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# EXPLORING HOW SUBSISTENCE FARMERS VIEW THE BENEFICIAL EFFECTS OF CONSERVATION AGRICULTURE AND ITS ADOPTION IN MOPANI DISTRICT, LIMPOPO PROVINCE (RSA)

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**Abstract:** Soil erosion rates are escalating due to intensive agriculture and unsustainable practices, presenting significant challenges for small-scale farmers. To address this issue, the adoption of Conservation Agriculture (CA) is essential, requiring commitment from stakeholders and adjustments in tillage methods. The primary objective of this research was to statistically assess farmers' perceptions of the benefits of CA. The aim was to investigate the extent to which technical knowledge and perceived economic and environmental benefits correlate with and predict farmers' intention to implement CA practices. A quantitative research approach with purposive sampling was used. Primary data were collected using questionnaires developed with Evasys software from the University of the Free State. Physical copies of bar-coded EvaSys questionnaires were distributed for self-administration. The data were organized and analysed using Microsoft Excel and the Statistical Package for the Social Sciences (SPSS), utilizing descriptive statistics such as means, standard deviations, and score ranges to present the results. Thirty-five farmers met the study's criteria, with females representing 56.3% and males 43.8%. Most participants were between 36 and 60 years old. Farmers expressed positive views on CA, citing benefits such as increased yields, reduced costs, and improved soil structure. Their motivations for adopting CA included economic benefits, reduced risks, and improved environmental outcomes. Participants demonstrated a strong understanding of CA principles, including minimum soil disturbance and crop diversification. Their positive attitudes were linked to benefits like effective erosion control and improved soil health, underscoring the importance of CA for sustainable farming. These findings can inform policy by aligning government support with farmers' needs. Understanding farmers' views on CA is crucial for enhancing extension services and promoting its adoption, ultimately improving food security, climate resilience, and environmental sustainability.

**Keywords:** subsistence farmers, conservation agriculture, sustainable agriculture adoption, Mopani district, South Africa

## 1. Introduction

There is a need to increase food production to meet the needs of the growing population, while on the other hand, the land must be protected by reducing environmental impact (Foley et al., as cited in Giller et al.

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2015). Cameron et al. (2015) argued that meeting the needs of a growing world population can be challenging, as dietary preferences change daily, especially in food production, which is resource-intensive. Swanepoel et al. (2017) stated that high levels of soil degradation and decreased soil fertility pose a danger to agricultural productivity.) He further indicated that droughts lead to complete crop failure, and as a result, the growing population system became pressure-stressed. Suraj and Behera (2014) concur that alleviating poverty, ensuring food security for a growing population, and maintaining agricultural systems on diminishing natural resources, together with the adverse effects of climatic inconsistency, pose a serious challenge. Zanella et al. (2015) maintain that one of the main ecosystem services in food production depends largely on well-functioning, well-managed soil and on the maintenance of the four pillars of food security, namely food access, availability, utilization, and stability. Therefore, conquering food security for a population that is growing and alleviating its poverty, and at the same time sustaining its agricultural systems in diminished natural resources and negative impacts of climatic variability can be challenging (Suraj & Behera 2014).

Theophilus and Boateng (2015) argue that one of the oldest ways of managing the environment, especially by individuals, is agriculture; however, this has led to uncaring and inappropriate agricultural practices that have caused environmental sustainability distress. Another aspect highlighted by Rolila et al. (2017) is that agricultural farming methods are a basic way of life and have been around for many years; however, the environmental sustainability impacts of agricultural practices influence present and future climate change effects. Kuhlman and Farrington (as cited in Theophilus & Boateng, 2015) maintain that factors such as climate change, global population growth, and income growth pose threats to food security, ecosystems, and the economy. According to Cameron et al. (2015), policies on agricultural development have been successful over the last five decades in increasing food production by emphasizing the use of external inputs such as mechanization, fertilizers, chemicals, and pesticides. However, it was later discovered that high productivity from conventional agricultural practices led to serious environmental degradation (Asghar, 2010). Johan et al. (2008) suggest that, to sustain ecology, economy, and the provision of food for the growing population, farmers need to be wise in their adoption of agricultural production methods. There is a broader concern about soil productivity and the environmental implications of conventional agricultural practices in many regions worldwide, as they involve the maximum use of soil tillage, such as disk or hoe (Knowler & Bradshaw, 2007). Wolff and Stein (as cited in Suraj & Behera, 2014) concur that agricultural production systems that are mostly tillage-based, with extensive mechanization, contribute to soil erosion, groundwater pollution, biodiversity loss, and land resource degradation.  As a result, these concerns have led farmers and governments to seek out alternatives for food production approaches that will sustain productivity and maintain the soil structure (Theophilus & Boateng 2015).

