Evaluating the adoption of conservation agriculture among smallholder farmers in Hazyview, Mpumalanga, South Africa

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DECLARATION:

I hereby declare that the above-mentioned dissertation/ thesis is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

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DECLARATION

I, Glen Themba Mendi, declare that this dissertation, entitled "**EVALUATING THE ADOPTION OF CONSERVATION AGRICULTURE AMONG SMALLHOLDER FARMERS IN HAZYVIEW, MPUMALANGA, SOUTH AFRICA**", submitted to the University of Mpumalanga for the degree of Master of Agriculture in Agricultural Extension and Rural Resource Management in Agricultural Science. The work contained herein is my original work with the exception of the citations, and this work has not been submitted to any other University in partial or entirely for the award of any degree.

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DECLARATION ON PUBLICATIONS RELATED TO THE RESEARCH

1. Publication 1- Undergoing review

EXAMINING THE IMPACT OF SOCIO-ECONOMIC CHARACTERISTICS ON CONSERVATION AGRICULTURE AMONG SMALLHOLDER FARMERS IN HAZYVIEW, MPUMALANGA

Authors: Mendi, G.T. and Matiwane, B. M.

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DETERMINANTS OF THE BARRIERS PREVENTING SMALLHOLDER FARMERS FROM ADOPTING CONSERVATION AGRICULTURE IN HAZYVIEW, MPUMALANGA

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DEDICATION

I would like to dedicate this work to all individuals involved in agricultural program development, policymaking, and extension services in developing nations. Their relentless efforts in promoting efficient adaptation strategies within the agricultural sector, particularly among smallholder farmers, deserve my utmost appreciation and recognition.

ABSTRACT

This study addresses the pressing challenges posed by climate change to the agricultural sector in Africa, emphasizing the urgent need to scale up adaptation and mitigation strategies among rural smallholder farmers. The research aims to evaluate the adoption of Conservation Agriculture (CA) among smallholder farmers in Hazyview, Mpumalanga, South Africa. Specific objectives include delineating the socio- economic characteristics of the farmers, assessing the CA adoption rate, identifying barriers to adoption, and determining the perceived benefits of CA. A random sampling technique was employed to select 221 registered smallholder farmers in Hazyview. Data were collected through structured questionnaires and analysed using descriptive statistics (percentages, means, and ranks) and a binary logistic regression model to infer the socio- economic factors influencing CA adoption. The findings revealed that the most widely adopted CA practices were crop rotation, intercropping, and mulching; however, the overall adoption rate remained low. Significant barriers to adoption included limited availability of inputs, restricted access to information, and insufficient financial resources. Most farmers recognised several benefits of CA, such as controlling soil erosion, increasing production, saving money and labour, reducing soil degradation, and improving soil fertility. The binary logistic regression model indicated that the age of respondents, level of education, and frequency of extension visits significantly influenced CA adoption ($p< 0.01$). Additionally, training on CA also had a statistically significant impact on adoption ($p< 0.05$). The model's goodness of fit, evaluated through the Hosmer- Lemeshow test, was deemed acceptable ($p = 0.65$), demonstrating high predictive accuracy with a correct prediction rate of 77%. The study concludes that while there is strong recognition of CA's benefits, addressing socio- economic barriers and increasing extension services are crucial to enhancing adoption. Recommendations include tailored extension services, practical training programs, improved access to resources, and simplified communication strategies for farmers with lower educational levels.

Keywords: Adoption, Barriers, Conservation Agriculture, Evaluation, Smallholder Farmers

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ABBREVIATIONS

ABET	Adult Basic Education and Training
CA	Conservation Agriculture
CF	Conventional Farming
CSA	Climate-Smart Agriculture
DARDLEA	Department of Agriculture, Rural Development, Land and Environmental Affairs
GHGs	Greenhouse gases
IPCC	Intergovernmental Panel on Climate Change
SA	South Africa
NGOs	Non-Government Organisations
FAO	Food and Agriculture Organization
SOM	Soil Organic Matter
SSA	Sub-Saharan African
SPSS	Scientific Package for Social Science
Ha	Hectare
ZT	Zero-tillage

CHAPTER ONE

INTRODUCTION

This chapter includes several key components, such as the study's background, problem statement, research questions, aim and objectives, hypothesis, the study's significance, delimitation, the definition of terms used, and the theoretical framework.

1.1.Background of the Study

The agricultural sector plays a significant role in sustaining the livelihoods of numerous rural South Africans (Pienaar and Traub, 2015). It contributes about 2.3% to the nation's GDP, accounts for 40% of export earnings, and employs 4.6% of the country's workforce (Stats SA, 2017). Over 70% of people in rural areas rely on agriculture for their livelihoods, underscoring its critical role in creating jobs, ensuring food security, and alleviating poverty (Stats SA, 2017). Approximately 43.7% of agricultural households in South Africa primarily depend on agriculture for food, while 37.5% consider it a supplementary food source (Mashamaite, 2014). This highlights the indispensable role of agriculture in rural livelihoods and food security nationwide.

Despite its importance, the agricultural sector faces numerous challenges, such as population growth, depletion of natural resources, energy shortages, climate fluctuations, and global market integration (Ntshangase et al., 2018). These challenges highlight the necessity of re-evaluating policies and institutions that support initiatives aimed at ensuring food security. Among various strategies promoting sustainable agriculture, CA stands out as a particularly promising framework (Fuentes-Llanillo et al., 2021). In southern Africa, smallholder farmers are increasingly turning to CA as a panacea to the challenges associated with conventional farming (CF), such as high labour costs, soil degradation, and inconsistent yields (Stevenson et al., 2014; Andersson & D'Souza, 2014). CA addresses these limitations by introducing alternative practices that mitigate soil degradation, improve labour efficiency, and optimize rainfall utilization, leading to reduced production costs and improved productivity (Ngwira et al., 2020; Makate et al., 2019).

Before adopting CA, smallholder farmers in Africa predominantly practised CF, which often led to low yields due to unsustainable practices and soil degradation (Knowler & Bradshaw, 2007; Umar et al., 2011). For instance, in Zimbabwe, farmers reported yield increases of up to 30% after transitioning to CA practices, underscoring its potential to improve productivity (Marongwe et al., 2011). Soil nutrient depletion caused by wind and water erosion remains a critical challenge, particularly in regions like Mpumalanga, South Africa, where erratic rainfall patterns exacerbate soil degradation (Thierfelder & Wall, 2009; Pedzisa et al., 2015; Mabhaudhi et al., 2019).

CA addresses these issues by maintaining at least 30% soil cover with crop residues or organic mulch, which minimizes erosion, enhances soil biota, and improves nutrient cycling. This contrasts with CF, which relies on soil disturbance to create a seedbed, often leaving the soil vulnerable to erosion and nutrient loss (Giller et al., 2015). In Mpumalanga's Hazyview area, smallholder farmers adopting CA have seen improvements in soil health and productivity, although challenges like limited access to inputs and technical support persist (Modi & Mabhaudhi, 2020; Ndlovu & Zenda, 2022). Given its potential to mitigate these challenges, CA is widely promoted by international agricultural experts and researchers as a sustainable alternative for smallholder farmers across Sub-Saharan Africa, including South Africa (Baudron et al., 2007; FAO, 2023).

According to Derpsch (2005), CA represents a farming practice aimed at maximizing the efficient utilization of natural resources such as soil, water, and biological resources. It serves as a long-term agricultural strategy allowing farmers to optimize yields and profits while safeguarding and enhancing the environment for future generations (Kirkegaard et al., 2011; Guto et al., 2011a; Hobbs, 2007). The potential expansion of CA in Africa is largely contingent on adoption rates observed in North and South America, where tillage challenges are mitigated using herbicides and fertilizers (Ndah et al., 2014; Thierfelder & Wall, 2012; Langyintuo and Mekuria, 2005). CA is anchored on three main principles: minimal soil disturbance (zero-tillage), organic soil cover, and crop rotation, all of which play pivotal roles (Thierfelder, Bunderson, & Mupangwa, 2015). By integrating these approaches, CA demonstrates significant potential for enhancing agricultural productivity and environmental sustainability (Mupangwa, Mutenje, Thierfelder, & Nyagumbo, 2017; Thierfelder et al., 2016).

In CA, mechanical tillage is restricted, allowing soil biota to play a crucial role in soil aggregation and nutrient balance (Bolliger et al., 2006; Brown et al., 2017). Consequently, CA is advocated as a cornerstone of long-term agricultural sustainability (Wall, 2007; Hobbs, 2006). Studies indicate that CA mitigates compaction and soil erosion, enhances water penetration, and fosters favorable soil structure (Giller et al., 2009; Chiputwa et al., 2010; Corbeels et al., 2014). Additionally, embracing CA enhances soil fertility, regulates soil temperatures, and suppresses weed growth (Sommer et al., 2012; Kassam et al., 2019; Kaumbutho and Kienzle, 2007). Wall (2007) highlights the high adoption rates of CA in South American nations, particularly Brazil, and the frequent application of conservation agriculture practices in Australia. Despite years of CA promotion in Africa, most farmers, especially smallholders, remain hesitant to adopt these practices (Derpsch, 2008; Steward et al., 2018).

Smallholder farmers face a range of barriers that hinder the adoption of Conservation Agriculture (CA). These barriers are multifaceted, encompassing socio-economic, biophysical, and institutional factors. For instance, socio-economic challenges such as gender disparities, limited educational attainment, and inadequate financial resources significantly impact adoption rates (Erenstein, 2003; Wall, 2007). Biophysical elements, including soil quality, climate variability, and topographical constraints, further complicate CA implementation (Giller et al., 2009).

Research in sub-Saharan Africa has demonstrated that farmer-specific conditions, such as their preferences, farm size, and the availability of inputs, play a crucial role in determining adoption levels (Nkala et al., 2011; Giller et al., 2011). Nyanga (2012) highlights that cultural norms and socio-economic characteristics often impede the dissemination of CA practices, emphasizing the importance of tailoring interventions to local contexts.

In the Mpumalanga province, factors such as access to extension services, financial constraints, and local knowledge systems shape farmers' perceptions of CA. For example, a study by [Insert Local Reference or Study] underscores that smallholder farmers in this region perceive the high labour demands of CA and the lack of suitable machinery as significant barriers. Moreover, farmers often rely on traditional tillage practices due to limited awareness of CA's long-term benefits.

In the Mpumalanga province, including Hazyview, factors such as access to extension services, financial constraints, and local knowledge systems shape farmers' perceptions of CA. A study by Khwidzhili and Worth (2016) emphasizes that smallholder farmers in this region perceive the high labour demands of CA and the lack of suitable machinery as substantial barriers to its adoption. Additionally, many farmers continue to rely on traditional tillage practices due to limited awareness of the long-term benefits associated with CA. This reliance on conventional methods not only restricts their ability to adopt sustainable practices but also perpetuates challenges related to soil degradation and reduced agricultural productivity.

To ensure broader adoption, it is essential to integrate farmers' perceptions and traditional knowledge systems into CA promotion strategies. Participatory approaches, such as involving farmers in designing interventions, have shown promise in increasing acceptance and sustainability (FAO, 2023).

Apart from individual considerations, other factors influenced by the local or regional environment also play a significant role in CA adoption. These factors include accessibility to appropriate equipment, inputs, and knowledge required for CA adoption, market conditions, and policies that either facilitate or impede the adoption of new agricultural technologies (Siziba, 2008). For example, Zimbabwe has widely adopted some CA principles such as intercropping and crop rotation, with minimal soil disturbance being recently introduced by extension agents and development organizations (Mazvimavi et al., 2007; Mugandani & Mafongoya, 2019). However, the adoption of no-tillage practices remains low, with only 0.3% of smallholder farmers utilizing them (Ngwira et al., 2013). In South Africa, CA practices have been promoted for many decades but are primarily adopted by large-scale commercial farmers (Dumanski et al., 2006; Guto et al., 2011a).

The primary objectives of CA are to enhance crop yield, mitigate soil degradation, and reduce the risk of crop failure, ultimately contributing to increased food security (Derpsch et al., 2010). Additionally, practicing CA offers benefits in terms of productivity, income generation, and sustainable land use (Blignaut et al., 2015). Areas that have adopted CA have demonstrated long-term environmental and productivity improvements (Derpsch, 2008; Giller et al., 2015).

1.2. **Problem Statement**

Despite decades of advocacy from researchers, agronomists, and extension workers for the adoption of CA to mitigate the adverse impacts of conventional farming practices, smallholder farmers in South Africa, particularly in the Mpumalanga province, have been slow to embrace CA methodologies. The success of CA hinges on the simultaneous application of its three guiding principles: minimum soil disturbance, permanent soil cover, and crop rotation (Derpsch et al., 2010). However, many smallholder farmers fail to implement all three principles concurrently, often adopting only one or two, which leads to soil degradation, disease outbreaks, and reduced yields (Giller et al., 2009; Mazvimavi & Twomlow, 2009; Pannell et al., 2014).

Each principle of CA contributes uniquely to improving soil health and ecosystem resilience. Minimum soil disturbance helps prevent compaction and erosion, preserving soil structure and enhancing fertility (Montgomery, 2007). Permanent soil cover plays a dual role by reducing erosion and improving moisture retention, while also suppressing weed growth and creating a microhabitat for beneficial soil organisms (Thierfelder et al., 2009). Crop rotation disrupts pest and disease cycles, enhances nutrient cycling, and improves overall productivity, as observed in multiple contexts (Makate et al., 2017; Nyanga, 2012).

While the benefits of CA are well-documented, its adoption among African smallholder farmers remains limited (Nyanga, 2012). This disparity is particularly pronounced in Mpumalanga, where socio-economic constraints, cultural practices, and limited access to CA-related resources hinder widespread adoption. Interviews with local farmers reveal perceptions of CA as labour-intensive, especially during the initial stages, and concerns about the upfront costs of adopting CA practices, such as acquiring cover crop seeds or specialized equipment. Additionally, localized soil conditions, farmer preferences, and traditional farming knowledge often conflict with the core principles of CA.

For example, while permanent soil cover offers resilience against droughts in Mpumalanga's semi-arid climate, farmers have reported challenges in sourcing and maintaining sufficient organic mulch due to limited biomass availability and competing uses for crop residues, such as livestock feed. These insights emphasize the need for context-specific strategies that incorporate local knowledge and farmer perceptions into the design and promotion of CA practices.

In South Africa, the adoption of CA remains notably low, particularly among smallholder farmers, who often rely on conventional maize cultivation methods involving manual soil disturbance and limited crop diversity (Dube et al., 2021; Nkala et al., 2022). This dependency has exacerbated soil degradation and reduced agricultural productivity, posing threats to food security and rural livelihoods (Laker, 2010). Recent data indicates that smallholder farmers in Mpumalanga, including regions like Hazyview, still predominantly use traditional farming methods, despite efforts to promote sustainable alternatives (DARDLEA, 2021).

The high cost of CA implements, such as specialized seed drills and planters, presents a significant barrier to adoption, particularly for resource-constrained farmers (Mabhaudhi et al., 2019). Additionally, the transition from conventional farming to CA involves transactional costs, including the initial learning curve, risks associated with shifting practices, and potential income losses during the adaptation period (Thierfelder et al., 2020).

Research has identified several factors influencing the adoption of CA, such as access to extension services, socio-economic conditions, and the perceived benefits of CA practices (Lee & Gambiza, 2022; Ndlovu & Zenda, 2024). However, there is a notable gap in understanding the specific reasons behind the low adoption rates of CA practices among smallholder farmers in Hazyview, Mpumalanga.

Furthermore, while the agronomic benefits of CA are well-documented, the critical role of agricultural extension services in facilitating the adoption of these practices has often been overlooked (Thierfelder et al., 2017; FAO, 2013). This oversight limits the development of targeted interventions that could effectively enhance the uptake of CA among smallholder farmers.

This study aims to fill knowledge gaps by investigating the factors influencing the adoption of CA among smallholder farmers in Hazyview. While the adoption of CA has been well-documented in rural areas of South Africa, significant challenges remain, particularly regarding its implementation in smallholder farming systems (Mabhaudhi et al., 2020; Sithole et al., 2019). By exploring the barriers and drivers of CA adoption in this specific region, this research seeks to provide valuable insights into how extension services can be tailored to better support farmers transitioning to sustainable agricultural practices. Recent studies have highlighted the key barriers to CA adoption in South Africa, including limited access to resources, high initial investment costs, and a lack of adequate training (Hunsberger et al., 2021; Giller et al., 2020).

Understanding these dynamics is essential for developing effective policies and programs that enhance food security and resilience in rural communities, especially those facing the challenges of climate change and resource scarcity. Ultimately, this research will contribute to a more nuanced understanding of the CA adoption landscape in South Africa, helping to inform strategies for improving agricultural practices and outcomes for smallholder farmers.

1.3. **Research Question**

The study aims to address the following key research questions:

1. What are the socio-economic characteristics of the smallholder farmers in Hazyview?
2. What is the adoption rate of conservation agriculture among smallholder farmers in the study area?
3. What are the main barriers preventing smallholder farmers from adopting conservation agriculture?
4. What are the perceptions of smallholder farmers towards CA practices and their benefits?

1.4. **The aim and objectives of the study**

The study aims to evaluate the adoption of conservation agriculture among smallholder farmers in Hazyview. The specific objectives of the study are to**:**

1. To assess the influence of socioeconomic factors on the adoption of Conservation Agriculture among smallholder farmers in Hazyview.
2. Evaluate the adoption rate of Conservation Agriculture among smallholder farmers
3. Determine the main barriers preventing smallholder farmers from adopting Conservation Agriculture
4. Ascertain the perceived benefits of Conservation Agriculture on smallholder farmers

1.5. **Significance of the study**

The significance of this study lies in its potential to address critical challenges in promoting sustainable agriculture and enhancing food security through the adoption of CA practices. Despite decades of advocacy and research emphasizing the benefits of CA, its adoption among smallholder farmers, particularly in Hazyview, remains alarmingly low. This study aims to fill this gap by investigating the barriers to CA adoption and assessing current adoption rates among smallholder farmers in the region.

Promoting Sustainable Agricultural Practices

Conservation Agriculture is recognized for its ability to enhance agricultural productivity while minimizing negative environmental impacts. By understanding the factors that influence the adoption of CA, this research can lead to the development of effective strategies tailored to the unique challenges faced by smallholder farmers in Hazyview. These strategies can facilitate the transition from conventional farming practices to more sustainable alternatives, ultimately improving crop yields and contributing to long-term food security. Research indicates that CA can significantly improve productivity and environmental health when effectively adopted (Kassam et al., 2019; Thierfelder et al., 2016).

Informing Policy and Support Programs

The outcomes of this research will be invaluable to policymakers and agricultural organisations, providing a clear picture of the current level of CA adoption among smallholder farmers in Hazyview. Insights from this study can inform the design of targeted interventions, incentives, and support programs aimed at encouraging broader implementation of CA practices. Such practices have demonstrated potential for enhancing the economic well-being of smallholder farmers by reducing production costs, improving soil fertility, and increasing yields (Gukurume et al., 2010; Marongwe et al., 2011).

Addressing Barriers to Adoption

Understanding the barriers to CA adoption is crucial for developing effective strategies. Research has shown that factors such as access to credit, age of farmers, training opportunities, and extension services significantly influence CA adoption rates (Chiputwa et al., 2011; Erenstein et al., 2010). By addressing these barriers, your research aims to empower smallholder farmers and improve agricultural resilience.

