivity.	Supported

Table 4.13 shows that hypothesis one (H1), which proposed that crop diversification practices significantly affect performance (crop productivity), was confirmed. Similarly, the second hypothesis (H2) proposed that soil and water conservation techniques significantly affect crop productivity was supported. The third hypothesis (H3), which proposed that temperature changes significantly influence crop productivity, was not supported.

Hypotheses (H4), which proposed a positive correlation between crop diversification techniques and crop productivity, and (H5), which proposed a positive correlation between soil and water conservation techniques and crop productivity, were supported.

4.7 Chapter summary

The chapter was structured to present the findings and the methods employed to obtain them. It consisted of multiple sections, each serving a distinct purpose. Initially, the chapter began by outlining the demographic results of the participants, encompassing details about the individual backgrounds, including academic qualifications, type of agricultural practices (rainfed, irrigation or both) and years of experience in farming. The reliability and validity of the research constructs by the research instruments were then discussed. Building upon the results of reliability and validity assessments, the chapter then presented the outcomes of the correlation and regression analysis together with the corresponding hypothesis testing. Overall, the data was effectively illustrated using tables, facilitating a comprehensive understanding of the results. Furthermore, the chapter also discussed the findings and interpreted results. Conclusions and recommendations will be provided in the subsequent chapter.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

The conclusions and reflections on the research objectives are presented in this final chapter. In addition, it points out areas or research questions that may require further research as they were not addressed in this study and finally gives practical recommendations that can be applied.

5.1 Summary of main findings

The study aimed to assess the perceptions of semi-commercial farmers in South Africa about climate change. To achieve this goal, the following summary outlines key findings aligned with each of the research objectives, providing insights into the perceptions of South African semi-commercial farmers in relation to climate change.

5.1.1 Objective one: Farmer's perceptions on climate change.

Farmers expressed different perceptions and perceived the rise in temperature as one of the explanatory factors influencing their decision to adopt adaptation strategies. The positive correlations ($p < 0.05$) between soil and water conservation techniques and temperature are consistent with those of previous researchers. For example, Mairura et al. (2021) found that farmers' perceived temperature increases correlated with soil and water conservation measures. A study by Atinkut and Mebrat (2016) on farmers' perceptions confirms and underpins the above statements. It shows that crop diversification practices and soil and water conservation techniques positively and strongly correlated with rising temperatures.

5.1.2 Objective two: Farmer's responsiveness to climate change.

Farmers increasingly integrate climate change adaptation techniques with growing resilience and adaptability into their practices. This was supported by a positive correlation between crop diversification, soil, and water conservation practices (corr. = 0.52; $p < 0.05$). The present results are consistent with the research of Addis and

Abirdew (2021), who found a positive correlation between crop diversification, soil, and water conservation measures, suggesting that implementing soil and water conservation measures improves the area available for crop diversification.

Tarfa et al. (2019) confirmed the results and found a positive correlation between crop diversification and soil and water conservation practices. Intercropping sorghum, maize with sweet potato and cowpea was the most used agricultural diversification technique in their study.

5.1.3 Objective three: Adaptation strategies on performance

The study established that adopting climate change adaptation strategies improves performance (crop productivity), and farmers may greatly increase resilience. This was supported by positive correlations between performance (crop productivity) and crop diversification (corr. = 0.51) and soil and water conservation (corr. = 0.58). The study's findings align with previous studies. For example, in a research study on mung beans, Kassa et al. (2022) found a significant positive correlation between farmers' perceptions and the grain measured. The performance-related attributes in the study focused on crop diversification, examining whether adopting disease-resistant crop varieties increases crop productivity, whether adopting high-yield crop varieties increases crop productivity, and whether adopting high-quality crop varieties increases crop productivity. These results indicated that adopting disease-resistant crop varieties, high-yield crop varieties, high-quality crop varieties, and organic amendments for soil conservation enhances crop productivity.

Furthermore, Fentie and Jemberu (2012) conducted a study on selecting enhanced wheat cultivars to validate and reinforce the findings. Their results from Spearman rank analysis revealed a significant correlation between farmers' crop diversification techniques and productivity.

5.2 Conclusions

The study concludes after summarising the results on the objectives supported by the literature, theory and hypotheses. This ensures that the study is coherent and aligned with the main objective.

5.2.1 Research question one: What are the perceptions of semi-commercial farmers about climate change?

The study concludes that semi-commercial farmers perceive increasing temperatures as the primary reflector for climate change. The hypothesis of the study confirms this. Similarly, earlier researchers, including Talanow et al. (2021) and Rapholo and Makia (2020), have documented farmers' observations of climate changes, such as increasing temperatures. Therefore, this conclusion aligns with these past scholars' findings. Furthermore, the findings indicate that respondents experienced increased evaporation, pest, and disease outbreaks in recent years. This is unsurprising, considering climate change will negatively impact water availability, soil degradation, drought, desertification, and increased disease outbreaks and crop pests (Dang et al., 2019). Farmers' responses generally showed concern about temperature changes, evaporation, pests, and disease outbreaks.