According to Corrie et al. (2017), production methods such as conservation agriculture (CA) should be encouraged as an alternative approach to sustaining, regenerating, conserving, and replenishing soil organic matter, as it improves and maintains soil health. Mutiu et al. (2015) concur that the CA approach causes environmental damage in any way and that it can also be practiced on a large scale in farming. Suraj and Behera (2014) state that the achievement of production intensification, increased yields, and the enhancement of natural resources complies with the three interrelated principles, and that good management of pests can be achieved through CA, as it is known to be a resource-saving system. CA is receiving serious attention worldwide for addressing challenges associated with conventional tillage (CT), such as soil degradation and reduced crop yields (Lindah et al. 2017). Therefore, this study will focus on the concept of CA, as a large number of farmers, especially grain farmers, are putting efforts into the application of it and its adoption due to the concerns that come with intensive agricultural practices, as well as their possible effects on human beings, the economy, and the environment.

### 1.1 Literature Review and Theoretical Framework

Crop production systems involving continuous, intensive soil tillage have led to high rates of soil degradation in South Africa, especially in areas used for grain production (Naabe et al. 2017). Agricultural practices that involve the removal of crop residues and vigorous, intensive tillage expose the soil to water and wind erosion, leading to degradation. Soil degradation as a result of agricultural practices that are permanently disturbing soil affects the productivity, health, and fertility of the soil, soil structure, compaction, salinity and nutrients (Nyagumbo et al. 2014). However, all these effects can still be restored by adopting only an economically and sustainably practiced agricultural practice (Swanepoel et al. 2017). As such, conservation agriculture (CA) is considered an agricultural farming technique that, when practiced, can yield good results (Naabe et al. 2017). The CA approach is used to manage agroecosystems, improving and sustaining yields and profits, and is a tool for food security (Thierfelder et al. 2014). Therefore, this literature review will focus on what CA is and its origins, principles, techniques, and agronomic, economic, and environmental aspects, and will further examine farmers' perceptions, awareness, and intentions towards CA, as well as its current status.

#### 1.1.1. Origin – history of CA

Conservation agriculture was originally known as conservation tillage, established as a practice that conserves natural resources and as a way of responding to the drastic degradation occurring due to agricultural production (Bobby et al. 2008). Minimizing/ reducing tillage and soil cover with residues was introduced in the 1930s, following questions about fragile ecosystem tillage in the mid-west United States (Kassam et al. 2015). Zero tillage originated in the USA and was successfully practiced for decades, was adopted in Brazil as a comprehensive approach called CA, and emerged as a solution to water erosion (Landers et al. 2003). In the 1940s, the machinery for seeding development was developed to enable direct seeding without soil tillage, thereby further elaborating the principles of CA by Edward Faulkner (Kassam et al. 2015). Due to severe degradation and disasters resulting from water erosion, CA practices such as zero tillage, frequent crop rotation, and cover crops were implemented in the early 1970s in Southern Brazil as a new agricultural practice to address all challenges linked to conventional tillage (Derpsch & Friedrich 2009).

In the 1990s, CA received special attention across African countries due to increased awareness and adoption among farmers in Tanzania, Mozambique, Zimbabwe, Zambia, etc. (Addis 2016). Friedrich et al. (2012) stated that CA adoption in South America in the early 1990s was reaching a significant level and in other countries, where in millennium it gained popularity in Europe, which led to an increase in adoption, further indicate that 125 000 000 ha worldwide were under CA in 2011, as shown in table 1 due to its popularity.