Filling Knowledge Gaps

This study will contribute to a deeper understanding of the dynamics surrounding CA adoption in South Africa, particularly in Mpumalanga Province. By addressing existing knowledge gaps related to barriers and enablers of CA, your work can inform future research directions and provide a foundation for developing more effective agricultural policies and practices tailored to local contexts.

In summary, the significance of this study lies in its potential to contribute to sustainable agriculture, enhance food security, inform policymaking, promote economic development, and fill knowledge gaps related to CA adoption among smallholder farmers in Hazyview, Mpumalanga, South Africa. By addressing the barriers to CA adoption, this research aims to empower smallholder farmers, improve agricultural resilience, and foster sustainable rural development.

1.6. **The delimitation of the study**

The delimitations of the study on evaluating the adoption of conservation agriculture among smallholder farmers in Hazyview, Mpumalanga, South Africa, are as follows:

1. Geographic Scope: The study focused specifically on smallholder farmers in the Hazyview region of Mpumalanga, South Africa. The findings may not be generalizable to other regions or agricultural contexts.
2. Sample Size: Due to resource constraints and time limitations, the study selected a limited number of smallholder farmers as participants. The findings may not represent the entire population of smallholder farmers in Hazyview.
3. Timeframe: The study was conducted within a specific period, and the findings may be influenced by the specific socio-economic and environmental conditions during that time. Long-term trends or changes may not be captured.
4. Language Barrier: The study was conducted in a specific language (e.g., English, local languages), and language proficiency may limit the participation of farmers who do not understand or speak the selected language(s).
5. Self-Reported Data: The study relied on self-reported data from smallholder farmers, which may be subject to biases, memory recall errors, or social desirability effects. The accuracy and reliability of the data may be influenced by these factors.
6. External Factors: The adoption of conservation agriculture may be influenced by various external factors such as government policies, market conditions, availability of

resources, and access to agricultural extension services. The study focused on the individual and socio-economic characteristics of farmers, but the impact of these external factors may not be fully examined.

7. Cross-sectional Nature: The study gathered data at a specific point in time, providing a snapshot of the adoption of conservation agriculture among smallholder farmers. A more holistic comprehension can be achieved by utilizing longitudinal data that captures changes and trends over an extended period.

It is important to acknowledge these delimitations to interpret the study's findings and understand the contextual limitations within which the research is conducted.

1.8. **Definition of key terms**

1) **Conservation Agriculture**: This is a farming system that entails a comprehensive set of minimum soil disturbance, organic soil cover, and crop diversification principles that allow farmers to achieve high yields while also conserving and enhancing the environment (Thierfelder, Bunderson, & Mupangwa, 2015).

2) **Adoption**: This relates to the implementation of at least two conservation agriculture principles and their continued use (Kassam et al., 2019).

3) **Barriers**: The components and constraints that prevent smallholder farmers from implementing conservation agriculture on their farms are referred to as barriers (Corbeels et al., 2014).

4) **Evaluation**: Refers to the systematic process of creating a thorough and condensed assessment or conclusion regarding the adoption of CA (Ndah et al., 2018).

5) **Conservation Agriculture principles**: These are the three basic farming principles that have been pushed around the world to help farmers enhance their production while also preserving the environment (Giller et al., 2015).

6) **Smallholder Farmers**: These are farmers that produce on a small scale for their consumption; they usually have limited markets and resources. As a result, they rely on friends and family for help (Marongwe et al., 2011).

CHAPTER TWO

LITERATURE REVIEW

2.1. **Introduction**

This chapter presents a comprehensive review of the existing literature related to the adoption of Conservation Agriculture (CA) practices among smallholder farmers. The review is organized into ten subsections: “Adoption,” “Theoretical framework” "The Concept of Conservation Agriculture," "Principles of Conservation Agriculture," "Adoption of Conservation Agriculture," "Socio-economic Characteristics Influencing the Adoption of Conservation Agriculture," "Barriers to Adoption of Conservation Agriculture," "Benefits of Adopting Conservation Agriculture," and "Conceptual Framework," “Conclusion.” The chapter aims to identify and assess existing knowledge gaps in the literature while providing a solid foundation for the current research.

2.2. **Adoption**

Worku et al. (2019) defines adoption rate as the extent to which an innovation is utilized over time, particularly when farmers fully comprehend its potential. The adoption of technology is quantified by the proportion of individuals who have embraced it compared to the total sampled population (Giller et al., 2011). Corbeels et al. (2020) distinguish three distinct dimensions of adoption: the frequency of adoption (incidence of adoption), the degree of implementation (intensity of adoption), and the speed of uptake (rate of adoption). Incidence of adoption measures the proportion of individuals adopting the technology within a specific timeframe relative to the sampled population size (Giller et al., 2015; Ndah et al., 2018).

Intensity of adoption, as elucidated by Kassam et al. (2019), gauges the percentage of a farmer's arable land dedicated to utilizing a particular technology. Conversely, the rate of adoption, as defined by Sunding and Zilberman (2001), is calculated by the ratio of individuals who have adopted a technology within a certain period to the total population under study. All three dimensions of adoption incorporate the element of time (Mupangwa & Thierfelder, 2014). Moreover, various theories, including the diffusion of innovation theory, have been proposed to elucidate the adoption process (Thierfelder & Wall, 2011).

2.3. **Theoretical framework: Diffusion of Innovation (DOI) theory**

This study integrates the Diffusion of Innovation (DOI) theory developed by Everett Rogers, which elucidates the process and factors influencing the spread of novel ideas or practices (Rogers, 2003; Dearing and Cox, 2018). According to Kaminski (2011), the diffusion process is the gradual introduction of innovation within a specific society. Adoption denotes individuals' decisions to fully implement the promoted innovation, while rejection occurs when individuals opt not to adopt or apply the innovation (Rogers et al., 2005; Oldenburg & Glanz, 2008). The adoption of agricultural innovations is shaped by farmers' perceptions of the innovation's advantages and benefits, alongside their socio-economic characteristics (Ndah et al., 2012).

As per the DOI theory, farmers' responses to a specific practice are categorized as either adoption or rejection (Mwaseba et al., 2006). Farmers' understanding and awareness of the practice play a pivotal role in their willingness to accept and adopt an innovation (Wejnert, 2002; Vargo et al., 2015). Therefore, farmers can develop comprehension and familiarity with an innovation when they receive reliable and relevant information from trusted sources (Rogers, 2003).

In this study, enhancing the adoption of conservation agriculture among farmers can be achieved by providing them with comprehensive information through agricultural extension agents who serve as intermediaries. The theoretical framework employed in this study encompasses essential components such as social systems and decision-making (Eubank & Tino, 2016), rendering it suitable for examining the adoption of conservation agriculture. This theory has also been widely used to forecast the adoption of agricultural practices, including conservation agriculture (Kassam et al., 2019; Corbeels et al., 2014).

Figure 2.1 illustrates the five stages in the process of innovation adoption, as outlined by Rogers (2003). These stages are knowledge, persuasion, decision, implementation, and confirmation. The central themes of this thesis focus on the decision-making process regarding innovation, the rate at which CA is adopted, and the perceived benefits of CA. These concepts form the basis of the methodology utilized in this study. The chosen theoretical framework also underscores the speed at which members of society embrace new technologies (Greenhalgh et al., 2004). Douthwaite (2002) elaborates that the adoption rate pertains to how quickly or slowly farmers adopt new technologies. According to Rogers (2004), an individual's adopter category typically determines the rate at which they adopt an innovation.

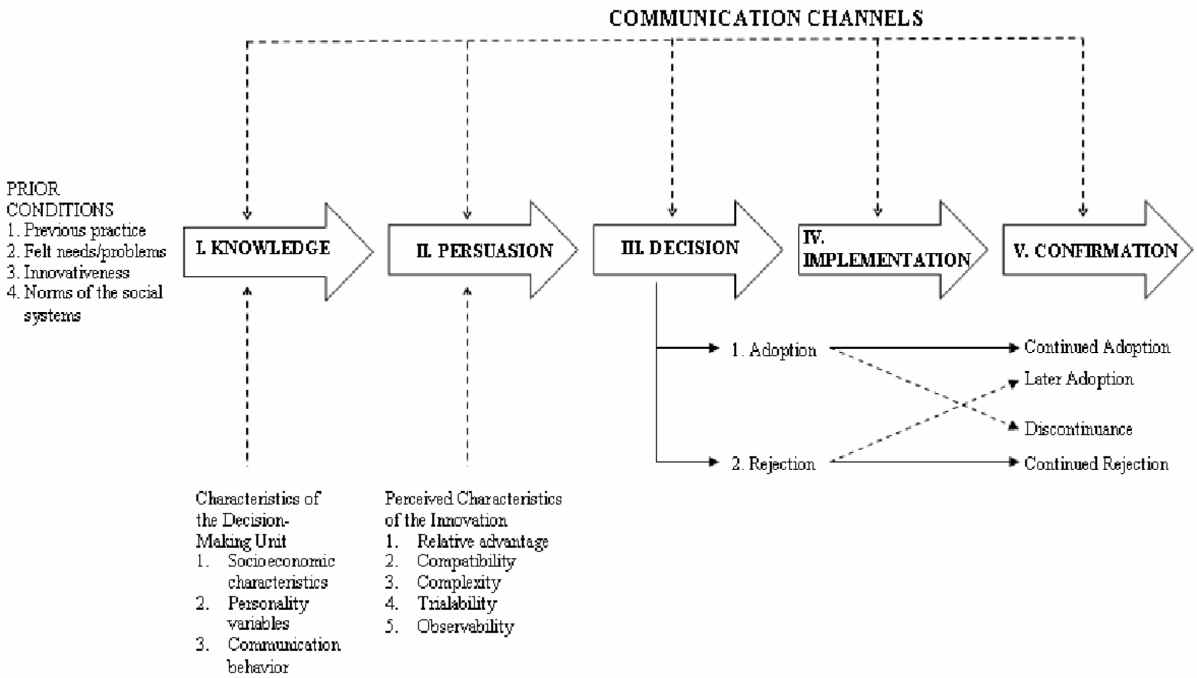

Figure 2.1: A Model Illustrating the Five Stages in the Process of Innovation Adoption
Source: Diffusion of Innovations, Fifth Edition by Everett M. Roger, 2003.

The theory identifies five categories of adopters: innovators, early adopters, early majority, late majority, and laggards (Fig.2.2). It posits that farmers who embrace conservation agriculture early encounter a narrower window of opportunity compared to those who adopt it later (Padel, 2001; Giller et al., 2015). Essentially, research suggests that successful adoption necessitates farmers undergoing transitional phases over time. This theory is invaluable for research as it enables the assessment of participants' innovation adoption rates, specifically within the context of conservation agriculture (Wejnert, 2002).

In recent studies, the DOI theory has been applied to understand the adoption of sustainable agricultural practices. For instance, Ndah et al. (2014) explored the adoption of CA in Sub-Saharan Africa and found that socio-economic factors, such as access to information and financial resources, significantly influenced adoption rates. Similarly, Kassam et al. (2019) highlighted the importance of tailored extension services in promoting CA adoption among smallholder farmers.

The DOI theory provides a robust framework for this study as it allows for a detailed examination of the factors influencing CA adoption and the categorization of farmers based on their innovativeness. By understanding these factors, the study aims to provide actionable recommendations for enhancing CA adoption among smallholder farmers in Hazyview, Mpumalanga, South Africa.

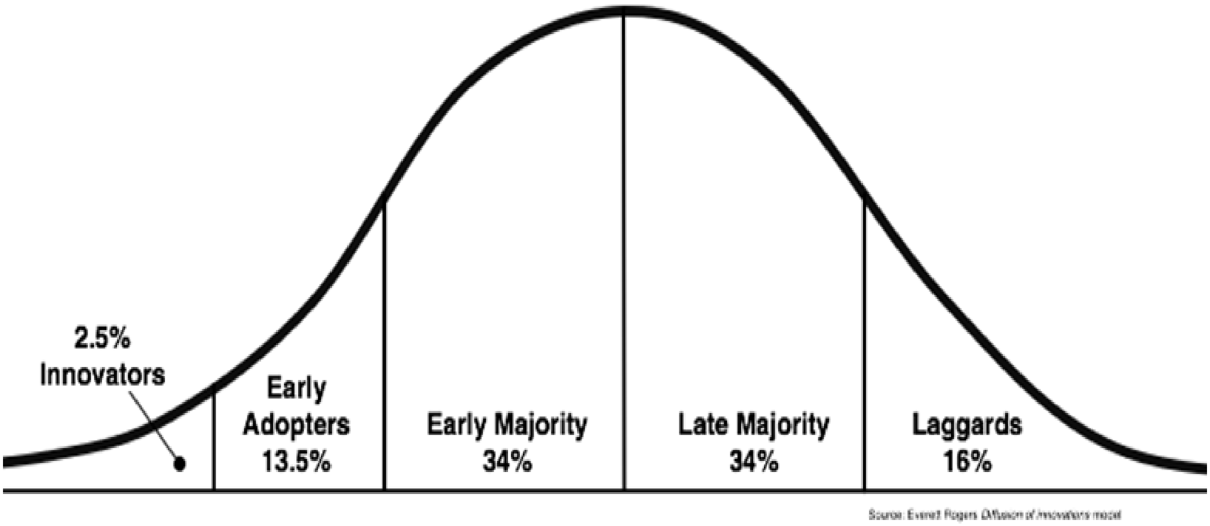

Figure 2.2: Classification of Adopters Based on Level of Innovativeness.
Source: Diffusion of Innovations, Fifth Edition by Everett M. Rogers, 2003.

2.4. **The Concept of Conservation Agriculture**

Conservation agriculture is a farming approach characterized by minimal soil disturbance, organic soil cover, and crop diversity, including crop rotation (Mango et al., 2017). Many countries, particularly in Africa, have expressed concerns over soil degradation due to intensive crop production over time, jeopardizing future productivity (Mazvimavi et al., 2009). CA presents smallholder farmers with a solution to mitigate food insecurity and increase yields (Thierfelder & Wall, 2011). It emphasizes environmentally-friendly farming practices that optimize yields while minimizing negative environmental impacts and enhancing societal benefits derived from a healthy environment (Baudeon et al., 2007).

Furthermore, CA has the potential to enhance existing field productivity and rejuvenate infertile soils. Studies have shown that CA reduces nutrient losses and soil erosion, enabling farmers to adapt to climate variability (Twomlow et al., 2006; Bolliger et al., 2006; Shetto and Owenya, 2007). Consequently, it also reduces greenhouse gas emissions by decreasing energy consumption (FAO, 2011a). Despite advocacy for CA principles in certain countries, challenges such as socioeconomic factors, biophysical constraints, and institutional limitations have hindered their full implementation (Kaumbuth and Kienzle, 2007; FAO, 2006).

Conservation agriculture as described by Derpsch et al. (2008), prioritizes soil conservation and sustainable farming practices while aiming to enhance long-term yields. It emphasizes minimal soil disturbance, the use of crop residues for soil cover, and crop rotation and intercropping with legumes (Twomlow et al., 2008). For CA to be effective, all three components must be implemented simultaneously (Wall, 2007). However, changing farmers' perceptions of conventional tillage and traditional farming methods is a significant challenge (Hobbs et al., 2008), with many still believing in the necessity of ploughing for healthy yields (FAO, 2011b). Despite widespread adoption of CA globally, its uptake has been slow in certain regions, particularly among smallholder farmers in Africa (Giller et al., 2015; Dumanski et al., 2006).

In contrast to conventional farming (CF), CA promotes environmentally friendly practices such as mulching, crop rotation, and zero-tillage (Marongwe et al., 2011; Knowler & Bradshaw, 2007). However, implementing CA requires fundamental changes in traditional agricultural practices, which many farmers oppose (World Bank, 2012). Despite resistance, the benefits of CA are significant, aiming to increase crop productivity while reducing production costs, conserving water, and maintaining soil fertility (Erenstein et al., 2012), making it a viable option for long-term agricultural sustainability and livelihood improvement.

CA strives to balance agricultural, environmental, and economic benefits by increasing revenue and output (Kizito et al., 2007), achieved through the application of improved agronomic technologies while enhancing and protecting natural resources (Twomlow et al., 2006; Kassam et al., 2009). The literature highlights CA's role in environmental preservation, sustained productivity, climate variability reduction, and food security enhancement (Derpch et al., 2010; Sumberg et al., 2012; FAO, 2008), with its popularity evident worldwide, particularly in Brazil, Australia, the United States, and Canada (Kassam et al., 2015; Ward et al., 2018; Corbeels et al., 2014).

It's crucial for smallholder farmers, especially in Africa, to adopt CA practices promptly due to their vulnerability to drought, labour shortages, and declining productivity (Giller et al., 2015). While the three main principles of CA are analysed globally, some scholars advocate for more practical and context-specific methods over zero-tillage (Brown et al., 2017). Nonetheless, there's hesitation in applying CA principles to smallholder farms and farming systems (Giller et al., 2015; Van Hulst & Posthumus, 2016; FAO, 2008a), highlighting diverse perspectives on CA adoption and implementation.

2.5. **Principles of Conservation Agriculture**

Conservation agriculture is advocated as a solution to combat soil degradation and low agricultural yields by incorporating three key principles (Nkala et al., 2011). These principles include minimum soil disturbance, soil cover, and crop diversity. Minimum soil disturbance, as defined by FAO (2015), involves practices such as partial soil disturbance, zero-tillage, and direct seeding, allowing only 25% or less of the land to be disturbed. Organic soil cover, on the other hand, involves shading the topsoil with agricultural residues, cover crops, and mulches to reduce soil damage and enhance productivity (Jost et al., 2016; Kassam et al., 2009). Lastly, crop diversity encourages crop rotation and intercropping, particularly with legumes, to prevent the spread of weeds, diseases, and pests (Giller, 2012; Baudron et al., 2012).

2.5.1. **Minimum Soil Disturbance**

Minimum soil disturbance, according to Giller et al. (2015), is the process of direct seeding and drilling the soil just in the section where seeds are sown using seeders. Hence, to prevent weeds and pests, weed and pest killers are applied (Kassie et al., 2009). The use of specialized tools (tine and disc planters), which improve soil structure and increase organic matter content, allows for little soil disturbance (Govaerts et al., 2009). Many studies support this practice, which includes limited and zero-tillage (no-till) because it reduces tillage and labour costs while simultaneously reducing soil deterioration (Hobbs et al., 2008).

According to FAO (2007), minimum tillage is the practice of tilling the land without turning it over. The soil structure and fertility are improved as a result. Derpsch et al. (2010) define zero-tillage (no-till) as a farming method that fosters zero soil disturbance from harvest to planting. Furthermore, the soil is only ploughed where the seeds are sown with zero-tillage. In contrast, just ripping lines or extremely small basins are dug for seeding with minimum tillage (Baudron et al., 2015; Brown et al., 2017; Derpsch et al., 2009). In contrast, with minimum tillage, just ripping lines or relatively small basins are dug for seeding (Baudron et al., 2015; Brown et al., 2017; Derpsch et al., 2009).

The minimum tillage component is currently employed on about 100 million hectares around the world (Giller et al., 2015). The principal producers are commercial farmers in South and North America (Derpsch, 2005; Fisher et al., 2018). Over 47% of the zero-tillage strategy is employed in South America, 39% in Canada and the United States, nearly 9% in Australia, and 3.9 per cent in Africa, Europe, and Asia (Derpsch et al., 2010). Furthermore, African countries consider Brazil's zero-tillage revolution as the means to reversing soil degradation and increasing soil fertility (Bolliger et al., 2006). On the other side, several developing countries are against the adoption of no-tillage farming. Moreover, high rates of unfavourable farmer evaluation (misperception) are one of the most significant barriers to zero-tillage implementation (Triplett and Warren, 2008).