5.2.2 Research question two: What are the adaptation strategies of semi-commercial farmers to climate change?

The study concludes that semi-commercial farmers employ adaptation strategies such as crop rotations for soil conservation, adopting disease-resistant crop varieties, introducing high-yielding and high-quality crop varieties, and using stored water for agriculture. This is evident through the findings of the study's hypothesis, which supported the claims. Similarly, previous scholars such as Magesa et al. (2023), Shikwambana & Malaza (2022), and Ogundeji (2022) have noted that crop diversification techniques such as improved crop varieties, disease-resistant varieties and utilisation of stored water for agricultural purposes. Therefore, this conclusion is consistent with that of past scholars. In addition, the study's findings indicate that farmers who adopt strategies to counteract the harmful effects of climate change will likely enhance crop productivity (performance). This is achieved by cultivating disease-resistant crop varieties, high-yield crop varieties, high-quality crop varieties, and organic amendments for soil conservation.

5.2.3 Research question three: How do adaptation strategies influence performance?

The study concludes that adaptation strategies improve performance (crop productivity). These strategies include adopting disease-resistant, high-yield, and high-quality crop varieties, as well as using stored water for agricultural purposes, crop rotations, and organic amendments for soil conservation. This is evident from the results of the hypotheses that support these claims. Similarly, previous scholars such as Agrawal et al. (2021) and Adgo et al. (2013) have shown that improved crop varieties and crop rotations improve crop productivity. For example, in terms of soil and water conservation, they found that the productivity of barley and maize was significantly higher when compared to that of the control. Therefore, this conclusion is consistent with that of such scholars that climate crop diversification increases crop productivity.

5.3 Overview of results and conclusions

The study provided an analysis of how semi-commercial farmers react to climate change. While temperature changes are commonly perceived, adaptation strategies such as the adoption of disease-resistant crop varieties, high-yield crop varieties and embracing crop rotations for soil conservation, as well as the use of stored water for agricultural purposes, were strongly perceived by respondents. However, the notable variability in opinions about access to finance highlights the diverse financial situations of farmers. Despite these variations, there is a consistent high perception of increased crop productivity enhanced by adopting climate change strategies (*i.e.,* crop diversification and soil water and conservation). The results further highlight interesting correlations, indicating interconnected perceptions between temperature changes, adaptation strategies and crop productivity. The regression model enhances our understanding, revealing that these adaptation strategies significantly contribute to farmers' perceptions on increased crop productivity**.**

5.4 Recommendations

These recommendations are provided following the study's findings.

- **Adaptation strategies:** Given the positive correlation between crop diversification techniques and perceived higher crop productivity and soil and water conservation techniques and productivity, policymakers and agricultural extension services should prioritise and promote these strategies. Training programmes and incentives could be designed to encourage adopting these practices among semi-commercial farmers.

- **Financial support:** Semi-commercial farmers without collateral have limited access to agricultural loans, which is a common issue. They have further challenges obtaining financing from commercial banks because they cannot use their agricultural land as collateral. Recognising the significant variety in perspectives on access to credit, as shown in the present study, interventions should be targeted to meet the different financial needs of semi-commercial farmers. Governments and financial institutions should collaborate to increase financing accessibility and develop tailored financial solutions that address the unique requirements of semi-commercial farmers. The financial power of farmers can be used to purchase crop varieties that can withstand changing environmental conditions and reduce the likelihood of food insecurity.

- **Education and communication:** Semi-commercial farmers must first be aware of the effects of climate change. This will help them develop effective strategies and limit the negative impact on their crops' productivity (performance). Given the interrelated perspectives indicated by the correlations, communication and education programmes should prioritise the relationships between temperature changes, adaptation strategies and crop productivity. Raising awareness about the possible benefits of various adaptation strategies can lead to farmers making more informed decisions.

5.5 Limitations and potential for further research

Ongoing research is crucial considering the dynamic and ever-evolving nature of climate change. Subsequent research endeavours may encompass more extensive analyses of the developing perspectives of semi-commercial farmers, considering regional differences and evaluating the long-term impact of adaption strategies on actual agricultural production. The study indicated that most respondents (57.78%) depend on rainfed agriculture, and 30% use combined irrigation and rainfed practices. For future studies, it would be important to distinguish between farmers who practice only rainfed agriculture and those who practice irrigation and rainfed agriculture. This will help in selecting appropriate strategies for these farmers. The study does not focus only on the current perceptions of semi-commercial farmers but also offers practical recommendations to enhance adaptation strategies in agriculture, emphasizing the importance of tailored strategies and continuous research efforts.

5.6 Chapter conclusion

The chapter presented a concise summary of the study's findings and a detailed exploration of the conclusions drawn. Despite encountering contradictory outcomes, which were anticipated based on existing literature, the chapter offered recommendations at both policy and farmer levels, informed by the findings and conclusions. The chapter concluded by discussing the limitations of the study and outlining possible directions for future research projects.