*Table 1: Total area under CA worldwide (Friedrich et al. 2012).*

| Continent | Area (ha) | Percent of total |
|---|---|---|
| **South America** | 55,464,100 | 45 |
| **North America** | 39,981,000 | 32 |
| **Australia & New Zealand** | 17,162,000 | 14 |
| **Asia** | 4,723,000 | 4 |
| **Russia & Ukraine** | 5,100,000 | 3 |
| **Europe** | 1,351,900 | 1 |
| **Africa** | 1,012,840 | 1 |
| **World total** | 124,794,840 | 100 |

In South Africa, CA was introduced after tillage-based farming practices led to severe soil degradation, resulting in profitability challenges and food insecurity in some rural areas (Parwada & Van Tol, 2016). That was when the agreement was reached that CA will be the only solution to achieving a viable, sustainable, and agriculturally climate-smart climate, as shown in Figure 1 (Landers et al. 2003). As such, the only challenge in the adoption of CA is knowledge of how to apply the technique, people's mindset, sufficient policies on commodity subsidies, proper herbicides for weed and vegetation management, and access to and availability of machines and equipment (Friedrich et al. 2012).

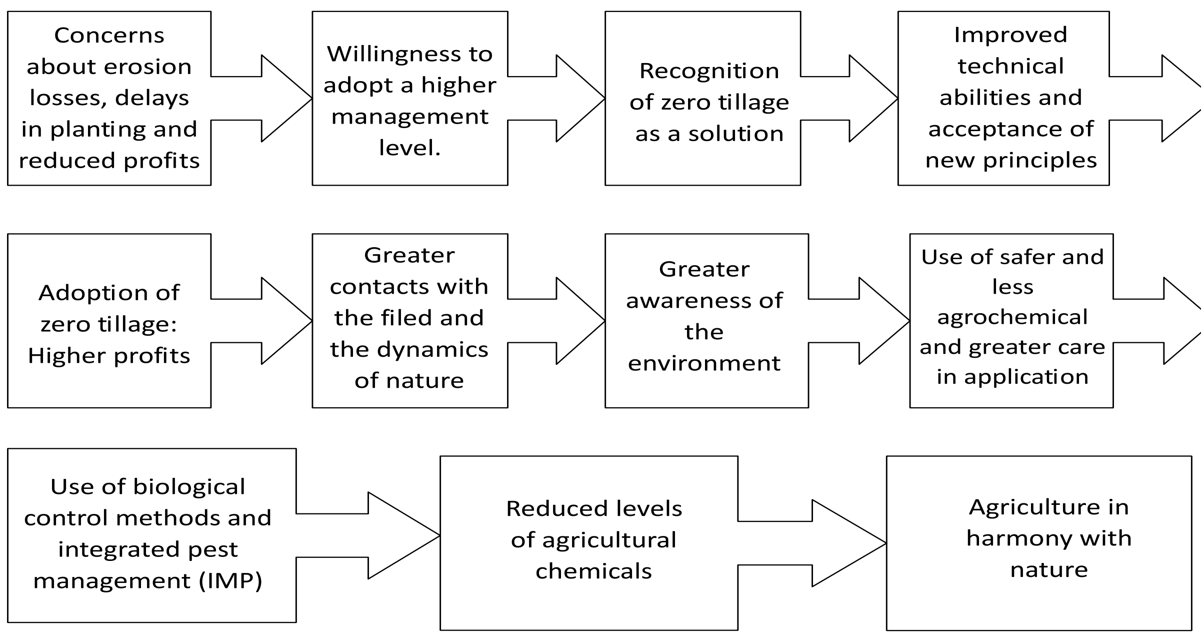

*Figure 1: Solution for attaining high profitability and productivity (Landers et al. 2003).*

### 1.1.2. CA concept

Conservation Agriculture is a concept that aims to achieve acceptable profits, conserve resources for crop production, and sustain production levels while conserving the environment (Suraj & Behera, 2014). FAO (as cited in Kassam et al. 2019) defines CA as agricultural practices that aim to promote and increase productivity and conserve soil by reducing tillage, rotating crops, and mulching. According to Thierfelder et al. (2014), CA is a system designed to address many agricultural challenges conventionally associated with soil degradation, variability, low yields, and high labor demand. Swanepoel et al. (2017) found CA to be a sustainable farming method and technique, and a possible solution to the challenges of conventional tillage, thereby improving and restoring soil health and fertility.