In Kenya, the minimum soil disturbance concept has a non-adoption rate of around 50%, which only includes farmers who are uninformed of the CA component (Giller et al., 2009). It is widely used in Malawi, with more than 70% of farmers using it (Kassam et al., 2009). Similarly, despite having a sufficient understanding of zero-tillage, over 75% of farmers in

Kenya, and Mozambique are unwilling to put it into practice (Chiputwa et al., 2010). As a result, questions concerning why most African smallholder farmers despise CA have arisen (Guto et al., 2011a).

No-tillage is a technique that smallholder and commercial farmers can adopt to address soil deterioration on their farms and in the environment (Bolliger et al., 2006). According to the literature, zero-tillage is the first and most significant stage in CA, farmers that use minimum tillage disturb the land as little as possible and only when necessary (Ngwira et al., 2013). As a result, only the areas where seed and fertility amendments (compost, manure, and fertilizer) will be sowed and placed are tilled (Dumanski et al., 2006). Additionally, this removes the requirement for ploughing labour and fuel, while also lowering greenhouse gas emissions (FAO, 2008b). The main benefit of not disturbing the soil is that crops can be planted right before or after the first autumn rains, resulting in higher yields. Little soil tillage promotes organic matter content, soil structure, and storage capacity (Baudron et al., 2007). Zero-tillage refers to the practice of planting seeds and fertilizing previously undisturbed soils (Knowler & Bradshaw, 2007). To execute zero-tillage, farmers are recommended to employ specialized equipment such as a direct seeder (ox-drawn planter) and ripper (Nhamo, 2007). In addition, no-tillage and cover crops work together to reduce water runoff, increase soil organic matter content, and stimulate soil microbial activity (Giller et al., 2009).

2.5.2. **Soil Cover**

Conservation agriculture relies heavily on the maintenance of a permanent organic soil cover. According to Kaumbutho and Kienzle (2007), soil cover is the process of covering farmed land after harvesting. Mulching, agricultural residues, and cover crops are only a few examples of soil-covering practices (Baudeon et al., 2007; Giller et al., 2009). Crop residues or cover crops act as a protective layer, minimizing the impact of rain on the soil and, as a result, soil erosion (Nyende et al., 2007). These procedures, according to the literature, limit evaporation and weed growth, therefore conserving the soil (Kassam et al., 2009). According to FAO (2007), crop residues remain on the topsoil regularly, while cover crops are only used when there is a considerable gap between harvesting and seeding crops. Dumanski et al. (2006) argue that cover crops improve CA efficiency by increasing biodiversity. Furthermore, most farmers around the world use cover crops to enhance soil fertility (Sainju et al., 2007). Mulching is the process of applying organic materials (compost, leaves) on the surface of the soil and over a crop to improve soil quality (Derpsch et al., 2010; FAO, 2011). Additionally, to protect the topsoil, some African smallholder farmers intercrop with living mulches (Dumanski et al., 2006).

In China, cover crops have a long and storied history dating back to the Chou dynasty (Giller et al., 2015). Soil cover is created by leaving cover crops and mulches made up of agricultural residues from previous harvests on the topsoil (FAO, 2007). Depending on the farming context, cover crops are used for a variety of reasons (Grabowski & Kerr, 2014). According to Giller et al. (2009), cover crops are useful for improving soil properties, production, and crop development. Furthermore, research demonstrates that by conveying carbon to the soil via crop residues, cover crops have a direct impact on microbial activity and biomass, as well as soil carbon sequestration (Sainju et al., 2007).

The majority of smallholder farmers have traditionally followed the conventional farming approach, in which crop leftovers are removed or mixed into the soil with a hand hoe or plough (Derpsch et al., 2010). Because the soil is exposed, it is easily blown and washed away by wind and rain, resulting in significant soil erosion (Franzluebbers & Stuedemann, 2008). The introduction of CA, on the other hand, affected the indigenous manner of farming and the mind-set of farmers. As a result, one of the primary components of CA is cover crops, which encourage farmers to leave crop residues as soil cover or mulch, which inhibits soil erosion and weed spread in the long run (Muzangwa et al., 2017).

Cover crops are generally used to prevent soil erosion caused by external factors like wind and rain (Giller et al., 2015). Soil cover also reduces the direct impact of rainfall on the soil surface (Steenwerth & Belina, 2008; Bhan & Behera, 2014). It acts as a soil canopy, protecting the field from extreme heat and lowering evaporation rates (Kassam et al., 2019). CA can also be used to supplement minerals and organic matter (OM) in the soil (Uchino et al., 2007). Under CA, mulching is employed to protect the soil (Steenwerth & Belina, 2008). In addition, some farmers choose to produce plants all the time rather than leave the soil bare (Giller et al., 2009). Several types of soil cover are typically applied between the planting holes and the rows (Derpsch et al., 2010). Furthermore, covering the soil not only lowers soil erosion but also helps to preserve soil temperature (Kramberger et al., 2009). As a result, soil microorganisms can thrive in a better environment. Farmers also profit from properly placed cover crops because they increase soil water content (Giller et al., 2015; Kaweesa et al., 2018).

According to Bechini & Castoldi (2009), crops planted after cover crops produce high-quality yields. Crops that are planted after legume cover crops, for example, will reap significant economic benefits because legumes provide nitrogen to the soil, which will benefit subsequent crops (Friedrich et al., 2012). Mulching is necessary for smallholder farmers because it increases soil fertility and controls weeds (Kramberger et al., 2009). Another advantage of using cover crops is that it helps to conserve ecosystems by reducing nitrogen leaching into water sources (Tonitto et al., 2005). Furthermore, some experts suggest that conservation legume-based systems reduce nitrate leaching by roughly 40% when compared to traditional fertilizer-based systems. (Kassam et al., 2019; Thierfelder & Wall, 2011).

2.5.3. **Crop Diversity (Crop Rotation and Intercropping)**

Crop rotation is a type of conservation agriculture utilized in a wide range of cropping systems (Giller et al., 2015). It is defined as the practice of interchanging crops from different families. For example, most farmers in southern Africa mix legumes with grains in the same cultivated land every year (Chiputwa et al., 2010). Lentil rotations, according to some sources, have enhanced the usage of cropping systems, improving soil fertility and weed management over time (Snapp et al., 2010; Franke et al., 2014; Giller et al., 2015). Furthermore, in southern Africa, rotations between leguminous plants and maize enhanced maize output by 78 per cent (Stevenson et al., 2014). According to researchers, conservation agriculture is distinct from conventional farming (Franke et al., 2014; Derpsch, 2005; Baudeon et al., 2007). Additionally, in most African countries, smallholder farmers tend to grow the same crops year after year, allowing weeds, diseases, and pests to thrive and reproduce, decreasing productivity (Nhamo, 2007). Conservation agriculture emphasizes crop rotation from multiple sources and the mixing of various crops in the same soil every season as a preventive measure (World Bank, 2006).

As emphasized by Giller et al. (2015), intercropping stands out as one of the most significant cropping systems, enabling farmers to cultivate two or more crops near each other. Furthermore, intercropped crops are also commonly planted in a variety of spatial patterns (Chiputwa et al., 2010). For many years, researchers and extension workers have promoted and recommended the use of CA, especially mix cropping and crop rotation (Baudeon et al., 2007). Smallholder farmers are encouraged to use intercropping or crop rotation to increase their yields (Ngwira et al., 2013). Maize is rotated with legumes by farmers all over the world because it conserves and increases soil fertility (Loss et al., 2015). Pests and diseases are also controlled by rotating and mixing crops, and the use of cover crops in conjunction with intercropping strategies is one of the most effective and strategic approaches utilized by most farmers (Twomlow et al., 2008). Furthermore, the incorporation of cover crops into the system aids in soil conservation by minimizing soil erosion and maintaining nutrient balance (Teasdale et al., 2007).

2.6. **Adoption of conservation agriculture**

2.6.1. **Adoption of conservation agriculture in Africa**

In Africa, conservation agriculture has long been advocated and recommended by NGOs, researchers, and extension agents to deal with soil degradation and climate change (Corbeels et al., 2014; Kassam et al., 2009). It enables farmers to enhance their products while simultaneously maintaining the environment. As a result, it can help farmers deal with challenges including soil erosion, soil infertility, and food insecurity (Mupangwa & Thierfelder, 2014). Ngwira et al. (2012) claim that CA is a solution to smallholder farmers' problems in Africa, particularly low productivity. Nonetheless, the adoption rate of CA in Africa is relatively low and limited due to a lack of funds and little or limited access to resources and knowledge (Shaxson & Pretty, 2009; Affholder et al., 2010).

According to Guto et al. (2011), most African farmers are resistant to adopting new technologies, which is why CA accounts for less than 1% of Africa's population. Wall (2007) argues that conservation agriculture is incompatible with the socioeconomic characteristics of most smallholder farms in southern Africa. Since farmers are diverse and own a variety of resources and farms, CA favours particular farmers in a specific region at different periods (Hobbs, 2007).

CA adoption is slowly gaining traction in Africa, with most smallholder farmers depending on traditional knowledge to enhance yields, while large-scale growers rely on scientific expertise and sophisticated equipment (Ngwira et al., 2012; Umar et al., 2011; Rockstrom et al., 2009). The literature shows that around 22 African countries (including South Africa) promote CA adoption (Kassam et al., 2019; Dumansky et al., 2014; Thirfeler et al., 2013). Since 2008, adoption of conservation agriculture has increased significantly, indicating that many African countries are beginning to embrace the approaches as a means of keeping up with population growth (Derpsch et al., 2009; Hove et al., 2011).). Furthermore, according to Wit et al. (2015), only nine African countries adopted CA in 2008, while fourteen countries did so in 2013, and seventeen countries had an area covered by CA in 2015.

Furthermore, international research organizations, non-governmental organizations (NGOs), and philanthropists are constantly advocating the use of CA principles in Africa to address climate change, food insecurity, and low output in small-scale farming systems (Kassam et al., 2013; Friedrich et al., 2011). Most smallholder farmers in Africa who embraced CA systems use minimum tillage with a very low combination of the other two elements (crop rotation and soil cover) (Derpsch et al., 2010). In contrast, the optimal effectiveness of CA is achieved when all three principles are implemented simultaneously. Baudron et al. (2007) reported that Zambia holds the highest rate of conservation agriculture adoption among southern African countries.

2.6.2. **Adoption of conservation agriculture in South Africa**

According to Ntshangase et al. (2018), South Africa (SA) is classified as a developing country; thus, it is extremely vulnerable to agricultural resource scarcity, and a substantial percentage of the country is prone to soil degradation. Consequently, the country is having difficulties in preserving and increasing soil fertility. Laker (2004) argues that SA is naturally prone to very low soil organic matter concentration. As a result, most small-scale farmers are under-producing. Furthermore, because around 60% of soils in South Africa (SA) have less than 0.5 per cent soil organic matter (SOM), farmers must employ CA, especially given the country's low rainfall rates, limited agricultural land, and a high proportion of smallholder farmers (Mazvimavi, Ndhlovu, Nyathi, & Minde, 2010). Researchers, NGOs, and extension workers have been promoting and publicizing CA to smallholder farmers for decades (Rockstrom et al., 2009). Despite this, large-scale commercial farms in South Africa employ it extensively (Kassam et al., 2019; Hove et al., 2011).

Furthermore, despite all efforts to promote CA, smallholder farmers are reticent to incorporate it into their farming operations (Kassam et al., 2009; FAO, 2009). In 2009, the CA system covered only 368,000 hectares of the 5.2 million hectares of cultivated land (DAFF, 2016). In addition, just 7% of all cultivated land was under no-tillage (Smith et al., 2016). Most smallholder farmers who have adopted CA are only adopting zero-tillage, with little usage of soil covers or crop rotation (Kassam et al., 2010; FAO, 2007). CA is a long-term panacea for enhancing crop yield and addressing soil deterioration (Giller et al., 2015). Despite this, the effectiveness of CA among smallholder farmers in South Africa is unknown because the majority of farmers are unwilling to adopt all the CA principles at once (Bollinger et al., 2014).

According to researchers, commercial farmers in South Africa have adopted some of the CA practices (reduced tillage and stubble mulching) (Midglet et al., 2015; Blignaut et al., 2015). Furthermore, adopting all three CA principles at the same time remains a challenge (Ngwira et al., 2013). South African grain growers are expected to adopt 20-30% of new technology, with the Western Cape Province accounting for more than 70% of all grain producers (ARC, 2014). Based on the Free State News report, the adoption rate of conservation agriculture (CA) among grain farmers in KwaZulu-Natal is estimated to be approximately 50 to 60 per cent, while in Mpumalanga, it ranges between 10 and 40 per cent. Consequently, the majority of farmers in Mpumalanga do not implement CA practices.

Conservation agriculture is still foreign to the vast majority of small-scale farmers in South Africa's emerging regions (FAO, 2005). According to Blignaut et al. (2015), smallholder farmers in Mpumalanga and Limpopo grow maize using traditional methods. In practice, the bulk of these farmers disturb the soil with hand hoes and mouldboard ploughs, and the crop leftovers are fed to livestock after harvesting (Kassam et al., 2011; Giller et al., 2015). As a result, the soil is exposed, and wind or water can readily blow or wash it away (Calegari & Ashburner, 2005). According to the literature, conservation agriculture's relevance is being examined, particularly in South African areas dominated by sandy soils (Berry, 2005; FAO, 2011). Despite this, the majority of large-scale farmers adopt zero-tillage in sandy soils (Mazvimavi et al., 2010). Furthermore, while sugarcane farmers do not use CA techniques, some cotton and vegetable producers in KZN use it (Ntsangase et al., 2018).

2.7. **Socio-economic characteristics influencing the adoption of conservation agriculture**

The adoption of conservation agriculture by smallholder farmers has a lot of potential for increasing productivity while also preserving the land. Smallholder farmers' gender, age, educational background, agricultural experience, and other socioeconomic characteristics are important since they are likely to influence farmers' decisions on whether or not to adopt CA (Wall, 2007; FAO, 2011). According to research, younger farmers are more open-minded, informed, and willing to try new technologies than their elders (Mazyimavi, 2010). As a result, the importance of age in CA adoption is emphasized (Knowler & Bradshaw, 2007; Langyintuo and Mekuria, 2005). Understanding the socio-economic characteristics of smallholder farmers is crucial before promoting an innovation (Affholder et al., 2010). Furthermore, CA may benefit certain farmers while at the same time contradicting some socio-economic factors (Baudron et al., 2007). CA systems are less popular among African farmers since they do not fit their environment (Loss et al., 2015; Giller et al., 2015; FAO, 2007).

2.7.1. **Gender**

Men are typically the majority in Africa's agricultural industry (Nweke and Enete, 1999). Household heads are usually the key decision-makers in Sub-Saharan Africa when it comes to the usage of updated and promoted innovations. As a result, male-headed households have a better chance of embracing new technologies due to their social and cultural status in society.

Female farmers face challenges in adopting Conservation Agriculture (CA) due to limited resources and gender bias in extension service delivery (Langyintuo and Mungoma, 2008). Gender is considered a significant factor influencing CA adoption, with women often being overlooked in adopting and transferring agricultural technologies. Societal norms and cultural institutions that prioritize women's roles in domestic responsibilities, while men are expected to seek employment outside the home, further contribute to the gender disparity in CA adoption.

Additionally, according to Bazezew (2015), male farmers have easier access to CA information than female-headed households. Even though the majority of female farmers are non-adopters, Chichongue et al. (2020) suggest that women are more likely than male farmers to adopt CA practices. Female farmers in Africa are often disregarded. However, they make a significant contribution to the household and national economy (Bamire et al., 2002). Giller et al. (2015) state that women encounter socio-cultural obstacles that restrict their access to resources, which in turn impacts their ability to adapt and utilize CA practices to improve their productivity.

2.7.2. **Age**

Studies conducted in different countries have produced conflicting findings regarding the influence of age on the adoption of Conservation Agriculture (CA) (Mazvimavi & Twomlow, 2009; Langyintuo & Mungoma, 2008). In many adoption studies, farmers' age is a major factor in their decision to adopt new agricultural technology (Akudugu et al., 2012). Younger farmers are more open-minded, knowledgeable, and willing to explore new technology than their elders (Mazyimavi, 2010; Langyintuo and Mekuria, 2005). According to Giller et al. (2009), CA has been accepted by both young and elderly farmers over time. The disparity in findings regarding the impact of age on the adoption of Conservation Agriculture (CA) could be attributed to different factors. One possible explanation is that younger individuals have a higher capacity for learning about new technologies, while older farmers may possess extensive knowledge about the profitability of their existing farming systems, making them more hesitant to embrace CA (Knowler & Bradshaw, 2007).

Additionally, Langyintuo and Mekuria (2005) propose that older farmers could be more inclined to adopt new technologies due to the benefits of having accumulated financial resources, increased extension contacts, and higher creditworthiness. On the contrary, Fujie (2015) argues that age has a negative and significant impact on the likelihood of adopting conservation agriculture. In other words, Fujie's findings suggest that older farmers are less inclined to embrace conservation agriculture practices compared to their younger counterparts. These contrasting views shed light on the complex relationship between age and technology adoption in the context of conservation agriculture.

2.7.3. **Educational level**

Recent studies highlight the pivotal role of education in promoting the adoption of Conservation Agriculture (CA) among farmers. According to Sarungbam (2011), education plays a crucial role in empowering farmers to absorb and understand new information, leading to a greater motivation to adopt complex agricultural technologies. Additionally, farmers with higher levels of education tend to be less risk-averse, which increases their willingness to experiment with innovative practices (Giller et al., 2015). Moreover, given that conservation farming practices require substantial information and knowledge, farmers with a reasonable level of education are more likely to embrace them (Wall, 2007; Mutune et al., 2011). Additionally, reading and writing are essential as they allow farmers to understand technical advice and adopt advanced agricultural technologies.

Recent research provides strong evidence for the significance of higher education levels in the adoption of Conservation Agriculture (CA). According to Teklewold and Köhlin (2011), access to formal education and extension services plays a crucial role in improving farmers' understanding and technical proficiency concerning CA practices. Similarly, Mavunganidze et al. (2013) highlight the positive impact of farmers' formal education on their willingness to embrace and implement CA techniques. These studies emphasize that a well-educated farming community is more likely to adopt CA, resulting in better sustainable agricultural practices.

2.7.4. **Household size**

According to Chiputwa et al. (2011), household size positively influences the adoption of Conservation Agriculture (CA) practices. In numerous Sub-Saharan African (SSA) countries, family labour plays a crucial role in the agricultural practices of smallholder farmers. Household size has been identified by Bamire et al. (2002) and Idrisa et al. (2012) as a key factor influencing the adoption of agricultural methods, directly affecting the availability of manpower for farm operations. Studies suggest that larger households are more inclined to embrace conservation agriculture (CA) compared to smaller ones (Bisangwa, 2013; Ngombe et al., 2014). This trend could be attributed to the fact that farmers with larger families generally possess more available resources and are, therefore, more willing to explore and implement new agricultural technologies. However, the impact of farm size on adoption remains uncertain.