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APPENDIX A: RESEARCH QUESTIONNAIRE

SECTION A: DEMOGRAPHICS

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1. Please select the category that includes your age.

1: Under 18 ☐ 2: 18 -34 ☐ 3: 35-54 ☐ 4: 55 -64 ☐ 5: Above 65 ☐

2. What is your highest level of education?

1: Primary ☐ 2: Secondary ☐ 3: Tertiary ☐ 4: None ☐

3. Please select the category that includes your years in farming.

1: Under 10 years ☐ 2: 10-24 years ☐ 3: 25-39 years ☐ 4: Above 40 years ☐

4. Which type of agriculture do you practice?

1: Rainfed only ☐ 2: Irrigation only ☐ 3: Rainfed and Irrigation ☐ 4: Other ☐

SECTION B:

FARMERS' PERCEPTIONS OF CLIMATE CHANGE

<u>Temperature</u>

1. In recent years, I have experienced an increase in temperature.

1: Strongly disagree ☐ 2: Disagree ☐ 3: Neutral ☐ 4: Agree ☐ 5: Strongly agree ☐

2. In recent years, I have experienced an increase in evaporation.

1: Strongly disagree ☐ 2: Disagree ☐ 3: Neutral ☐ 4: Agree ☐ 5: Strongly agree ☐

3. In recent years I have experienced an increase in pest and disease outbreaks.

1: Strongly disagree ☐ 2: Disagree ☐ 3: Neutral ☐ 4: Agree ☐ 5: Strongly agree ☐

Rainfall

1. In recent years I have experienced an increase in rainfall.

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

2. In recent years I have experienced an increase in floods.

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

3. In recent years, I have experienced a delay in rainfall onset.

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

1.2 RESPONSIVENESS OF FARMERS TO CLIMATE CHANGE

Crop diversification

1. As a farmer, I have adopted disease-resistant crop varieties.

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

2. As a farmer, I adopted high-yield crop varieties.

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

3. ***As a farmer, I have adopted high-quality crop varieties.***

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

Soil and water conservation

1. As a farmer, I use organic amendments for soil conservation.

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

2. ***As a farmer, I have adopted crop rotation for soil conservation.***

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

3. ***As a farmer, I frequently use stored water for agricultural purposes.***

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

1.3 ACCESS TO CREDIT

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1. I have access to adequate credit.

1: Strongly disagree ☐ *2: Disagree* ☐ > *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

2. Loans are offered at affordable rates.

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

3. I have easy access to finance.

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

4. ***I have access to alternative sources of finance (e.g., grants from the government).***

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

1.4 PERFORMANCE

---

1. Adopting disease-resistant crop varieties increases crop productivity.

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

2. Adopting high-yield crop varieties increases crop productivity.

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

3. Adopting high-quality crop varieties increases crop productivity.

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

4. ***Adopting organic amendments for soil conservation increases crop productivity.***

1: Strongly disagree ☐ *2: Disagree* ☐ *3: Neutral* ☐ *4: Agree* ☐ *5: Strongly agree* ☐

END OF THE QUESTIONNAIRE: THANK YOU FOR YOUR TIME

APPENDIX B: ETHICAL CLEARANCE CERTIFICATE

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School Ethics Committee
Constituted under the University Human Research Ethics Committee (Non-Medical)

Ethics Clearance Certificate

Ethics protocol number: WBS/BA788404/417
This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (below).

Project title	Responsiveness of South African semi-commercial farmers to climate change
Investigator / Researcher	Dr Bheki Maliba
Nature of Project	MBA (Research Article)
Decision of the Committee	Approved, provided stakeholders and participants are guaranteed anonymity and confidentiality.
Issue Date of Certificate	2023-08-04
Expiry date	Date of submission of the project / research report
Chairperson	Dr Pius Oba ☎ +27 11 717 3976 +27 82 733 6587 pius.oba@wits.ac.za

Declaration by Researcher

One copy must be signed by the Researcher and returned to the Chairperson of the Wits Business School Ethics Committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I undertake to resubmit the protocol to the Committee.

Signature

2023-08-10
Date:

APPENDIX C: LANGUAGE EDITING MEMORANDUM

EDITING CONFIRMATION

To whom it may concern:

This memo serves to confirm that the manuscript/research project detailed below has been language-edited and/or proof-read.

Regards,

-SM001-

SM *(Cert. Lang. Ed.)*
Language Editor

****

Manuscript Title:

RESPONSIVENESS OF SOUTH AFRICAN SEMI-COMMERCIAL FARMERS TO CLIMATE CHANGE

Author:

BHEKI MALIBA

Issued on:

27/02/2024

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The editors/proofreaders make(s) no claim as to the accuracy of the manuscript contents nor the objectives of the author. While all possible efforts have been made to ensure the text as edited is readable and grammatically correct, the author(s) have the option to accept or reject suggestions and trackable changes made to the document before submission.

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