FAO (as cited in Friedrich et al. 2012) refers to CA as an approach to the management of agro-ecosystems to improve and sustain productivity, profit, and food security, thereby preserving and enhancing the environment and resource base. Kassam et al. (2019) define CA as a group of management principles producing crops by applying as few disturbances to the soil as possible. A tool for sustaining and managing agricultural land, an enhancer of below and above the ground of natural biological processes (Friedrich & Kienzle 2007). CA serves as an intervention, with mechanical tillage minimized to zero in some cases and external inputs applied at optimal levels to avoid interference with biological processes or disruptions (Choudhary et al. 2016). As shown in Figure 2, CA provides direct benefits for environmental issues, such as soil, air, and water quality, including land degradation, biodiversity loss, and climate change (Bobby et al. 2008). The approach now practiced by many countries to increase food production involves rebuilding soil, optimizing inputs, and operating sustainably (Virginia et al. 2015). According to Thierfelder et al. (2014), there are three principles that come with the implementation of CA, and those are minimum soil disturbance, surface crop residue retention, and crop rotations as shown in Figure 3. Suraj and Behera (2014) found that the principles of CA are mostly practiced by minimizing soil disturbance, permanently covering the soil with cover crops or crop residues to achieve high productivity.

#### 1.1.2.1 Minimal mechanical soil disturbance

Minimum soil disturbances can be applied by reducing or minimizing tillage or by avoiding excessive machinery compaction of soil and by direct seeding (Virginia et al. 2015). The process by which many pore sizes and stable soil aggregates are produced by soil biological activity is called biological tillage (Choudhary et al. 2016). Giller et al. (2015) point out that the aforementioned process is incompatible with the use of mechanical tillage because biological soil structuring processes are eliminated.

#### 1.1.2.2 Permanent organic soil cover

Maintenance of permanent soil cover can be achieved through the use of cover crops, intercrops, and mulching with organic matter and crop residues (Friedrich et al. 2012). Crop residues from the previous harvest can be used as soil cover, especially in the dry season, to retain moisture soon after harvest. Crop residues are used to protect the soil against extreme weather temperatures, soil erosion, and suppress weeds, and improve soil fertility (Pittelkow et al.2015). Crops such as cool-season grasses and/or legumes can be used as cover crops, as they can protect the soil against erosion. Friedrich et al. (2012) concur that legumes not only provide protection but also add nitrogen to the soil, which is considered to reduce the costs of fertilizers. However, in some areas, especially semi-arid areas, cover crops are not used because they are believed to compete with other crops (cash crops) for water, thereby restricting crop growth (Pittelkow et al. 2015).

Permanent soil cover by green manure or mulch complements the effects of zero tillage by building up soil organic matter, which is done by not troubling and disturbing the soil (Kassam et al.2012). FAO (2015) concurs that mulch reduces evaporation and prevents crusting by protecting the soil surface. However, Ndoli et al. (2018) argue that maintaining permanent full soil cover is difficult in places where water is a limiting factor or in very dry areas for crop production. Kassam et al. (2012) substantiate the fact that even if there is no complete soil cover, but with adequate organic matter, CA practices play a vital role in increasing productivity and building up soil organic matter.

#### 1.1.2.3 Diversification of crop species grown in sequences and/or associations

Diversifying crop rotations plays a vital role in maintaining soil health, reducing pest and disease challenges (Ndah et al. 2013). Diversification can be achieved by using appropriate crop sequences, in which nitrogen-fixing species can be planted to promote soil fertility and health (Pittelkow et al. 2015).

There are many benefits that are associated with diversification of crop rotation and those are: improves overall productivity and profitability long term; controls disease, pests and weeds; improves the fertility of soil; and assists in reducing the failures of crops, especially when there is an outbreak of disease and drought (Kassam et al.2012).

### 1.1.3. Theoretical framework

CA adoption as an innovation often involves multiple processes, including the application of behavioral theories. As exemplified in Figure 2 below, this study is grounded in the Diffusion of Innovations Theory (DOI) and the Theory of Planned Behavior (TPB) because they effectively categorize CA attributes and provide a robust framework (Rogers, 2003; Ajzen, 1991). The DOI framework comprises five key variables: Relative Advantage, Compatibility, Complexity, Trialability, and Observability, all of which play a fundamental role in shaping adoption rates. This study specifically tests the hypothesis that a farmer's positive perception of CA adoption is closely linked to both environmental and economic advantages, leading to the continuation or expansion of CA practices (Rogers, 2003). According to the TPB, an individual's intention to perform a behavior is often the immediate determinant of that behavior. This intention is predicted by main constructs such as attitude, subjective norm, and perceived behavioral control. Consequently, the perceptions of CA's potential benefits and the intention to adopt are central themes in this study, providing insights into the psychological drivers of adoption (Ajzen, 1991).