2.8. **Barriers preventing the adoption of conservation agriculture**

CA's components are complementary in the sense that when more of them are adopted in each situation, the benefits increase dramatically (Gama & Thierfelder, 2011). This is why researchers advocate for it to be implemented as a package. However, because of several barriers, less than half of smallholder farmers in southern Africa use the entire package of CA (Baudron et al., 2007; Mutsindikwa, Dumba, Munguri, & Mvumi, 2011). Barriers are any internal and external constraints that prohibit farmers from adopting conservation agriculture practices (Kassam et al., 2009). Farmers across the world use CA to increase yields, reduce soil deterioration, and protect the environment (Derpscch et al., 2010).

According to researchers, smallholder farmers encounter a variety of challenges to CA adoption, including perception, lack of capital resources, lack of information, and poor extension service delivery (Baudron et al., 2014; Guto et al., 2011). Despite the growing acceptance of CA around the world, farmers' mindsets continue to be a major issue, as CA adoption requires farmers to renounce their previous agricultural practices (conventional farming) (Wall, 2007; Ngwira et al., 2014). Most smallholder farmers associate farming with disturbing or preparing the soil with a plough or hoe, thus converting to CA requires a mindset shift (Giller et al., 2011).

Thierfelder et al. (2016) highlight that a significant proportion of smallholder farmers in Africa encounter challenges when adopting Conservation Agriculture (CA) due to limited agricultural resources. Consequently, many rely on manual labour, such as using hand hoes, for seedbed preparation. Furthermore, research indicates that farmers in low-income countries have limited access to information about conservation agriculture (Baudron et al., 2007; Mupangwa et al., 2016). When making decisions about CA components, farmers consider factors such as feasibility, costs, benefits, and external conditions like institutional and natural factors (Derpsch et al., 2010; Rufino et al., 2011). Some components may be easier to implement, while others may present greater difficulties (Kassam et al., 2009). For example, Zambian farmers were found to adopt mulching and crop rotation practices less frequently compared to farmers in other African countries (Thierfelder et al., 2014. Similar findings were reported in Zimbabwe (Hove, 2011).

According to Wall (2007), if farmers adopt conservation agriculture, they will be able to perceive their farms as businesses rather than just a method to feed their families. However, many farmers in Southern Africa are finding it difficult to leave their conventional farming methods (Pannell et al., 2014). After harvesting, smallholder farmers often allow livestock to graze on agricultural wastes, while others use crop remains for roofing and fencing (Umar et al., 2012). CA, on the other hand, is the opposite of traditional farming in that it forbids farmers from removing soil covers, making it difficult for them to adopt it (Pedzisa et al., 2015a). Most farmers believe CA is ineffective in the short term and so does not enhance production (Arslan et al., 2014). As a result, the greatest hurdle to conservation agricultural adoption is farmers' mindsets (perception). Furthermore, most smallholder farmers consider CA as a capital-intensive farming practice (Derpsch et al., 2010). The adoption of CA in African countries is low due to this misperception (Baudron et al., 2012; Giller et al., 2015).

Most African smallholder farmers cannot afford the necessary equipment (rippers, hoes, and sprays), herbicides, and fertilizers to adopt CA effectively (Giller et al., 2009; Derpsch & Friedrich, 2009; Thierfelder & Wall, 2009). Smallholder farmers have limited access to adequate machinery (Derpsch & Friedrich, 2009). Furthermore, most farmers in southern Africa doubt CA's feasibility, especially when yields are low (Giller et al., 2009; Baudron et al., 2014). Rufino et al. (2011) emphasize that smallholder farmers in the tropics face difficulties in adopting Conservation Agriculture (CA) due to the challenge of preserving crop remains. These remains are necessary for feeding animals during the dry season, making it impractical for some farmers to fully implement CA. This is one of the reasons why CA adoption among smallholder farmers in Africa is limited.

Another issue highlighted by CA adopters is the insufficient availability of labour (Giller et al., 2011). The labour-intensive nature of CA practices hinders its widespread adoption. Chiputwa, Langyintuo, and Wall (2011) contend that the increased labour intensity associated with certain CA techniques acts as a deterrent to their adoption. This suggests that the labour requirements of CA practices can be a significant barrier for farmers, impacting their willingness to adopt specific CA approaches.

Adoption rates are low in southern Africa because smallholder farmers lack the information, skills, and equipment needed to conduct conservation agriculture (Bollinger et al., 2014). Liniger et al. (2011) believe that a lack of information and understanding is a fundamental barrier to CA adoption. Most farmers lack the skills and capacity to apply CA due to inadequate extension services (Knowler & Bradshaw, 2007). For example, according to Shetto and Owenya (2007), Tanzania's adoption of CA is hampered by a lack of machinery and farm power. In addition, extension workers are ineffective, with some lacking awareness of CA's application. According to Sanginga and Woomerm (2009), smallholder farmers are uninformed of CA since agricultural organizations and extension personnel are not transferring information and facilitating innovations. Farmers develop misconceptions about CA as a result of their lack of knowledge, and this is the most significant barrier (Ngwira et al., 2013). According to the research, most farmers are unaware of the long-term production and environmental benefits of CA (Giller et al., 2009).

2.9. **The benefits of adopting conservation agriculture**

CA proponents argue that it has several advantages, one of which is increased yields. Although the results of CA yield study vary based on factors such as geography, expertise, input utilization, and the type of CA principles used, it has been demonstrated that CA can increase crop yields in the long term under the correct conditions (Giller et al., 2015; Smith et al., 2016; FAO, 2015; Midgley et al., 2015; Hobbs et al., 2007).

2.9.1. **Agronomic benefits**

2.9.1.1. **Improves soil health**

Researchers and extension workers in southern Africa continue to support and promote CA as a sustainable practice that improves soil richness by retaining and adding soil organic matter (SOM), making it a viable alternative to conventional farming (Haggblade and Tembo 2003). High soil organic matter (SOM) designates that the soil is healthy, fertile, and productive, whereas low SOM signifies that the soil has a poor structure, low water infiltration rate, crusting tendency, and poor nutrient uptake, and therefore the soil is infertile (Baudron et al., 2014; Hobbs et al., 2008). Furthermore, poor agricultural practices, such as conventional farming, deplete SOM and put farmers' ability to produce high yields in jeopardy (Lal, 2015; Kassam et al., 2009; Laker, 2004). As a result, increasing SOM in arable soils is crucial for productivity growth (Lal, 2004; Kassam et al., 2019).

Researchers claim that CA improves soil health by incorporating organic soil cover and intercropping or rotating crops with legumes, increasing SOM (du Preez et al., 2011; Lal et al., 2004; Farooq et al., 2011). CA increases SOM while also fixing nitrogen in the soil, conserving water and soil, and enhancing nutrient efficiency (FAO, 2007). Reduced tillage and organic soil cover increase microbial activity in the soil, while mulching reduces evaporation and keeps moisture in the soil. Crop rotation, when combined with legumes, helps to minimize the spread of weeds, pests, and diseases while also increasing soil quality (Pittelkow et al., 2015).

2.9.1.2. **Environmental benefits**

Crops that are left in the field after harvesting act as a shield against raindrop splash effects, allowing the soil to absorb the dissipated raindrops without damage (Thierfelder et al., 2012). As a result, water infiltration will increase, while runoff will decrease. This entire process is crucial in preventing and easing soil deterioration since the permanent organic soil cover is responsible for lowering the velocity of wind or water on the surface (FAO, 2009). In addition, crop residue acts as a soil cover, reducing run-off. As a result, the environment will be protected because no harmful substances will enter rivers, streams, or oceans. Pest-feeding microorganisms benefit from CA in contrast to conventional farming because soil cover provides habitat and can also supply food for beneficial insects (FAO, 2014). Cover crops and intercropping, which is the opposite of mono-cropping, are used to reduce genetic biodiversity loss (Baudron et al., 2014). Because it conserves and increases SOM, CA is vital for climate change mitigation (IPCC, 2007). It also helps to mitigate the negative consequences of global warming by lowering greenhouse gas emissions and sequestering carbon in the atmosphere (Pedzisa et al., 2015; Knot, 2014; Powlson et al., 2016).

2.9.1.3**. Economic benefits**

Many smallholder farmers across the world are motivated by the three key economic benefits of adopting CA (Kassam et al., 2009). Conservation agriculture saves time and money by eliminating the need to excavate the soil or physically eradicate weeds. As a result, labour, fuel, and equipment costs are reduced (Blignaut et al., 2015). Midgley et al. (2015) state that most farmers adopt CA because it increases productivity while lowering costs. For example, CA is used by farmers in Latin America who rely solely on family and friends for labour since it reduces the amount of labour required for farming (Kassam et al., 2019). Organizations in southern Africa are promoting CA to smallholder farmers to enhance agricultural productivity. Organizations in southern Africa are promoting CA to smallholder farmers since it is effective in increasing agricultural output sustainably, hence enhancing food security and rural life (Siziba, 2008).

2.10. **Conceptual framework**

2.10.1. **Introduction**

Figure 2.1 illustrates the socio-economic characteristics, barriers, and perceived benefits associated with smallholder farmers' adoption of conservation agriculture. Embracing conservation agriculture holds considerable potential for enhancing productivity and preserving land resources among smallholder farmers (Giller et al., 2011).

2.10.2. **Socioeconomic Characteristics**

In this study, the researcher investigates the socioeconomic characteristics of smallholder farmers as independent variables. These characteristics encompass factors such as age, education level, farm size, income, access to resources, and agricultural experience. The researcher hypothesizes that these variables will have an impact on the adoption of conservation agriculture. The study aims to explore how these socioeconomic factors might influence farmers' decisions to embrace conservation agriculture practices. Additionally, researchers claim that younger farmers are more informed, open-minded, and willing to try new practices than their more experienced counterparts (Mazyimavi, 2010; Wall, 2007; FAO, 2011). Age is therefore stressed as being important in CA adoption (Knowler & Bradshaw, 2007; Langyintuo and Mekuria, 2005). Before promoting innovations, it is essential to understand the socio-economic traits of smallholder farmers (Affholder et al., 2010). Additionally, the approach might be advantageous to some farmers but at odds with the socio-economic status of smallholder farms (Baudron et al., 2007; Thierfelder et al., 2017). In most cases, African farmers are less likely to adopt CA practices since they do not fit their environment (Loss et al., 2015; Giller et al., 2015; FAO, 2007).

2.10.3. **The barriers**

The study considers barriers faced by smallholder farmers as one of the key components towards CA adoption. The adoption of CA is impeded by various barriers, including a lack of capital resources, CA implements are relatively expensive to a typical smallholder farmer, poor extension services, and negative perception (Baudeon et al., 2007; Shetto & Owenya, 2007). The attitudes of smallholder farmers toward indigenous farming may affect their choice to employ CA. Because most smallholder farmers believe that farming involves disturbing and preparing the soil by clearing away undesirable by-products, which is the exact opposite of CA, it is challenging for them to switch to CA practices (Thierfelder et al., 2015).

2.10.4. **Perceived Benefits of Conservation Agriculture**

Another key component of the conceptual framework is the perceived benefits of conservation agriculture. It is hypothesized that farmers' perceptions of the advantages and benefits associated with conservation agriculture, such as improved soil fertility, water conservation, reduced labour, and increased yields, will positively influence their adoption decisions. As a result, the adoption of CA is influenced by farmers' mindsets. According to Hobbs (2007), the acceptance or rejection of CA can be directly influenced by how smallholder farmers perceive the innovation. Additionally, transitioning from conventional farming to conservation agriculture demands a conceptual shift among adopters (FAO, 2007; Kassam et al., 2019). Conversely, Hobbs et al. (2008) assert that numerous smallholder farmers in Africa show hesitance in embracing contemporary agricultural technologies. To enhance the implementation and uptake of Conservation Agriculture (CA), these farmers must make adjustments to their conventional farming methods (Giller et al., 2011; Corbeels et al., 2020).

The adoption of conservation agriculture (CA) by smallholder farmers can be attributed to its various benefits in agronomy, environment, and economics. Research by Chiputwa et al. (2011), Derpsch (2003), and Ngwiri et al. (2012) have highlighted the advantages of CA, which include improved agricultural practices and environmental sustainability. In South America, for example, farmers are encouraged to adopt CA due to its positive impacts on agriculture and the environment (Hobbs et al., 2008). According to Kassam et al. (2019), Conservation Agriculture (CA) not only boosts agricultural productivity but also preserves soil health. Over time, CA has been shown to decrease production expenses and improve soil fertility, as supported by the findings of Knowler and Bradshaw (2007). These benefits of CA make it an attractive option for smallholder farmers. Moreover, CA is in line with Climate-Smart Agriculture (CSA) practices, which assist farmers in confronting the challenges posed by climate change (Affholder et al., 2010; Thierfelder & Wall, 2012; Blignaut, 2013).

2.10.5. **Adoption of Conservation Agriculture**

The dependent variable of the study is the adoption of conservation agriculture among smallholder farmers. It represents the binary outcome of either adopting or not adopting conservation agriculture practices. The study aims to evaluate the adoption of conservation agriculture among smallholder farmers in Hazyview. This investigation will involve examining the factors that contribute to the adoption or non-adoption of conservation agriculture among the target population. In Africa, smallholder farmers may face challenges in adopting conservation agriculture due to a lack of knowledge and skills (Giller et al., 2009; Andersson and Corbeels et al., 2014). Extension organizations play a crucial role in providing information on new technologies to farmers, including conservation agriculture (Bollinger et al., 2014). However, research suggests that limited access to information and resources can contribute to farmers' reluctance to embrace conservation agriculture, particularly among female farmers (Kassam et al., 2009; Kassam et al., 2019). Gender imbalances in the delivery of extension services may further hinder the adoption of conservation agriculture among female farmers (Langyintuo & Mungoma, 2008; Ngoma et al., 2016).

The adoption of conservation agriculture practices by smallholder farmers may be hindered by a lack of financial resources. Limited access to capital makes it challenging for farmers to implement conservation agriculture practices, as they often require specialized equipment that is more expensive than conventional equipment (Doss, 2004; FAO, 2007; Thierfelder & Wall, 2009). Additionally, the cost of herbicides and pesticides needed for weed and pest control poses a financial burden for farmers in underdeveloped nations, further deterring their adoption of conservation agriculture (Kassam et al., 2009). The labour-intensive nature of conservation agriculture, particularly in the absence of herbicides, can also increase labour costs for farmers (Giller et al., 2009). These financial constraints and increased labour requirements may discourage smallholder farmers from adopting conservation agriculture practices.

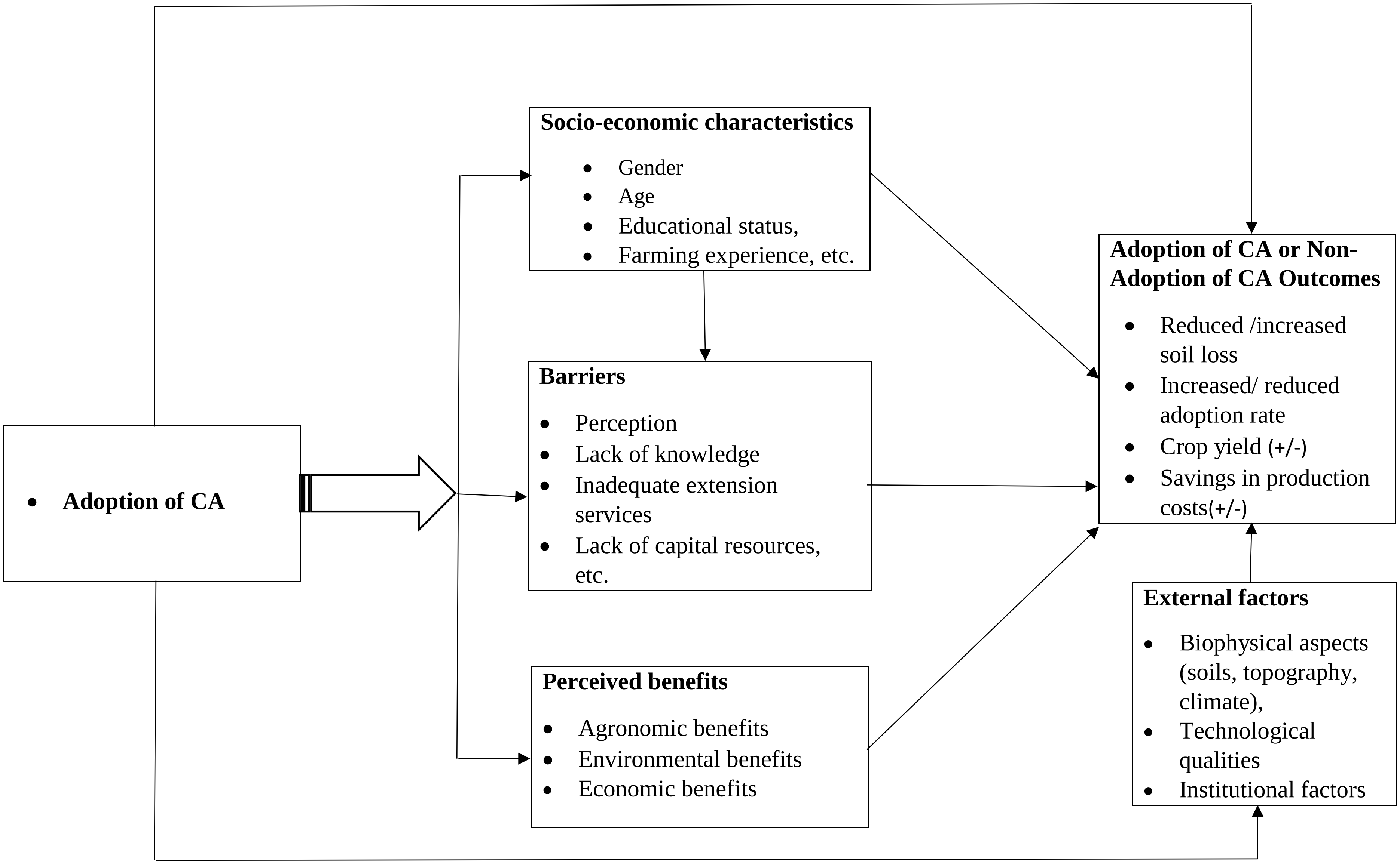

Figure 2.1: Conceptual framework Source: Own Work 2022

2.11. **Conclusion**

This literature review critically examined the existing literature on the adoption of Conservation Agriculture. Several research studies have highlighted that a lack of clarity regarding the definition and understanding of CA adoption contributes significantly to the variations in adoption rates (Andersson and D'Souza, 2014; Glover et al., 2016). The literature suggests several unanswered questions, including the challenge of determining whether a farmer should be classified as an adopter or a non-adopter based on certain criteria (Ngoma, 2016).

Contrary to the mainstream view in the literature, some studies argue that the existing literature reveals inconsistencies in identifying and defining CA adoption, particularly when it comes to farmers who implement one or two CA principles. Critics argue that the existing frameworks in the literature oversimplify the adoption process, leading to disagreements among researchers regarding whether farmers who only practice crop rotation or intercropping should be considered adopters.

Whilst the existing literature highlights key concepts such as minimum tillage, residue retention, and crop rotation (or intercropping), this study will expand upon this by introducing a nuanced classification of CA adoption levels. Based on gaps identified in the literature, this study will address the following questions: What constitutes full, partial, and low adoption of CA? In this study, three levels of CA adoption were defined:

- Full Adoption: Implementing all three CA principles, namely minimum tillage, residue retention, and crop rotation (or intercropping).
- Partial Adoption: Utilization of two principles, either minimum tillage with rotation/intercropping or residue retention.
- Low Adoption: Implementation of only one principle.

This classification allows for a more accurate assessment of the extent and intensity of CA adoption among smallholder farmers, considering the context-specific factors that shape their decision-making processes (Pedzisa et al., 2015). By addressing the questions of what constitutes full, partial, and low adoption, this study aims to contribute to the ongoing debate on the measurement and interpretation of CA adoption in southern Africa.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1. Introduction

This section provides an overview of the research design employed in the study. It outlines details about the specific demographic being targeted and its characteristics. Additionally, it discusses the sample size and the techniques used to select participants from the target population. The chapter further addresses the instruments used for data collection, including their piloting, validity, and reliability. It also covers the data collection methods and processes, as well as the methodologies employed for data analysis. Ethical considerations relevant to the study are also discussed. Lastly, the chapter elaborates on the operational definitions of the variables used in the study.

3.2. Study Area

The study was conducted in Hazyview, which is part of the local municipality of Mbombela in Mpumalanga. According to StatsSA Census (2011), Hazyview is divided into six regions, four of which are in the urban sector (Vakansiedorp, De Rust, Numbipark, and Hazyview SP), and two of which are in the rural sector (Sanbonani and Shabalala community). As a result, the focus of the research was on the two rural areas. These communities were chosen because they are in rural areas with a high population of small-scale farmers (Dlamini et al., 2014). There has never been a study like this one, which emphasizes the necessity of carrying out this investigation and determining the impact of CA adoption on smallholder farmers in the study area. Furthermore, Hazyview is situated in a fertile agricultural area (Udjo, 2014). It has a total population of 19 257 people and 5 499 houses, with a total area of 22.69 square kilometers (Census, 2011). Furthermore, Shabalala is the largest village (9.39 km^2) in Hazyview, with a total population of 15 022 people living in 4 308 houses (Dlamini, 2014). Sanbonani, on the other hand, is the tiniest of the settlements, with only 219 residents and 39 households.

The gender breakdown in Shabalala shows that women make up 51.47 per cent of the population and men make up 48.53 per cent. While the total racial make-up indicates that 99.6% of the population is black African, 0.2 per cent is coloured, and 0.1 per cent is white or Indian (StatsSA, 2011). In addition, Siswati (83.3%), Tsonga (8.9%), Sotho (3.4%), and Zulu (1.3%) are among the languages spoken in the study area, with Xhosa and Sepedi also being spoken (3.2%). Economic activity is sparse in Hazyview, particularly in rural areas. In the neighbourhood and taxi rank, informal trades are the most popular (Dlamini, 2014). Small spaza businesses can be found throughout rural areas (StatsSA, 2011). Agriculture and tourism are the primary economic activities in the studied area. Hazyview is one of the areas chosen to promote tourism because of its proximity to Kruger National Park (Mucina & Rutherford, 2006). The Sabie River and the Noord San River are the main sources of water for farmers in the Hazyview area, and water from these two rivers is pumped to the Shabalala and Sanbonani settlements. According to Schurink (2000), a pipeline transports water from the Mgwenya River to Hazyview. The towns of Shabalala and Sanbonani are located at 25°02'31.01"S 31°10'05.43" and 25°02'31.01"S 31°10'05.43" respectively.

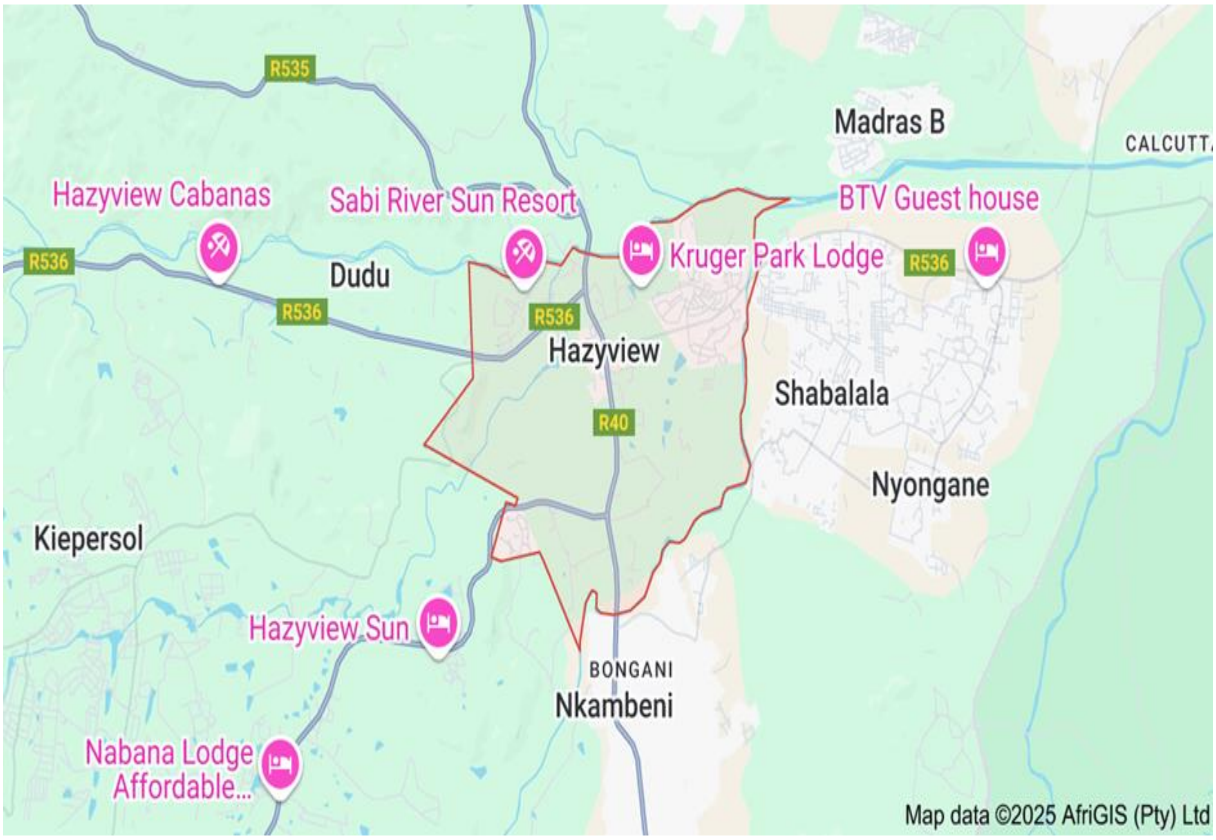

Figure 3.1: Map of the study areas
Source: Map data 2025

3.3. **Research design**

Research design is a critical component of any study, as it outlines the framework for how the research will be conducted, facilitating the coordination of all elements involved in the project (McCombes, 2022). This study employs a descriptive research design to explore the adoption of CA among smallholder farmers. By adopting a descriptive approach, the research aims to generate new insights into the current state of CA adoption and the factors influencing it.

A descriptive survey is a research method that collects data from respondents to assess the present state of the subject being investigated concerning one or more variables. The primary objective of this design is to determine the frequency of occurrence or the extent of interconnections among different components (Kumar et al., 2020). This design effectively addresses questions related to "how" and "why," allowing for the collection of data about variables without impacting the environment or altering any variables (Burns & Grove, 2001). Researchers commonly use this approach to verify or establish theories, validate existing practices, identify errors in current methodologies, and ascertain what practices are already in use (Grove et al., 2012).

The descriptive methodology employed in this study enabled the determination and analysis of conservation agricultural practices currently utilized by smallholder farmers. Descriptive studies are typically quantified and analyzed using statistical tools (Kotrlik et al., 2011), making it straightforward to identify the number of smallholder farmers adopting CA. Kerlinger and Lee (2000) describe a descriptive study as a quantitative method that focuses on how many, how well, or whom a particular issue affects. This research design is favoured for its flexibility in presentation and the rapid collection of data from participants (Johnson & Christensen, 2000). By utilizing well-structured questions, the study effectively gathered information regarding CA uptake and allowed for the correlation of factors when common responses were identified among participants (Johnson & Turner, 2003).

Overall, the descriptive research design provides a robust framework for understanding the complexities of CA adoption among smallholder farmers, facilitating the identification of key factors that influence their decision-making processes and ultimately contributing to the development of targeted interventions to promote sustainable agricultural practices.

3.4. **Population for the Study**

The target population refers to a specific group of individuals, elements, services, or households from whom statistical information is intended to be obtained. Ngechu (2004) defines a population as a well-defined group that is the focus of a research study. In this study, the population consisted of all registered smallholder farmers in Hazyview, specifically in the Shabalala and Sanbonani communities. According to DARDLEA (2021), there is a total of 330 registered smallholder farmers in these areas. Among them, the Shabalala village has 230 registered smallholder farmers, while the Sanbonani community has 100 registered smallholder farmers.

3.5. **Sampling Procedure and Sample Size**

3.5.1. **Sampling Procedure**

The study employed random sampling to select the smallholder farmers who participated in the research. Random sampling involves randomly selecting respondents from the population using a random number generator, as described by Denzin (2000). This approach ensures that every smallholder farmer in the population has an equal chance of being chosen to participate in the study, thus promoting fairness in the selection process (Meng, 2013).

3.5.2. **Sample Size**

From the total population of 330 registered smallholder farmers in Hazyview, a random sample of 221 respondents was selected to participate in the survey from the Shabalala and Sanbonani communities. The researcher employed specific formulas to determine the appropriate sample size. The aim was to ensure the reliability and validity of the findings, maintain consistency, and enable generalization of the results within the study's field while acknowledging the unique nature of the project. The sample size calculation considered a 5% margin of error and a 95% confidence level to ensure a robust analysis.

Sampling procedure

- n = $\frac{N \times X}{(X+N-1)}$
- where:
- $X = Z_{\alpha/2}^2 \times p \times (1-p) / MOE^2$,
- $Z_{\alpha/2}$ – is the critical value of the normal distribution for a confidence level of 95% = 1.95
- MOE- Represents the margin of error = 5% (0.05)
- p - Represents the sample proportion = 50%(0.5)
- N - Represents the population size = 330
- n - Represents the sample size =?
- $X = (1.95)^2 \times 0,5 \times (1-0.5)/(0.05)^2$
- = 665.64

- Therefore:

$$n = \frac{330 \times 665.64}{(665.64 + 330 - 1)}$$

- = 220.844
- = 221 respondents

3.6. **Data Collection**

3.6.1. **The instrument for Data Collection**

This research utilised a combination of primary and secondary data sources. To gather primary data, structured questionnaires were administered to smallholder farmers. The questionnaires were divided into four sections.

- **Section A** collected information about the farmers' socioeconomic characteristics.
- **Section B** focused on obtaining data related to the adoption of conservation agriculture practices. Farmers were presented with a list of five practices—cover crops, mulching, intercropping, crop rotation, and minimum tillage (zero-tillage) and asked to indicate whether they had adopted each practice, grading their response as Adopted (1) or Not Adopted (0). An adoption score was calculated based on the number of strategies used by each farmer.
- **Section C** aimed to evaluate the severity of barriers faced by smallholder farmers. The questionnaire listed eight barriers, and farmers were requested to rate them using a 3-point Likert scale, indicating whether they considered each barrier as Very Severe (3), Severe (2), or Not Severe (1).
- **Section D** assessed the perceived benefits associated with the adoption of conservation agriculture. Participants rated their level of agreement with a series of statements using a scale ranging from Strongly Agree (5) to Strongly Disagree (1), with intermediate options of Agree (4), Neutral (3), and Disagree (2).

In addition to gathering primary data through questionnaires, the research incorporated secondary data sources. Contextual information and support for the research objectives were obtained by consulting secondary sources such as journals, textbooks, and proceedings relevant to the study topic. This comprehensive approach to data collection ensures a robust analysis of the factors influencing CA adoption among smallholder farmers in Hazyview.

3.7. **Data Analysis**

The data collected from the study area underwent analysis using SPSS 29 (Statistical Package for the Social Sciences). To present a concise overview of the data, descriptive statistics such as frequency tables, percentages, and pie charts were employed. Additionally, to investigate the correlation between the socioeconomic characteristics of smallholder farmers and their adoption of Conservation Agriculture, a binary logistic regression analysis was conducted. This analytical approach allowed for the examination of the factors influencing the adoption of CA among the smallholder farmers in the study.

3.7.1. Descriptive Analysis

Descriptive analysis was utilized to investigate the collected data, allowing for a deeper understanding of specific behaviours and trends among the respondents (Waliman, 2011). This method involves gathering information on individuals, situations, events, and behaviours, and employing statistical tools such as frequency counts, percentages, averages, charts, and rankings to organize and present the findings (Lawless & Heymann, 2010). By using SPSS 29, the study quantitatively organized the data, addressing the "what" questions related to current CA practices employed by smallholder farmers, their perspectives on adopting CA, and the barriers they face in this process. Consequently, the study effectively answered the four research questions and objectives.

3.7.2. Objectives and Analysis Techniques

Objective 1: To assess the influence of socioeconomic factors on the adoption of Conservation Agriculture among smallholder farmers in Hazyview, descriptive analysis techniques such as frequency counts, percentages, and tables were employed to characterize and present the findings. Additionally, a binary logistic regression model was used to examine the relationship between socioeconomic characteristics and the likelihood of adopting CA.

Objective 2: The study aimed to evaluate the adoption rate of CA among smallholder farmers. This was achieved through descriptive analysis, which involved counting the frequency and calculating the percentage of CA adopters and non-adopters. According to DARDLEA (2021), agricultural extension agents in Hazyview introduced CA to small-scale farmers in 2010, establishing this as the baseline year for the study. The adoption rate was computed using the following formula:

Adoption rate = $\frac{New\ adoptees}{Total\ registered} \times 100$

In this study, three levels of CA adoption were defined:

- **Full Adoption:** Implementing all three CA principles—minimum tillage, residue retention, and crop rotation (or intercropping).
- **Partial Adoption:** Utilizing two principles, either minimum tillage with rotation/intercropping or residue retention.
- **Low Adoption:** Implementing only one principle.

Objective 3: To determine the barriers preventing smallholder farmers from adopting CA, descriptive analysis techniques such as percentages and frequency counts were employed. These methods quantified and summarized the data related to barriers, with results presented in a table format for clarity.

Objective 4: The study ascertains the perceived benefits of conservation agriculture on smallholder farmers. This analysis captured the farmers' opinions and perspectives, with results also presented in a table format for ease of comprehension.

3.7.3. Inferential Statistics

To further analyze the collected data, the study employed inferential statistics, allowing for generalizations about the larger population based on a sample (Lowry, 2014). Specifically, a binary logistic regression model was utilized, treating the adoption score of each participant as the dependent variable. This model illustrates how socioeconomic characteristics influence the adoption of CA among smallholder farmers.

Logistic regression is a statistical technique commonly used when the dependent variable has binary or categorical outcomes, extending the concept of simple linear regression (Wright, 1995; Afifi et al., 2004). In this study, the dependent variable was categorized as either "adopted" or "not adopted," representing two distinct classes (0 or 1). The logistic regression model estimated the likelihood of the dependent variable taking a specific value based on the socioeconomic characteristics of the farmers (Ros, 2006).

The primary aim of this research was to assess the extent of CA adoption among smallholder farmers in Hazyview. The binary logistic regression model investigated the association between independent variables (socioeconomic characteristics) and the dependent variable (CA adoption). The model's development draws upon foundational works in the field (Wright, 1995; Krishnapuram et al., 2005).

3.8. **The model**

The logistic regression model used in this study represents CA adoption through a dichotomous variable denoted as R, where a value of 1 indicates that a smallholder farmer has adopted CA, and a value of 0 indicates non-adoption. Considering the socioeconomic characteristics of the farmers enables the model to compute the probability of a smallholder farmer choosing to adopt or not adopt CA. This research ultimately aims to provide a comprehensive assessment of the extent to which smallholder farmers in Hazyview have embraced conservation agriculture practices.

The explicit form of the model is as follows:

$$\boldsymbol{Log\ \left(\frac{pi}{1-pi}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + B_n X_n + \varepsilon} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

Where:

Y represents the choice to adopt or not to adopt conservation agriculture, with 1 indicating a farmer adopting CA and 0 representing otherwise.

β_0 is the constant term

β_1-β_{10} are the standardized partial regression coefficients

μ represents the error term in the model.

Table 3.1: The predictor variables hypothesized with their operational descriptions and measurements

Variable and code	**Operational description**	**Measurement units**	**Expected sign**
Age (AGE)	Number of years	Number	+
Gender (GENDR)	Respondent’s gender	Male =1 and female =2	+
Marital status (MERITS)	State of being married or notmarried	Single =1; married = 2, divorced = 3, widowed = 4	+
Level of education (EDUC)	Educational attainment level	No school = 1 = primary school = 2, secondary school = 3, ABET = 4, tertiary education =5	+
Farming experience (FAMEXP)	The number of years involved in agricultural activities	≤ 5 = 1, 6 -10 = 2, 11 -15 = 3, 16 - 20 = 4, >20 = 5	+
Farm size (FAMSZ)	Number of hectares farmers own	≤2.5 = 1, 2.6 - 5.0 = 2, >5.0 = 3	+
Average monthly income	The amount of all income converted to a monthly basis	<10 000 = 1, >10 000 = 2	+
Extension visit	The state of receiving visits from extension agents	Yes = 1, No = 2	-
Type of employment	Occupation	Agricultural related job = 1, Non-agricultural related job = 2	-
CA training	The state of receiving training in CA	Yes = 1, No = 2	+
Number of households	The number of people who reside in the house	≤ 5 = 1, 6 - 10 = 2, >10 = 3	+

The "expected sign" column in the table refers to the hypothesized direction of influence that each predictor variable is expected to have on the adoption of Conservation Agriculture. These expectations are based on theoretical assumptions or prior research findings on how these variables influence farmers' decisions to adopt sustainable practices. This suggests that factors such as income, education, and training typically have a positive influence on adoption, while factors like employment outside agriculture or lack of extension support may negatively impact adoption decisions.

3.9. **Ethical consideration**

When collecting data, the researcher considered the following principles that relate to ethics:

1. Voluntary participation – The participants were informed that their participation is entirely optional and that they can opt-out at any moment.
2. Obtaining informed consent – Before beginning data collection, the researcher sought ethical approval.
3. Privacy and anonymity- All of the information provided by the respondents was kept private. Only the researcher had access to personal information (such as names and ID numbers) that could be used to identify the participants.
4. Honesty and transparency – Participants in the study were notified of the nature of their participation in the data collection procedure. The study was not prejudiced, and all responders were treated equally. As a result, the participants were not kept in the dark about anything.
5. Minimising the risks of harm – Neither the participants nor the environment were harmed because of the study. All data collection processes and technologies were appropriate and respectful to the context and respondents
6. Results communication – The participants were assured that they would receive feedback after the study had been concluded.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. **Introduction**

This chapter presents the results of the socio-economic data collection in alignment with the study objectives. The data is presented using tables, charts, and the researcher's interpretation. These visual representations and accompanying analysis provide a comprehensive understanding of the socio-economic characteristics examined in the study.