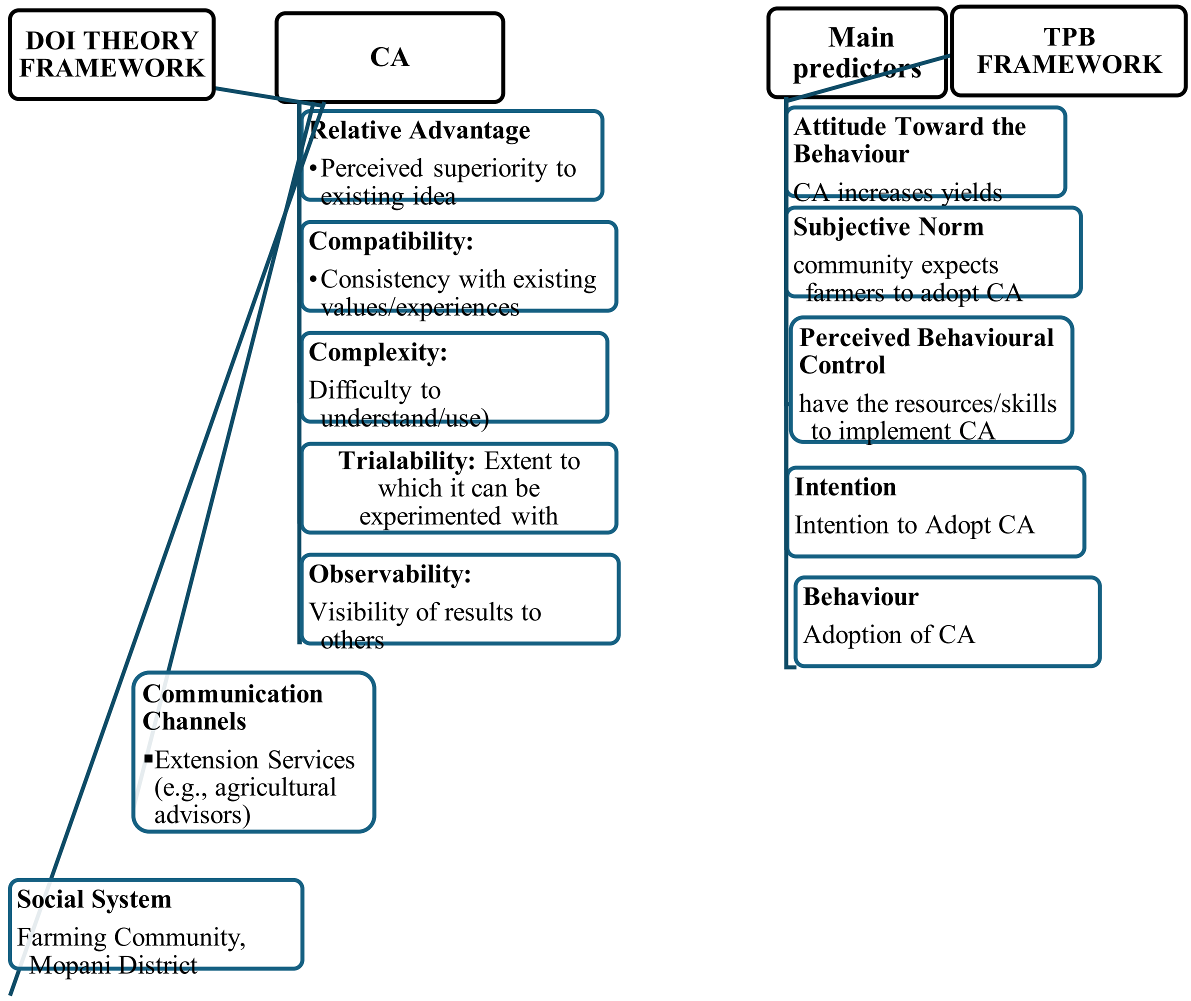


*Figure 2: Key elements of the research conceptual framework of the DOI Theory and TPB Framework.*

### 1.1.4 Problem Statement and Research Gap

Soil health globally is increasingly threatened by intensive agricultural practices that prioritize short-term yields over long-term ecological sustainability (Lal, 2015). This issue is exacerbated by factors such as excessive soil ploughing, monocropping, and reliance on chemical inputs. If not addressed, these practices can lead to escalating rates of soil erosion, biodiversity loss, and environmental degradation

(Kassam et al., 2012). In developing countries, including South Africa, the impacts of these challenges are particularly acute, jeopardizing the livelihoods of a significant portion of the population that depends on agriculture. In Southern Africa, agricultural sustainability is significantly compromised by environmental degradation, manifesting as accelerated soil erosion and declining soil fertility (Lal, 2015). In South Africa, particularly in the Limpopo province, the economy is heavily reliant on subsistence farming, which is vulnerable to erratic climatic conditions and poor land management practices stemming from intensified conventional agriculture (Moeletsi & Hamandawana, 2022).