4.2. **Socio-economic Characteristics of the respondents**

Table 4.1: Demographic Characteristics of Respondents

Variable	Category	Frequency	Percentage
Gender	Male	82	37.1%
	Female	139	62.9%
Age	≤30 years	10	4.5%
	31-40 years	11	4.9%
	41-50 years	41	18.6%
	51-60 years	74	33.5%
	>60 years	85	38.5%
Marital Status	Single	29	13%
	Married	44	20%
	Divorced	93	42%
	Widow	55	25%
Education Level	No formal education	78	35.3%
	ABET	13	5.9%
	Primary	75	33.9%
	Secondary	55	24.9%
	Tertiary	0	0%
Household Size	1-5 members	121	55%
	6-10 members	73	33%
	>10 members	26	12%
Land Size	2.5 hectares	60	27.1%

	2.6-5 hectares	110	49.8%
	>5 hectares	51	23.1%
Employment Status	Employed	86	38.9%
	Unemployed	135	61.1%
Income Level	<R10,000	178	80.5%
	>R10,000	43	19.5%
Farm Experience	<5 years	19	8.6%
	5-10 years	90	40.7%
	11-15 years	58	26.2%
	16-20 years	33	14.9%
	>20 years	21	9.5%
Cooperative Membership	Yes	121	100%

Discussion of Results

The demographic profile of smallholder farmers in Hazyview provides valuable insights into the socio-economic and structural dynamics that influence the adoption of Conservation Agriculture (CA) in the region.

4.2.1 Gender Distribution

The study reveals that 62.9% of respondents are female, with males constituting 37.1%. This significant participation of women in farming aligns with findings from studies such as Kalungu et al. (2013), which highlighted women's active involvement in agricultural activities. Women are often primary actors in crop production, yet they frequently face barriers such as limited access to productive resources, education, and financial assets. These challenges are deeply entrenched in patrilineal societal structures that prioritize male decision-making (Mazvimavi & Twomlow, 2009; Khoza et al., 2019).

In Sub-Saharan Africa, household heads, typically males, hold primary decision-making authority over adopting new agricultural technologies (Baffoe-Asare et al., 2013; Bazezew, 2015). Male-headed households have been shown to adopt CA practices more frequently than female-headed households (Amadu et al., 2020). This disparity stems from men’s relatively greater access to credit, extension services, and land. Conversely, women's adoption of CA is positively associated with its labour-reducing potential, a critical factor for those burdened with significant household responsibilities (Chompolola & Kaonga, 2016). Therefore, empowering women farmers through targeted interventions is crucial to ensuring widespread CA adoption.

4.2.2 Age Distribution

The data indicates that 38.5% of respondents are over 60 years old, followed by 33.5% aged 51-60, 18.6% aged 41-50, and smaller proportions below 40 years. This age distribution reflects a trend observed in rural farming communities, where older individuals dominate agricultural activities due to limited youth involvement. Young people often migrate to urban areas or pursue alternative livelihoods, perceiving farming as less attractive or profitable (Anyoha et al., 2013).

Age significantly influences CA adoption. Older farmers, despite their agricultural experience and social networks (Branca & Perelli, 2020), may resist adopting new practices due to deeply entrenched traditional methods (Makate et al., 2019b). On the other hand, younger farmers, characterized by greater innovativeness and risk tolerance, are more likely to adopt CA. This duality highlights the need for targeted strategies to engage both age groups effectively.

4.2.3 Marital Status

The findings reveal that 42% of respondents are divorced, followed by 25% who are widowed, 20% who are married, and 13% who are single. Marital status shapes household dynamics and resource availability, indirectly affecting CA adoption. Research by Mugandani and Mafongoya (2019) indicates that single farmers may show higher interest in innovative practices due to fewer family obligations, whereas married individuals face shared decision-making processes that can either facilitate or hinder adoption. The high proportion of divorced and widowed farmers may indicate a shift in household responsibilities, with implications for labour availability and decision-making power.

4.2.4 Education Levels

Education levels among respondents indicate that 35.3% lack formal education, 33.9% completed primary school, 24.9% completed secondary school, and none attained tertiary education. This low educational attainment constrains farmers' capacity for innovation and adoption of CA practices, as noted by Teklewold and Köhlin (2011). Literacy and education enhance the ability to comprehend technical recommendations, which is critical for implementing CA effectively (Matata et al., 2010).

The lack of tertiary education among respondents highlights the need for tailored training programs that simplify CA principles and techniques. Adult education programs, farmer field schools, and extension services can bridge this gap by providing practical, accessible knowledge to improve adoption rates.

4.2.5 Household Size

Household size data show that 55% of respondents have households with 1-5 members, 33% have 6-10 members, and 12% have more than 10 members. Larger households, as observed by Jona (2016), may drive farmers to adopt improved technologies to meet food and income demands. However, balancing family needs and production capacity remains a challenge, emphasizing the need for innovations like CA that enhance productivity and resource use efficiency. Smaller households may face labour constraints, making CA's labour-saving aspects particularly appealing.

4.2.6 Land Size

Farm sizes are predominantly between 2.6 and 5 hectares (49.8%), with 27.1% owning 2.5 hectares or less and 23.1% owning more than 5 hectares. Limited land size constrains the adoption of CA practices, as larger farms often provide more flexibility to experiment with new technologies (Gbetibouo, 2009). Smallholder farmers with minimal land may prioritize immediate returns over long-term investments like CA, underscoring the importance of policies that provide financial and technical support to these farmers.

4.2.7 Employment and Income

A substantial proportion of respondents (61.1%) are unemployed, with 80.5% earning less than R10,000 annually. Farming serves as the primary income source for 72.9% of respondents, highlighting the sector's critical role in livelihoods despite its low financial returns. Economic constraints limit farmers' ability to invest in CA practices, as noted by Sebeho (2016). Strengthening access to subsidies, microfinance, and input support programs could mitigate these barriers, enabling smallholders to adopt and sustain CA.

4.2.8 Farming Experience

The average farming experience of respondents is 12 years, with 40.7% having 5-10 years of experience. Experience is positively associated with CA adoption, as experienced farmers are more adept at managing risks and understanding long-term benefits (Maddison, 2006; Hassan & Nhemachena, 2008). However, younger and less experienced farmers may require additional training and mentorship to build the confidence and skills necessary for CA adoption.

4.2.9 Cooperative Membership

All respondents are members of cooperatives, underscoring the pivotal role of collective action in CA adoption. Cooperatives facilitate knowledge exchange, resource pooling, and social support, enhancing members' ability to adopt CA practices (Ngwira et al., 2014; Chisenga, 2015). Leadership within cooperatives plays a crucial role in promoting CA, emphasizing the need to strengthen these organizations for wider adoption. Encouraging active participation and leadership training within cooperatives can further amplify their impact.

Conclusion

The demographic and socio-economic characteristics of smallholder farmers in Hazyview reveal both opportunities and challenges for CA adoption. Gender dynamics, age distribution, education levels, and economic constraints highlight the need for targeted interventions to address barriers. Leveraging cooperative networks, enhancing access to resources, and implementing tailored educational programs can significantly improve CA uptake in the region.

4.3. Agricultural Extension Services and Adoption of Conservation Agriculture

4.3.1. Training in Conservation Agriculture by extension agents

Figure 4.5 visually represents the distribution of respondents based on their training status related to the adoption of Conservation Agriculture. Notably, the figure discloses that a substantial majority, constituting 63% of smallholder farmers, have not received any training in CA adoption. In contrast, 37% of respondents reported having received training in CA practices. This stark contrast underscores that a significant portion of farmers currently lack the essential skills and knowledge required for the comprehensive implementation of CA practices.

Furthermore, the data indicates that training plays a statistically significant role in influencing the adoption of CA. Specifically, farmers who have undergone training in conservation agriculture exhibit a greater propensity to embrace these practices. This observation aligns with prior research conducted by Bisangwa (2013) in Lesotho, Ntshangase et al. (2018) in South Africa, and Chisenga (2015) in Malawi, all of which consistently demonstrated a positive correlation between CA training and the adoption of CA practices. More recent studies have reinforced this finding, indicating that targeted training programs significantly enhance farmers' understanding and implementation of CA techniques, leading to improved agricultural outcomes (Morgan & Gambiza, 2022; Lee & Gambiza, 2022).

These findings underscore the paramount importance of implementing robust training and capacity-building programs for farmers to augment their comprehension and proficiency in CA techniques. The provision of training initiatives can be a pivotal factor in enhancing the adoption of CA practices among smallholder farmers and elevating the overall quality of their agricultural endeavours. As highlighted by the study conducted by Tufa et al. (2023), the integration of practical demonstrations and hands-on training in CA practices has been shown to increase adoption rates and improve farmers' confidence in implementing these techniques effectively.

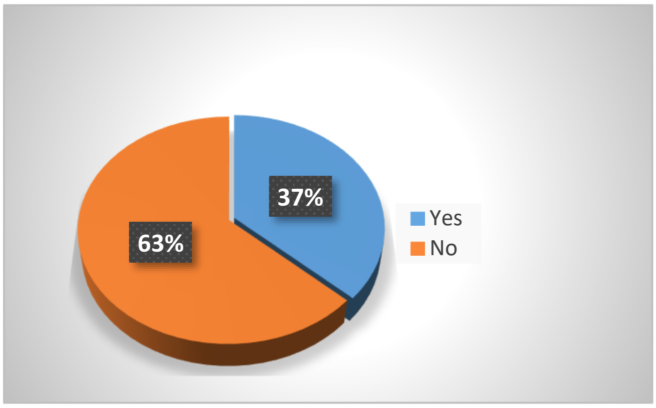

Figure 4.1: Training in Conservation Agriculture
Source: Field Survey 2022

4.3.2. Extension visit

Table 4.6 presents data concerning the interaction dynamics between smallholder farmers and extension agents in the context of adopting CA. The table reveals a noteworthy finding: every smallholder farmer in the study area received visits from extension agents, whether on a one-time or recurring basis. This unequivocally signifies that extension officers had ample opportunities to engage with farmers and promote CA practices. When compared to the research of Ortmann and King (2007), who reported that government extension consultants in developing nations usually visited smallholder farmers once or twice a year, it becomes evident that the farmers in this study experienced more frequent interactions with extension agents. This suggests that extension officers had greater chances to disseminate information and offer support related to CA adoption during their visits.

Additionally, the table underlines the strong preference among South African smallholder farmers for receiving information on CA adoption from local extension officers. This preference could be attributed to the fact that extension officers can communicate in a more accessible manner, avoiding complex academic terminology. Smith et al. (2016) discovered that smallholder farmers often encounter difficulties in comprehending and applying information presented in academic language. Prior studies conducted by Akpalu (2013) and Carlisle (2016) have demonstrated that smallholder farmers with access to high-quality extension services are more inclined to embrace CA practices. Conversely, Marenya (2017) found that a lack of technical knowledge concerning proper CA implementation can impede smallholder farmers from fully adopting it.

Collectively, the data strongly suggest that the visits and interactions between smallholder farmers and extension agents assume a pivotal role in promoting and facilitating the adoption of CA practices. This underscores the paramount importance of effective extension services that furnish farmers with clear, pragmatic, and accessible information. Such services enhance farmers' understanding and competence in successfully implementing CA techniques. Recent findings by Morgan and Gambiza (2022) emphasize that consistent and targeted extension visits, coupled with practical demonstrations, can significantly improve the adoption rates of CA among smallholder farmers, thereby contributing to enhanced food security and agricultural sustainability.

Table 4. 6: Extension visits to the respondents

Variables	Frequency	Percentage
Yes	221	100
No	0	0
Source: Field Survey 2022	N= 221	100

4.3.3. Frequency of visits by Extension Officers

The frequency of extension visits is a key factor in the successful adoption of CA. Table 4.7 presents data on how often smallholder farmers in Hazyview received visits from extension officers. The results show that 28.9% of farmers were visited monthly, while 24.8% received visits twice a year, and 20.7% were visited quarterly. Additionally, 13.2% reported visits more than once a month, while 12.4% received annual visits.

These findings suggest that frequent engagement with extension officers enhances the dissemination of CA-related knowledge and improves adoption rates. Studies in South Africa indicate that farmers who receive regular visits and hands-on training are more likely to adopt CA principles than those with limited extension support (Kassam & Friedrich, 2022). The increased frequency of visits in Hazyview reflects a proactive extension service, surpassing the once-or-twice-a-year standard observed in many African nations.

Farmers who received more frequent visits expressed higher trust in extension officers, reinforcing previous studies that link farmer trust to an increase in the adoption of sustainable agricultural practices (Makate et al., 2022). Research also highlights that ongoing extension engagement helps address the concerns of farmers, reduces uncertainties, and provides practical solutions for implementing CA effectively (Kassam & Friedrich, 2022

Table 4.7: Frequency of Visits by Extension Officers

Frequency of Visits	Number of Respondents (N = 221)	Percentage (%)
Once a year	27	12.4
Twice a year	55	24.8
Quarterly	46	20.7

Monthly	64	28.9
More than once a month	29	13.2

Source: Field Survey, 2022

4.3.4. Effectiveness of Extension Services in Promoting CA

The effectiveness of agricultural extension services in promoting Conservation Agriculture is crucial for enhancing the adoption of sustainable practices among smallholder farmers. This evaluation is based on respondents' perceptions, as illustrated in Table 4.8. Approximately 37.2% of respondents rated the extension services as highly effective, correlating this perception with positive outcomes from the implementation of certain CA practices. Conversely, 41.3% viewed the services as moderately effective, indicating that while they have adopted some aspects of CA, they have not fully embraced all practices. This suggests that although farmers recognize the support provided by extension officers, significant challenges remain in achieving full adoption of CA principles.

Notably, 12.4% of respondents rated the services as less effective, and 9.1% deemed them ineffective. These ratings point to ongoing barriers hindering the full adoption of CA, which may stem from limited resources, the complexity of CA principles, or communication barriers. Research by Akpalu (2013) and Morgan & Gambiza (2022) supports the assertion that extension services must be tailored to local contexts and incorporate practical demonstrations to be more effective.

Overall, over 70% of respondents find extension services effective to some extent, even if they have not fully adopted all CA practices. The generally positive perception of extension services reflects the incremental nature of CA adoption, suggesting that farmers may still benefit from partial adoption of CA principles, which enhances their view of extension services.

Bridging the Gap: Perceived Effectiveness vs. Full Adoption

It is essential to note that while 37.2% of respondents rated the services as highly effective, this does not imply that the same percentage has fully adopted all CA practices. The perception of effectiveness may be driven by partial adoption or improvements in yield or soil quality resulting from implementing even one or two CA principles. This highlights the complexity of

CA adoption and underscores the value of continued extension support to guide farmers toward full implementation.

Table 4.8: Effectiveness of Extension Services in Promoting Conservation Agriculture

Effectiveness Indicator	**Number of Respondents (N = 221)**	**Percentage (%)**
Highly effective (Perceived full CA support)	82	37.2
Moderately effective (Perceived partial support)	91	41.3
Less effective	27	12.4
Ineffective	21	9.1

Source: Field Survey, 2022

CHAPTER FIVE
THE ADOPTION OF CONSERVATION AGRICULTURE AMONG SMALLHOLDER FARMERS

5.1. **Introduction**

In this chapter, the study presents the outcomes obtained through data collection, which primarily aimed to assess the rate of adoption of conservation agriculture among smallholder farmers in the research area. The findings are illustrated through tables and charts, and the researcher provides analysis and interpretation, aligning with the study's objectives.

5.2. **Results and Discussion**

5.2.1. Awareness of CA practices

Table 5.1 presents the respondents' level of awareness regarding various conservation agriculture (CA) practices. Most of the participants show awareness of crop rotation (90.5%), intercropping (86.0%), and mulching (63.3%). However, awareness levels drop significantly for cover crops (39.8%) and zero-tillage (22.6%). Conversely, the findings reveal a notable lack of awareness among respondents regarding certain CA practices. Specifically, the results indicate that a significant portion of participants are not aware of cover crops (60.2%) and minimum tillage (zero-tillage) techniques (77.4%). These results indicate that most respondents have a general understanding of CA practices, suggesting a potential for higher adoption rates if further training and information dissemination are provided to improve their awareness.

These findings are consistent with Langyintuo (2005), who noted that crop rotation, intercropping, and mulching concepts are well-known among farmers, possibly due to the efforts of government and non-governmental extension services. Additionally, Langyintuo and Mungoma (2008) reported that awareness of CA practices, such as crop rotation in Zimbabwe, improved because of the presence of NGOs.

Recent studies also emphasize the importance of awareness in the adoption of CA practices. According to Kassie et al. (2020), awareness and knowledge dissemination are critical factors in promoting CA among smallholder farmers. Similarly, Mupangwa et al. (2021) found that targeted extension services significantly enhance farmers' understanding and adoption of CA practices. Morgan and Gambiza (2022) further demonstrated that farmers with greater awareness of CA principles were more likely to recognize its long-term benefits, such as improved soil health and reduced erosion, thereby increasing adoption rates. Lee and Gambiza (2022) highlighted the role of community demonstrations and farmer field schools in raising awareness and promoting experimentation with CA practices. These insights collectively suggest that addressing awareness gaps through effective extension services and training initiatives can contribute to the wider adoption of CA practices among smallholder farmers in the region.

In conclusion, this report reveals varying levels of awareness among smallholder farmers in Hazyview regarding different conservation agriculture practices. While some practices enjoy high recognition, others require more attention and education. Addressing these awareness gaps through effective extension services and training initiatives can contribute to the wider adoption of conservation agriculture practices among smallholder farmers in the region.

Table 5.1: Level of Awareness of Conservation Agriculture Practices among Respondents

Practice	**Aware (n, %)**	**Not Aware (n, %)**
Cover Crops	88 (39.8%)	133 (60.2%)
Mulching	140 (63.3%)	81 (36.7%)
Intercropping	190 (86.0%)	31 (14.0%)
Crop Rotation	200 (90.5%)	21 (9.5%)
Minimum Tillage (Zero-Tillage)	50 (22.6%)	171 (77.4%)

Source: Field Survey Data, 2022 (N = 221)

Note: Respondents could provide multiple responses.

5.2.2. The ability of the respondents to adopt CA

Figure 5.1 displays the respondents' self-assessed ability to adopt conservation agriculture (CA). The data reveals that 41% of participants perceive their ability to adopt CA as poor. 23% of respondents believe they have an average ability to adopt CA, while 26% consider their ability to be very poor. Only 10% of the surveyed individuals perceive their ability to adopt CA as above average. These findings are congruent with the study conducted by Giller et al. (2015), which suggests that small-scale farmers in unindustrialized countries encounter challenges in adopting Conservation Agriculture due to various socio-economic factors.

Although farmers know CA practices, many of them do not possess the necessary skills and resources to fully apply all three CA principles on their farms (Muzangwa et al., 2017). This observation is consistent with the conclusions drawn in studies conducted by Jat, Wani, and Sahrawat (2012), Rusere et al. (2020), and Kassam et al. (2015). These studies also emphasize the challenges faced by smallholder farmers in effectively adopting CA due to prevailing socio-economic constraints.

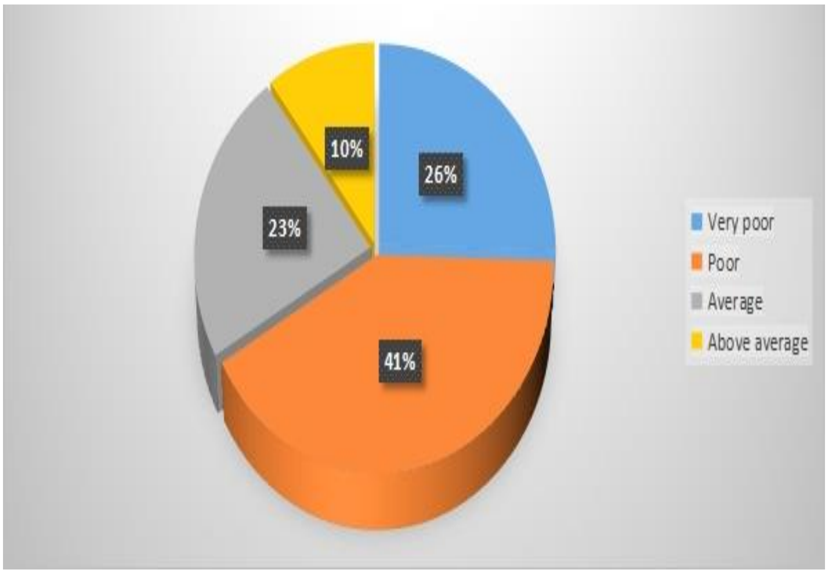

Figure 5. 1: The ability of respondents to adopt CA
Source: Field Survey 2022

5.2.3. The adoption rates of different CA practices among the respondents

The data in Table 5.2 illustrates the rates at which respondents in the study area have adopted various CA practices. The data shows that crop rotation is the most widely adopted CA practice, with 82.8% of the 221 participants indicating its use on their farms. On the other hand, minimum tillage (Zero-tillage) is among the least popular practices, with only 6.3% of respondents implementing it. Intercropping is adopted by most of the respondents, with 77.4% incorporating it into their farming systems, while 58.4% use mulching. Cover crops, however, have a lower adoption rate, with only 13.6% of respondents employing them on their farms.

These findings are congruent with research conducted by Muzangwa et al. (2017), which also reported that crop rotation is the most adopted CA practice among rural farmers. However, the results differ from the findings of Raaijmakers and Swanepoel (2020), who found that crop residues and no-tillage are highly adopted practices in South Asia. The variations in adoption rates could be attributed to factors such as regional differences, availability of resources, farmers' preferences, and the level of awareness and knowledge about different CA practices in the respective study areas.

Table 5.1: Distribution of farmers according to Conservation Agriculture practices adopted

Variables	**Frequency**	**Percentage**
Cover crops	30	13.6
Mulching	129	58.4
Intercropping	171	77.4
Crop rotation	183	82.8
Minimum tillage (Zero-tillage)	14	6.3
Total	221	100

Source: Field Survey data 2022 NB: Multiple responses

5.2.4. The adoption rate of CA according to years

Table 5.3 illustrates the historical trend in the adoption of CA practices among smallholder farmers in the study area. Prior to 2010, the adoption rate of CA was relatively low, with only 19% of farmers incorporating these practices. This figure increased to 24.9% between 2010 and 2013, indicating a gradual rise in adoption. The period from 2014 to 2017 witnessed a slight uptick in the adoption rate, reaching 26.2%. Notably, the data reveals a more substantial increase, with 29.9% of respondents initiating CA adoption between 2018 and 2021. According to DARDLEA (2021), the introduction of CA to smallholder farmers in Hazyview by extension personnel in 2010 played a pivotal role in driving its adoption.

These findings suggest that the efforts of extension agents in introducing CA have indeed contributed to its growing adoption among smallholder farmers. However, it is important to note that while there is increased adoption of certain CA practices up to the 2010-2022 cropping season, the proportion of farmers fully embracing the complete CA package remains relatively low at 11.7%. This lower rate could be attributed to the grading system employed, which assesses adoption based on the number of CA practices farmers have integrated. It implies that while some farmers have adopted specific CA practices, the comprehensive adoption of the entire CA package remains a challenge for many respondents.

Table 5.2: The adoption year of CA practices

Variables	Frequency	Percentage
Before 2010	42	19
2010-2013	55	24.9
2014-2017	58	26.2
2018-2021	66	29.9
Total	221	100

Source: Field Survey data 2022 NB: Multiple responses

$$\text{Adoption rate} = \frac{New\ adoptees}{Total\ registered} \times 100$$

$$= \frac{137}{179} \times 100$$

$$= 76.5\%$$

According to the computations, it can be deduced that 76.5% of the respondents in Hazyview have adopted at least one or more conservation agriculture (CA) practices since the year 2010. These findings suggest a substantial rise in the adoption rate of CA practices after its introduction by extension officers in 2010. These findings align with Bhatt et al. (2006), who suggested that farmers typically go through a transitional period when adopting new technologies, and there is often a time gap between their initial awareness of the technology and their eventual decision to adopt and implement it.

The data shows that a substantial portion of the respondents have embraced CA practices over the years, indicating a positive trend towards the adoption of sustainable agricultural practices in the study area. This suggests that the efforts of extension officers in promoting and disseminating information about CA have been effective in creating awareness and motivating farmers to adopt these practices.

5.2.5. Number of CA practices adopted

In this study, the adoption of conservation agriculture is categorized into three levels: low, partial, and full adoption. Full adoption is characterized by the simultaneous integration of all three CA principles, specifically minimum tillage, residue retention, and crop rotation or intercropping. Partial adoption entailed the implementation of two of these principles, while low adoption referred to the adoption of just one principle. The findings revealed that farmers seldom embraced all three CA principles concurrently, underscoring the incremental nature of CA adoption over time.

According to the data in Table 5.4, the distribution of respondents across various levels of CA adoption reveals that 67.9% of respondents adopted only one CA practice, while 20.4% have adopted two CA practices. Only a small percentage (11.7%) of the respondents have achieved full adoption by implementing all three CA principles. This indicates that the overall adoption of CA is relatively low, largely because most farmers have opted to adopt only one CA practice.

These findings are consistent with the research conducted by Tambo and Mockshell (2018), which similarly reported low rates of CA adoption in Sub-Saharan Africa (SSA). In their study, which encompassed nine SSA countries, they discovered that merely 8% of smallholder farmers had fully embraced the complete CA package. The incremental nature of CA adoption, where farmers progressively integrate various practices over time, is likely a contributing factor to the observed low adoption rates in this study and the broader SSA context.

Bridging the Gap: Perceived Effectiveness vs. Adoption Levels

The data on adoption levels presented here highlights a key point: while only 11.7% of farmers have fully adopted all three CA principles, the majority have adopted at least one or two. This partial adoption explains the relatively high ratings of extension service effectiveness reported in Chapter 4, where 37.2% of respondents perceived extension services as highly effective. Farmers may perceive benefits even from partial CA adoption, which likely contributes to the higher effectiveness ratings.

This discrepancy between perceived effectiveness and full adoption highlights the need for continued extension services to support farmers in progressing from partial to full adoption. Farmers who have adopted only one or two principles may still view extension services positively due to the incremental benefits they experience, such as improved soil health or increased yields from implementing even a single CA principle.

To bridge this gap, extension services should focus on providing targeted support and guidance to help farmers move from partial to full adoption. This may involve addressing specific challenges faced by farmers at each stage of adoption, such as access to inputs, equipment, or knowledge gaps. By supporting farmers throughout the adoption process, extension services can facilitate the transition to full CA adoption, maximizing the benefits of this sustainable agricultural approach.

Table 5.3: Number of CA practices adopted by respondents

Level of adoption	Frequency	Percentage
Low	150	67.9
Partial	45	20.4
Full	26	11.7
Total	221	100

Source: Field Survey data 2022 NB: Multiple responses

5.2.6. Satisfaction rates

According to the findings presented in Table 5.5, it is evident that a significant proportion of respondents in this study expressed dissatisfaction with conservation agriculture (CA). Specifically, 55.7% of the respondents indicated that they were unsatisfied with CA. Only a small percentage (14%) of the respondents reported being satisfied with CA. A considerable portion of the respondents (30.3%) expressed a neutral stance regarding their satisfaction with CA. These findings contradict the results reported by Mazvimavi et al. (2010), who found that the majority of smallholder farmers in developing countries were satisfied with the perceived benefits of CA, even if they had not fully embraced it. The discrepancy in findings could be attributed to various factors such as differences in contexts, farmer perceptions, and the specific challenges faced by the respondents in this study.

Furthermore, it is important to recognize that the satisfaction or dissatisfaction expressed by the respondents might be influenced by their individual experiences and perceptions of the outcomes associated with CA. The results highlighted by Giller et al. (2015), which suggest that farmers' satisfaction with CA is linked to increased agricultural productivity and reduced soil erosion, imply that the lack of contentment among the respondents in this study could be attributed to factors like limited access to resources, implementation challenges, or unmet expectations regarding the benefits of CA. A more in-depth analysis and investigation would be necessary to uncover the specific reasons behind the respondents' dissatisfaction and to identify potential areas for improvement that could enhance their satisfaction and promote the adoption of CA practices.

Table 5.4: Satisfaction rate of respondents

Rate of satisfaction	Frequency	Percentage
Dissatisfied	123	55.7
Neutral	67	30.3
Satisfied	31	14
Total	221	100

Source: Field Survey data 2022 NB: Multiple responses

5.2.7. Total land size dedicated to CA

The data presented in Figure 5.2 highlights the variation in the land size dedicated to conservation agriculture among the respondents. 46% of the respondents allocated less than one hectare of land for CA, indicating a relatively small-scale adoption. Conversely, only 11% of the respondents dedicated more than 5 hectares of land to CA, indicating a higher-scale adoption. The majority of respondents (43%) allotted a land area ranging from 1 to 5 hectares for CA.

Notably, the introduction and promotion of CA by extension agents in 2010 appear to have influenced the amount of land allocated to CA practices. As farmers accumulate experience and knowledge in CA over the years, they tend to increase the acreage dedicated to CA. This expansion can be attributed to the positive outcomes observed by farmers, such as higher agricultural yields, reduced labour costs, and improved soil quality. As these benefits become more apparent to farmers, they become increasingly inclined to allocate larger portions of their land for CA practices.

These findings are consistent with the study conducted by Meijer et al. (2015) concerning the adoption of agricultural practices and forestry innovations in sub-Saharan Africa. The results imply that the adoption of conservation agriculture is characterized not only by the partial implementation of specific practices but also by the partial allocation of farm area to CA. Similar studies conducted in Zambia by Ngoma et al. (2018) and in Malawi by Ngwira et al. (2014) have reported varying proportions of land under CA practices among adopters, providing additional support for the concept of partial adoption in terms of land area.

The diverse allocation of land for CA practices among respondents underscores the importance of comprehending the factors that influence farmers' decisions regarding land allocation. Factors such as the availability of resources, perceived benefits, and economic considerations may all contribute to determining the extent to which land is dedicated to CA. Further investigation and analysis are warranted to delve into these factors and identify strategies that can encourage larger-scale adoption of CA practices.

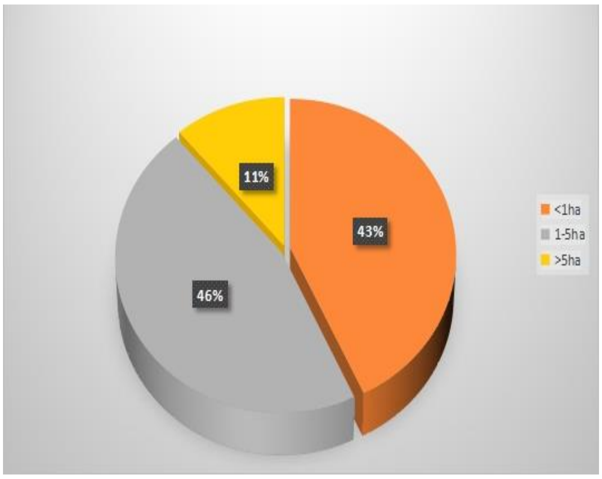

Figure 5. 2: Total size of land dedicated to conservation agriculture
Source: Field Survey 2022

5.2.8. Recommendation of CA from farmer to farmer

According to the data presented in Figure 5.3, most respondents (67%) in the study area are disinclined to recommend conservation agriculture (CA) to other smallholder farmers. In contrast, only 33% of the respondents are willing to offer advice to fellow farmers regarding the adoption of CA. These findings imply that a significant portion of smallholder farmers harbours reservations or dissatisfaction with CA, leading to a reluctance to recommend it to others. These findings are consistent with the assertion made by Ntshangase et al. (2018) that

CA may not be entirely suitable for smallholder farmers in poor countries, primarily due to its focus on long-term benefits. Consequently, there appears to be a limited inclination among farmers to recommend the adoption of CA to their peers. Smallholder farmers frequently contend with immediate economic challenges and prioritize practices that yield immediate profits or benefits. CA, with its emphasis on long-term soil health and sustainability, may not always align with the short-term economic priorities of smallholder farmers.

The reluctance to recommend CA adoption to fellow farmers may be influenced by various factors, including limited access to resources, a lack of awareness regarding the long-term benefits of CA, and challenges in implementing and sustaining CA practices. This underscores the importance of tailoring CA promotion efforts to the specific circumstances and immediate needs of smallholder farmers. To encourage wider adoption, it is essential to address the immediate economic concerns of farmers and make the potential long-term benefits of CA more tangible and accessible.

Additional research and targeted interventions are required to identify strategies that can enhance the acceptability and adoption of CA among smallholder farmers. Potential approaches may involve improving the economic viability of CA practices, offering comprehensive training and support to farmers, and effectively communicating and demonstrating the benefits of CA.

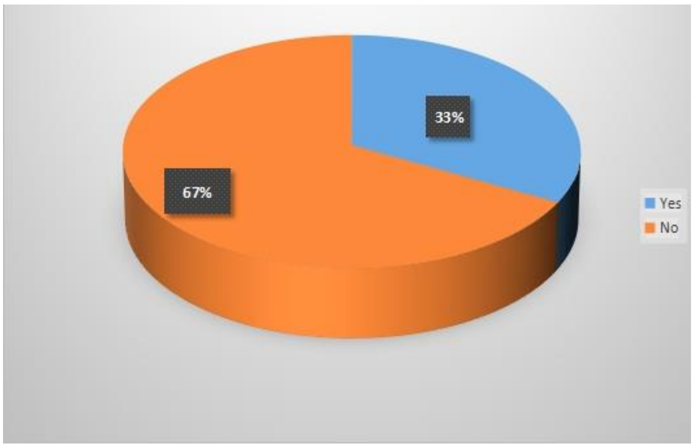

Figure 5. 3: Recommendation of CA from farmer to farmer
Source: Field Survey 2022

CHAPTER SIX

THE BARRIERS OF SMALLHOLDER FARMERS TOWARDS ADOPTING CONSERVATION AGRICULTURE

6.1. **Introduction**

This chapter presents the findings of the data collection conducted to identify the barriers hindering the adoption of conservation agriculture (CA) among smallholder farmers in the study area. The data is presented in tables, and the researcher provides an interpretation of the findings based on the study objectives. The barriers identified include inadequate financial capital, poor delivery of extension services, lack of equipment and inputs, misconceptions and preferences for traditional farming methods, lack of skills, and limited access to information. The researcher provides an overview and analysis of these barriers, highlighting their significance and implications for CA adoption.

6.2. **Barriers to the adoption of CA**

Table 6.1 presents several key barriers to the adoption of conservation agriculture (CA) among smallholder farmers in the study area. The respondents were presented with a list of eight barriers. The barriers identified include inadequate financial capital, poor delivery of extension services, lack of equipment and inputs, misconceptions and preferences for traditional farming methods, lack of skills, and limited access to information. The respondents were requested to indicate whether they were affected by each barrier (graded as Yes (1) or No (2)).

The first major barrier identified in the table is inadequate financial capital, which was cited by 74.2% of respondents. This indicates that most farmers lack the necessary financial means to adopt CA. These results align with the claims made by Makate et al. (2019b) and Abdulai (2016), highlighting the significant upfront investments required for CA, including labour, equipment, and inputs. Limited financial resources and cash flow make it challenging for farmers to afford these investments, thereby hindering the adoption of CA. However, 25.8% of respondents reported no limitations due to insufficient financial resources, suggesting that some farmers have access to financial capital or alternative means of financing their farming activities

Another significant barrier identified in the table is the inadequate extension services, mentioned by 73.8% of respondents. This finding suggests that farmers are dissatisfied with the extension services provided to them. Conversely, 26.2% of respondents did not experience inadequate extension services, suggesting that a subset of farmers receives sufficient support, potentially from well-functioning extension systems or private agricultural consultants. These farmers might have access to well-functioning extension systems or receive assistance from private agricultural consultants. Similar results were reported by Habanyati (2017), indicating that a significant proportion of households in Zambia had not received extension services in over a year. The lack of access to extension services and training can impede farmers' knowledge and understanding of CA practices, limiting their ability to adopt and implement them effectively.

A significant number of respondents, 65.2% and 63.3% respectively, identified inadequate equipment and lack of supporting inputs as barriers to the adoption of conservation agriculture (CA). This indicates that many farmers rely on manual labour using hand hoes and lack access to farm power and machinery, as well as essential inputs such as herbicides. In contrast, 34.8% of respondents did not encounter inadequate equipment as a barrier, suggesting that some farmers have access to suitable farm equipment and tools, such as tillage implements or machinery for implementing CA practices. Similarly, 36.7% of respondents were not affected by the limited availability of inputs. This suggests that some farmers have better access to inputs required for CA practices, such as seeds, fertilizers, and herbicides. They may have access to reliable input supply chains or participate in government-supported input subsidy programs. Similar findings were reported by Shetto and Owenya (2007) in Tanzania and Esabu and Ngwenya (2019) in Uganda, emphasizing the importance of appropriate machinery and inputs in facilitating CA adoption.

The table shows that 62.9% of respondents have a preference for indigenous farming (conventional farming) over CA and have misconceptions about CA, including a preference for monoculture over crop rotation. It indicates that many farmers in the study area find it difficult to abandon their traditional farming methods and embrace CA practices. However, 37.1% of respondents indicated that they did not have misconceptions or a preference for traditional farming methods. This implies that a subset of farmers in the study area has a positive attitude towards adopting CA and is open to change from their traditional practices. This finding aligns with Giller et al. (2015)'s assertion that perception plays a role in CA adoption.

Lack of skills was identified as a barrier by 61.1% of respondents, highlighting the majority of farmers' insufficient knowledge and abilities to implement CA effectively. However, 38.9% of respondents reported no lack of skills, suggesting that a significant proportion of farmers possess the necessary knowledge and skills for successful CA implementation. This aligns with the findings of Chisenga (2015), emphasizing the importance of skills and training in promoting CA adoption

Limited access to information and a lack of clear understanding of CA were barriers mentioned by 57.9% and 48% of respondents, respectively. However, 42.1% of respondents had a good understanding of CA, while 52% were not affected by limited access to information. This suggests that a significant number of farmers in the study area have access to relevant information and a clear understanding of CA, potentially through alternative sources beyond formal channels. These findings support the idea that limited information access and understanding can hinder CA adoption, as suggested by Nyamangara et al. (2013).

In conclusion, addressing the barriers to CA adoption requires interventions to improve financial resources, enhance extension services, provide necessary equipment and inputs, address misconceptions, develop farmers' skills, and enhance access to information. By addressing these barriers, smallholder farmers can overcome challenges and increase their adoption of conservation agriculture practices.

Table 6.1: Barriers to the Adoption of Conservation Agriculture Practices

Barrier	**Affected (Yes, n, %)**	**Not Affected (No, n, %)**
Limited access to information	106 (48.0%)	115 (52.0%)
Lack of clear understanding of CA	128 (57.9%)	93 (42.1%)
Insufficient financial resources	164 (74.2%)	57 (25.8%)
Inadequate extension services	163 (73.8%)	58 (26.2%)
Limited availability of inputs	140 (63.3%)	81 (36.7%)
Insufficient skills	135 (61.1%)	86 (38.9%)
Misconceptions and preference for traditional methods	139 (62.9%)	82 (37.1%)
Inadequate equipment	144 (65.2%)	77 (34.8%)

Source: Field Survey Data, 2022 (N = 221)
Note: Respondents could provide multiple responses.