Conventional agricultural systems, characterized by intensive tillage and contemporary farming inputs such as modern machinery, chemicals, and fertilizers, contribute to the decline in soil health, increased resource degradation, and rising operational costs. Limpopo, as a major contributor to the country's agricultural output, continually faces challenges related to its semi-arid climate and land degradation. Moreover, the province is expected to support a large segment of smallholder and subsistence farmers, further complicating the sustainability of the agricultural sector (Moeletsi & Hamandawana, 2022). On the other hand, the country is not known to be rich in agricultural resources and is often more susceptible to degradation due to its naturally low SOM (Corrie et al. 2017). According to Rohila et al. (2017), soil erosion rates are increasing in their natural habitats, and the environmental impacts are driven by the intensification of agriculture, which shows unmanageable resource use and the use of contemporary production inputs such as fertilizers, chemicals, and modern machinery. The majority of small-scale farmers face a significant challenge posed by soil erosion (Njabulo et al. 2018). Across various countries, the adoption and spread of CA require the commitment of all stakeholders and the transformation of tillage to CA systems, which necessitates a full understanding of the environmental, economic, and social benefits offered by the systems (Amir et al. 2014).

In response to these challenges, the agricultural sector, through its extension and advisory services, advocates for CA as a viable solution. Defined as an environmentally friendly farming system, CA is based on three core principles: minimum soil disturbance (or no-till), permanent soil cover with crop residues or cover crops, and crop rotation or diversification of species (FAO, 2020). Although the agronomic and ecological benefits of CA are well-documented globally, its adoption is hindered by barriers related to knowledge, perception, and socioeconomic factors among small-scale farmers. The adoption rates of CA among these farmers remain inadequately understood, despite policy promotion within the district. Addressing CA adoption involves multiple behavioural processes that shape farmers' knowledge and perceptions regarding the effectiveness of innovation (Ajzen, 1991). Consequently, there exists a gap in quantifying how farmers view the benefits of CA, whether they are currently practicing it or have been exposed to it, particularly regarding the balance between challenges and the economic and environmental gains. This study aimed at investigating the extent to which technical knowledge and perceived economic and environmental benefits correlate with and predict the intention of farmers in the Mopani District to implement Conservation Agriculture practices. Therefore, this study was designed to achieve the following primary objectives as follows:

- ✓ To quantify the level of technical knowledge held by farmers in the Mopani District with regard to the three core pillars of CA.
- ✓ To assess the mean perception scores of farmers attributed to the economic viability and environmental impact of CA.
- ✓ To measure the strength of farmers' intentions to adopt CA practices in the next three to five years by making use of a standardized Likert scale.
- ✓ To determine the statistical correlation between a farmer’s level of knowledge and their perceived economic and environmental benefits of CA thereof.
- ✓ To identify significant demographic predictors influencing a farmer’s intention to implement CA techniques.

## 2. Materials and Methods

### 2.1 Study Area and Participants

The research was conducted in the Mopani District Municipality of Limpopo Province, South Africa, specifically covering five local municipalities: Greater Giyani, Greater Letaba, Greater Tzaneen, Maruleng, and Ba-Phalaborwa. This area is characterized by a high population of small-scale farmers operating under diverse agro-ecological conditions.

The target population consisted of small-scale farmers actively practicing at least two of the three core principles of CA, ensuring the inclusion of an informed cohort. The criteria for inclusion were:

- Active practice of CA (specifically no-till, soil cover, and crop rotation)
- Age between 25 and 65 years
- Ability to read and write (to ensure reliable comprehension of the survey instrument)

### 2.2 Study Design, Sampling, and Size

An exploratory design was adopted in this study because it enables the researcher to identify the causes and factors underlying a given problem (Goertzen, 2017). According to McPeake et al. (2014), exploratory design aims to define the exact problem, thereby collecting information relevant to it; furthermore, it helps identify unknowns and alternative ways to address the problem. Another aspect highlighted by Dhawan et al. (2017) is that exploratory design helps answer questions such as “what” and “how”. Therefore, to answer the research questions of this study, this design was particularly valuable for its effectiveness in identifying problem causes and for guiding research activities accordingly.