6.3. **Severity level of the barriers to the adoption of CA**

Table 6.2 presents the severity of various barriers to the adoption of conservation agriculture (CA) among smallholder farmers in the study area. The respondents rated the listed eight barriers on a 3-point Likert scale as Very Severe (3), Severe (2), or Not Severe (1). The rating scale employed led to the actual mean of 2.4 being selected as the cut-off criterion. Very severe is indicated by a mean above 2.4 and not severe by a mean below 2.4. Items with mean scores equal to the cut-off criterion may be considered Severe. Using mean scores (MS) to rank the severity level of barriers as indicated by the respondents. These findings shed light on the challenges that farmers face in implementing CA practices and provide insights into the factors limiting their adoption.

The findings of the study indicate that limited availability of inputs, limited access to information, and insufficient financial resources are perceived as very severe barriers by a significant percentage of respondents. These barriers received the highest mean scores among all the barriers assessed. Specifically, "Limited availability of inputs" had a mean score of 2.56, "Insufficient financial resources" had a mean score of 2.51, and "Limited access to information" had a mean score of 2.41. These results are consistent with previous studies conducted by Nhamo and Lungu (2017) and Makate et al. (2019), which emphasize the crucial role of information availability and financial constraints in impeding the adoption of Conservation Agriculture (CA).

Additionally, the data indicates that a significant number of farmers do not perceive a lack of clear understanding of CA, limited equipment, perception, poor extension service delivery, and lack of skills as severe barriers to the adoption of Conservation Agriculture (CA). These barriers had mean scores below the cut-off criterion of 2.4. Specifically, "Lack of clear understanding of CA" had a mean score of 2.37, "Inadequate equipment" had a mean score of 2.21, "Perception" had a mean score of 2.24, "Poor delivery of extension services" had a mean score of 2.24, and "Lack of skills" had a mean score of 2.20. The findings also suggest that many farmers face challenges due to their limited understanding of CA, which contributes to the low adoption rate. This finding aligns with the assertion made by Muzangwa et al. (2017) that poor understanding, exacerbated by inadequate delivery of extension services, is a primary reason for farmers' limited awareness of CA.

These findings highlight the multifaceted nature of the challenges faced by farmers in adopting CA. The availability of equipment, farmers' perceptions about the effectiveness of CA compared to traditional methods, deficiencies in the provision of extension services, and the need for enhanced skills are perceived as less severe barriers by the respondents. Overall, Table 6.2 provides valuable insights into the severity of various barriers to the adoption of CA. It emphasizes the need for targeted interventions that address specific issues such as access to inputs, information, financial resources, training, and improved extension services. By targeting these barriers, stakeholders can effectively support smallholder farmers in overcoming the challenges and promoting the wider adoption of CA practices.

Table 6.1: Severity level of the barriers to the Adoption of Conservation Agriculture

Variables	Very Severe	Severe	Not Severe	Mean Score
Limited access to information	121(54.8)	70 (31.7)	30(13.6)	2.41
Lack of a clear understanding of CA	105(47.5)	92(41.6)	24(10.9)	2.37
Insufficient financial resources	112(50.7)	109(49.3)	0(0.0)	2.51
Inadequate extension services	90(40.7)	94(42.5)	37(16.7)	2.24
Limited availability of production inputs	123(55.7)	98(44.3)	0(0.0)	2.56
Insufficient skills	87(39.4)	92(41.6)	42(19.0)	2.20
Misconceptions and preference for traditional methods (Perception)	88(39.8)	99(44.8)	34(15.4)	2.24
Inadequate equipment	83(37.6)	101(45.7)	37(16.7)	2.21

Note: The values in the parentheses are percentages, N = 221

Source: Field Data 2022

CHAPTER SEVEN

PERCEIVED BENEFITS OF ADOPTING CONSERVATION AGRICULTURE

7.1. **Introduction**

This chapter presents the findings of the data collection process, focusing on the perceived benefits of adopting conservation agriculture (CA) among smallholder farmers in the study area. The results are presented in tables and charts, along with the researcher's interpretation, in line with the objectives of the study.

7.2. **Perceived benefits of adopting CA**

Table 7.1 presents the perceived benefits of adopting conservation agriculture (CA) among farmers in the study area. The respondents rated nine statements on a 5-point scale, and the mean scores (MS) were calculated to determine the level of agreement. A mean score above 3.0 indicates a positive perception, while a score below 3.0 indicates a negative perception.

The findings of Table 7.1 indicate that farmers in the study area had a positive perception of the benefits of adopting CA, as all mean scores were above the cut-off point of 3.0. The statements that received the highest mean scores were "controls soil erosion" (MS = 4.03), "increases production" (MS = 4.01), "saves money" (MS = 3.95), "labour saving" (MS = 3.77), "reduces soil degradation" (MS = 3.62), and "improves soil fertility" (MS = 3.49). This suggests that the majority of respondents agreed with the positive effects of CA, such as enhancing productivity, saving costs through reduced labour requirements, conserving soil by controlling erosion, and improving soil quality. These findings align with previous research by Smith et al. (2020), emphasizing the importance of CA in increasing crop productivity and mitigating soil degradation. The findings of the study supported the positive perception of conservation agriculture benefits among farmers in Southern Africa.

Despite the favourable perception of CA's benefits, the study acknowledges the low adoption rate of CA in Hazyview, suggesting that farmers' perceptions alone may not significantly influence adoption. However, the positive general perception regarding the benefits of CA in the area is promising, as it has the potential to foster the widespread acceptance and adoption of CA, consequently resulting in sustainable agricultural productivity and enhanced farmers' livelihoods. Conversely, according to Hoveet et al. (2011), despite these advantages and numerous efforts to promote CA in Southern Africa over the years, the rate of adoption remains disappointingly low, with less than 1% of arable land practising CA.

In conclusion, Table 7.1 highlights the positive perception of CA's benefits among farmers in the study area, indicating their recognition of its potential for enhancing productivity, cost savings, soil conservation, and fertility improvement. However, the study acknowledges that other factors beyond perception contribute to the low adoption rate of CA in the region.

Table 7.1: Perceived Benefits of Adopting Conservation Agriculture

Variables	Strongly agree	Agree	Undecided	Disagree	Mean score
Improves soil fertility	25(11.3)	79(35.7)	97(43.9)	20(9.0)	3.49
Controls soil erosion	42(19.0)	144(65.2)	35(15.8)	0(0.0)	4.03
Reduce soil degradation	24(10.9)	90(40.7)	107(48.4)	0(0.0)	3.62
Mitigates Climate Change	0(0.0)	48(21.7)	173(78.3)	0(0.0)	3.22
Increases production	40(18.1)	144(65.2)	37(16.7)	0(0.0)	4.01
Saves time	14(6.3)	71(32.1)	98(44.3)	38(17.2)	3.28
Control weeds and insects	64(29.0)	157(71.0)	0(0.0)	0(0.0)	3.29
Labour saving	36(16.3)	99(44.8)	86(38.9)	0(0.0)	3.77
Saves money	59(26.7)	91(41.2)	71(32.1)	0(0.0)	3.95

Note: The values in the parentheses are percentages, N = 221

Source: Field, 2022

CHAPTER EIGHT
EMPIRICAL RESULTS AND DISCUSSION

8.1. **Introduction**

This section presents the results of a binary logistic regression model that analyses the socio-economic characteristics impacting the adoption of CA practices among smallholder farmers in Hazyview. The dependent variable in the model is whether farmers have adopted CA or not, while the independent variables include age, gender, marital status, household size, education level, access to credit, average monthly income, farming experience, farmland size, extension visits, and training on CA.

Multicollinearity Diagnostics

Before running the binary logistic regression, a multicollinearity test was conducted to check for high correlations between independent variables. The Variance Inflation Factor (VIF) and Tolerance values were used to detect multicollinearity, with VIF values above 10 indicating severe multicollinearity (Gujarati, 2020). The results are presented in Table 8.1:

Table 8.1: Variance Inflation Factor (VIF) and Tolerance Test for Multicollinearity

Variable	**VIF**	**Tolerance (1/VIF)**
Age of respondents	1.81	0.553
Gender of respondents	1.34	0.746
Marital status	1.55	0.645
Household size	2.12	0.472
Level of education	2.98	0.336
Credit access	1.29	0.774
Monthly income	1.85	0.541
Farming experience	2.04	0.489
Farmland size	2.76	0.362
Extension visits	3.15	0.317

Training on CA	2.67	0.375

Interpretation:

- All VIF values are below 10, suggesting that multicollinearity is not a concern in this dataset (Gujarati & Porter, 2021).
- The Tolerance values are all above 0.1, further confirming that multicollinearity is not present.

8.2. **Binary logistic regression: The empirical results of the socio-economic characteristics impacting the adoption of CA practices among smallholder farmers**

Table 8.2: Binary Logistic Regression Results for Socio-Economic Characteristics Influencing the Adoption of Conservation Agriculture

Variable	B (SE)	P ≤	Marginal Effect
Constant	-2.609 (1.419)	0.051**	-
Age of respondents	3.147 (1.216)	0.001***	0.457
Gender of respondents	0.170 (0.296)	0.551	0.012
Marital status	-0.165 (0.150)	0.271	-0.018
Household size	-0.310 (0.204)	0.124	-0.028
Level of education	3.527 (0.985)	0.000***	0.423
Credit access	-0.039 (0.292)	0.895	-0.002
Average monthly income	-0.023 (0.372)	0.952	-0.002
Farming experience	-0.036 (0.129)	0.782	-0.003
Farmland size	-0.202 (0.470)	0.668	-0.017
Extension visits	3.179 (1.298)	0.001***	0.453
Training on CA	2.049 (1.087)	0.049**	0.257

Model Summary

- **Prob > Chi²**: 0.000
- **Log-likelihood**: -389.95
- **Pseudo R²**: 0.072
- **Heteroskedasticity Test**:
    - Chi² = 0.430; Prob > Chi² = 0.449
- **Goodness of Fit Test**:
    - Chi² = 4.700; Prob > Chi² = 0.789

Notes

1. **Significance Levels**:
   - $p \leq 0.05$ (**): Statistically significant at the 5% level.
   - $p \leq 0.01$ (***): Statistically significant at the 1% level.
2. **Marginal Effects**:
   - Calculated at the mean values of the independent variables.
   - Indicate the change in the probability of adopting Conservation Agriculture (CA) for a one-unit change in the respective variable, holding all else constant.

8.2.1. Discussion of Significant Variables

8.2.1.1. Age of Respondents

Age was found to have a significant positive effect on the adoption of conservation agriculture (CA), with an estimated coefficient of 3.147 and a standard error of 1.216. The result is statistically significant at the 1% level ($p \leq 0.01$), and the marginal effect (0.457) suggests that older respondents are more likely to adopt CA.

This finding aligns with prior studies, such as Agholor and Sithole (2020) and Kedir et al. (2022), which also found a positive association between age and the adoption of sustainable farming practices. Older farmers are often more experienced, possess greater knowledge of farming systems, and are more likely to have the resources needed to implement CA effectively. Sithole et al. (2019) highlight that experience and accumulated skills play a crucial role in facilitating adoption, further reinforcing this result.

8.2.1.2. Level of Education

The level of education was a significant determinant of CA adoption, with a coefficient of 3.527 (SE = 0.985) and a marginal effect of 0.423. This variable was also statistically significant at the 1% level ($p \leq 0.01$). The findings suggest that higher educational attainment significantly increases the likelihood of adopting CA practices.

These results corroborate those of Azam (2015), who noted that educated farmers are better positioned to comprehend and implement innovative farming technologies. Similarly, Chavula et al. (2020) reported that education enhances farmers' decision-making capabilities, enabling them to adopt sustainable agricultural practices. In the context of Hazyview, education likely equips farmers with the technical knowledge and critical thinking skills necessary for understanding the benefits and application of CA techniques.

8.2.1.3. Extension Visits

Extension visits emerged as a strong factor influencing CA adoption, with a coefficient of 3.179 (SE = 1.298) and a marginal effect of 0.453. This variable was significant at the 1% level ($p \leq 0.01$), highlighting the critical role of extension services in promoting CA practices among smallholder farmers.

This finding supports Giller et al. (2015), who emphasized the importance of extension services in improving farmers' knowledge and reducing uncertainties regarding new agricultural practices. Similarly, Shiferaw et al. (2019) found that frequent interactions with extension agents significantly increased the likelihood of adopting CA. In Hazyview, extension services likely play a pivotal role in disseminating CA-related information and providing technical support to farmers.

8.2.1.4. Training on CA

Training on CA was also positively associated with its adoption, with a coefficient of 2.049 (SE = 1.087) and a marginal effect of 0.257. This variable was significant at the 5% level ($p \leq 0.05$), suggesting that participation in CA training programs substantially improves the odds of adoption.

Abadi et al. (2021) similarly noted that access to training and demonstrations significantly influences farmers' acceptance of new agricultural technologies. Training provides practical, hands-on experience, helping farmers understand CA's benefits and applications. In the Hazyview context, training activities likely bridge knowledge gaps, enabling smallholder farmers to adopt CA practices with confidence.

8.3. Summary of Key Findings

The results highlight four socio-economic factors significantly influencing the adoption of CA practices in Hazyview: age, education level, extension visits, and training. These findings underscore the need for targeted interventions to:

1. Encourage participation in training programs.
2. Improve access to and frequency of extension visits.
3. Promote educational initiatives tailored to farmers' needs.

4. Acknowledge the role of age-related experience in CA adoption strategies.

Such interventions can foster widespread adoption of CA, contributing to sustainable agriculture and improved food security in the region.

CHAPTER NINE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

9.1. **Introduction**

This chapter provides a condensed overview of the study's findings, including a discussion, conclusion, and recommendations. The results of the study are summarized, highlighting how each indicator influenced the research objectives. The conclusion presents the researcher's findings about the research objectives and offers recommendations for future research based on the findings.

9.2.**Summary of findings**

The study aimed to evaluate the adoption of CA among smallholder farmers in Hazyview, Mpumalanga, South Africa, focusing on two local communities: Shabalala and Sanbonani. The research was guided by four specific objectives.

The study's population was predominantly female, comprising 62.9%, with no notable differences in CA adoption rates between male and female-headed households. Although women played an active role in farming, their contributions were often overlooked in extension services. Age distribution revealed that 38.5% of farmers were over 60 years old; while older farmers generally resisted new practices, some adopted CA due to their experience and social connections. Marital status did not significantly affect CA adoption, but low educational attainment (with 35.3% lacking formal education) emerged as a barrier, as higher education levels correlated with improved adoption rates.

Most farmers had small family sizes (1-5 members), which may have motivated them to explore new agricultural practices for food security and economic reasons. Over 60% of respondents were unemployed and primarily depended on farming for their income, emphasizing the critical role of agricultural productivity in their livelihoods. Many farmers had substantial farming experience, typically ranging from 5 to 10 years; however, older farmers were less likely to adopt new practices unless convinced of their advantages.

All farmers reported some interaction with extension agents, which was linked to higher adoption rates. Despite this contact, many had not received specific training in CA; those who did were more inclined to adopt CA methods. Awareness of CA practices was generally low, with crop rotation being the most recognized and practiced method, while zero tillage saw the least adoption. Despite these knowledge gaps, farmers held positive views on the benefits of

CA, recognizing its potential to control soil erosion, enhance productivity, save costs, and lessen labor demands.

Regression analysis indicated that factors such as older age, higher education levels, frequent visits from extension agents, and training related to CA positively influenced the likelihood of adopting CA practices.

9.3. **Conclusion**

In conclusion, this study found that smallholder farmers in Hazyview, Mpumalanga, South Africa, generally held positive perceptions of the benefits associated with CA. However, despite these positive perceptions, significant barriers continue to hinder the widespread adoption of CA practices. The study revealed that 67.9% of respondents had adopted only one CA practice (low adoption), 20.4% had adopted two CA practices (partial adoption), and only 11.7% had fully implemented all three principles of CA. This relatively low full adoption rate is consistent with findings from other studies in Sub-Saharan Africa.

Despite the low full adoption rate, the null hypothesis that there is no adoption was rejected in favour of the alternative hypothesis (Ha), confirming that smallholder farmers in Hazyview have adopted certain aspects of CA, particularly practices such as crop rotation and minimum tillage. The relatively high percentage of farmers adopting at least one or two CA principles suggests a foundation for potential future expansion in full adoption, but it also underscores the need for continued support and targeted interventions to address the existing barriers.

The effectiveness of extension services in promoting CA also emerged as a key factor. Approximately 37.2% of respondents rated the extension services as highly effective, while 41.3% viewed them as moderately effective. These findings highlight the importance of extension services in promoting CA practices, although challenges such as communication issues and farmers' limited capacity to invest in new technologies persist.

Recommendations

Based on the findings, the following recommendations are proposed to enhance CA adoption rates in Hazyview, Mpumalanga:

1. **Context-Specific Extension Services**: Extension services in Hazyview should focus on improving the quality and frequency of support offered to farmers. Although all

respondents received some form of extension contact, many still face barriers in adopting Conservation Agriculture. Extension agents should provide practical, tailored guidance to help farmers integrate multiple CA principles. Emphasis should be placed on clear, step-by-step demonstrations and more frequent follow-ups, especially for farmers with limited education or older farmers who may be resistant to change. Extension programs should also prioritize gender-sensitive approaches, ensuring women receive adequate support to overcome existing barriers to adoption.

2. **Customized, Hands-On Training Programs**: The study highlights a need for localized, hands-on training that considers farmers' specific educational backgrounds, ages, and gender. Farmers with lower levels of formal education and older farmers may need training that is visual, simplified, and hands-on to help them understand CA practices better. Training should focus on practical demonstrations of each CA principle, starting with basic practices such as crop rotation, and progressing gradually to more advanced practices like zero tillage. Gender-inclusive training is crucial to ensure women farmers are not left out of the adoption process.
3. **Improved Resource Access and Financial Support**: Given the resource constraints identified in the study, it is essential to provide smallholder farmers with direct access to the necessary equipment to implement CA, such as no-till machinery and mulching materials. Additionally, financial support mechanisms, such as subsidies or microloans, should be introduced to help farmers overcome the financial barriers to acquiring these resources. This is especially important for farmers who rely solely on farming for their livelihood and face financial limitations.
4. **Tailored Communication Strategies**: Communication strategies should be adapted to the specific needs of the farmers in Hazyview. Extension agents should use simplified language, local dialects, and visual aids such as diagrams, charts, and videos to make CA principles easier to understand. This is particularly important for farmers with lower educational backgrounds. For older farmers, who may be more resistant to adopting new practices, extension services should rely on peer learning and encourage adoption through trusted social networks.
5. **Encourage Gradual, Incremental Adoption**: Given that farmers in Hazyview are already familiar with and practicing some CA principles (e.g., crop rotation), extension services should promote incremental adoption of CA practices. Rather than expecting farmers to adopt all three CA principles simultaneously, they should be encouraged to

begin with what they know and gradually integrate more complex practices, such as zero tillage. Extension agents should offer continuous support throughout this process, ensuring that farmers feel confident in their ability to adopt additional CA practices over time.

Addressing these specific barriers, such as limited training, resource access, and financial constraints through targeted, customized interventions, the adoption of CA practices in Hazyview can be significantly improved. This, in turn, will lead to enhanced soil conservation, increased productivity, and greater cost savings for farmers, contributing to more sustainable agricultural practices in the region.

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