For the purpose of this study, a quantitative research design was adopted, as it enables researchers to familiarise themselves with the problems and concepts to be studied. Moreover, it focuses primarily on the data to be measured and answers the "how" and "what" questions of a given situation in an effective manner. To ensure that participants are adding value to the purpose of this research, 32 farmers who met the set criteria were considered to achieve significant results. According to Burns and Grove (2009), for a study to obtain precise results, sample size, especially in quantitative research designs, requires a large sample to avoid sampling error, as smaller samples of less than thirty (30) yield results that are less precise, and too much sample size reduces efficiency. According to Creswell (2013), a proper sample size ranges from 30 to 500 participants; 32 participants were included in this study to ensure reliable results.

**2.3 Data Collection Instrument**

In order to obtain the objectives of this study, a survey in the form of a structured, pre-tested questionnaire as an instrument to collect data was appropriate, as survey research is flexible and appears in many forms or ways of collecting data by telephone or face to face, postal, pencil and paper questionnaires, web-based and emails (McPeake et al. 2014). To reach the desired number of respondents, hard copies of the barcode-enabled EvaSys questionnaires were created using the University of the Free State's software, printed, and either self-administered or distributed to participants face-to-face for data collection. The University of the Free State's Evasys software enables the researcher to obtain information from the expected number of respondents, guarantees objectivity and reliability, and is the most affordable way to gather quantitative data, as costs are very low (Debois, 2016). The instrument was developed based on the existing literature and divided into four main sections, using a combination of Likert-scale, open-ended, and categorical response options. The sections covered the following aspects:

- Socio-demographics (such as age, gender, and education)
- Knowledge and practice of CA, focusing on principles and duration of practice
- Perceptions and intentions towards CA measured on a Likert scale (1 = Strongly Disagree to 5 = Strongly Agree)
- Economic and environmental impact assessment, including cost savings estimates and observed ecological effects

Each questionnaire was accompanied by a covering letter signed by the researcher, explaining the purpose of the study and providing guidance on how to answer the questions. The letter also emphasized the value of the participants' responses and included the name and contact information of the responsible researcher.

### 2.4 Ethical Considerations

The proposal was submitted to the University of Free State's ethical committee for approval before data collection commenced. Upon receiving approval, the researcher drafted a covering letter to inform participants of the study's aim, the significance of their responses, and assurances regarding privacy, confidentiality, anonymity, and voluntary participation. During data collection, respondents were asked to sign a consent form indicating their willingness to participate in the study.

### 2.5 Limitations of the Study

The study initially aimed to target 50 farmers to align with its objectives. However, due to a limited number of farmers practicing CA in the area, the sample size was reduced to 32 respondents. This smaller sample presents a limitation, as it may not adequately represent the entire population of CA farmers, making it challenging to examine relationships between variables. Additionally, some respondents skipped questions, which could affect the reliability of the findings.

The primary limitation of this study was the small purposive sample size (N=32), which restricts the generalizability of the quantitative findings to the broader non-adopting population of the Mopani District. Although the study was originally intended to employ a mixed-methods approach, it was conducted during the middle of the COVID-19 pandemic. This situation compelled the researchers to adopt a quantitative approach, given measures implemented to curb the spread of the virus. As a result, the study suggests that integrating qualitative research in the future would provide a more comprehensive understanding of the topic. Despite the limitations and challenges faced during this research, it achieved its objectives.

### 2. 6 Data Analysis

The data was analysed using Descriptive Statistics to identify frequencies, percentages, and means, which helped summarize the views and pinpoint central tendencies in farmer perceptions. Factor Analysis was used to group the perceived benefits into key underlying driving forces, including economic, environmental, and risk-reduction factors. All statistical analyses were conducted using SPSS version 27.

## 3. Results and Discussion

### 3.1. Demographic profile of the Respondents

The demographic characteristics of the study participants revealed that, out of the 32 respondents, females comprised 56.3%, indicating that the majority of individuals practicing CA in the area were women. In contrast, males represented 43.8%. As shown in Table 2 below, most participants were aged between 36 and 60 years. Other studies have confirmed that age significantly influences the adoption of CA, with older farmers more likely to adopt no-till practices than their younger counterparts (Njabulo et al., 2018). Regarding educational attainment, the majority of respondents held a grade 9 to 12 qualification (31.3%) and a post-matric qualification (43.8%). Research indicates that higher education levels increase the likelihood of adopting CA, as better education facilitates the acceptance of new innovations. Typically, educated farmers tend to be younger than those with lower educational attainment. However, among the educated group, older farmers are predominant, likely due to their accumulated knowledge and experience, which enables them to access resources more effectively

*Table 2: demographic profile of the study participants*

| Variable | Description | Frequency | Percent ( %) | Valid Percent |
|---|---|---|---|---|
| Genda | Male | 14 | 43,8 | 43,8 |
| | Female | 18 | 56,3 | 56,3 |
| | Total | 32 | 100,0 | 100,0 |
| Age | 26-30 | 1 | 3,1 | 3,1 |
| | 31-35 | 3 | 9,4 | 9,4 |
| | 36-40 | 8 | 25,0 | 25,0 |
| | 41-50 | 8 | 25,0 | 25,0 |
| | 51-60 | 8 | 25,0 | 25,0 |
| | 61 or older | 4 | 12,5 | 12,5 |
| | Total | 32 | 100 | 100 |
| Education | Grade R to 8 | 4 | 12,5 | 12,9 |
| | Grade 9 to 12 | 10 | 31,3 | 32,3 |
| | Matriculated | 3 | 9,4 | 9,7 |
| | Tertiary | 14 | 43,8 | 45,2 |
| | Total | 31 | 96,9 | 100,0 |
| | Missing system | 1 | 3,1 | - |
| | Total | 32 | 100,0 | |

### 3.2 Farmer perceptions towards CA

The study's results clearly show that farmers have a positive and practical view of CA. Increased crop yields and reduced production costs were the main reasons behind their favourable perceptions. Farmers' views on CA were largely positive and directly connected to operational and sustainability aspects. The core perceptions driving positive attitude towards CA, as shown in Table 3 below, the most cited were that CA increases crop yield, saves production Costs, improves mechanisation Compatibility, climate change adaptability and is uncomplicated to apply

*Table 3: Farmers perceptions towards CA and its adoption*

| Perception | Mean Likert Score, 1-5 | Explanation/interpretation |
|---|---|---|
| Increase of crop yields | 4.61 | high agreement and most direct and immediate economic motivator |
| Savings in production costs | 4.50 | high agreement and Direct link to financial sustainability |
| Compatible with existing mechanisation. | 4.03 | moderate to high agreement and farmers perceive CA as viable within the current or planned farming systems. |
| Better to practice than conventional agriculture | 4.19 | In high agreement and the system is perceived as easier to practice and not as complicated as compared to the conventional method |
| Mechanisation to adapt to climate change | 4.38 | In high agreement and linked to minimal or reduced risks |

### 3.3 Factors Driving Adoption Intention

The primary motivation for adopting CA was the desire to increase crop yield, thereby improving profits and soil structure. This finding confirms that positive perceptions of these outcomes enhance farmers' intentions to adopt CA practices. The perceived benefits significantly influence the intention to continue and expand the use of CA. The key factors driving intentions to adopt CA are an increase in production and profit (91% of respondents) and soil structure improvement (84% of participants). Additionally, the importance of a long-term sustainability outlook was emphasized. Four main factors are perceived as benefits that drive the adoption of certain practices. These adoption drivers are categorized into four key areas:

- Economic Benefits: This area focuses on financial aspects, encompassing variables such as profit, cost savings related to fuel, inputs, labor, and overall market effectiveness.
- Environmental Benefits: This category addresses ecological factors, including variables that contribute to soil fertility, water quality, and the improvement of biodiversity.
- Risk Reduction: This factor is primarily associated with climate resilience. By adapting to climate change, practices can help reduce soil erosion and decrease the pressure from pests and diseases.

- Ease of Implementation: Lastly, the practices are viewed as the best farming methods because they are straightforward and easier to follow compared to conventional methods.

### 3.4 Economic Cost Savings

A significant portion of farmers (37.5%) believes that CA enhances production. Economic advantages are recognized by 25% of participants, particularly through the cost-benefit analysis of soil conservation. Notable benefits include reduced erosion costs (21.9%) and savings on fuel expenses (15.6%). A majority (59.4%) experienced an increase in crop income following the adoption of CA, while 21.9% reported a decrease and 12.5% observed no change. The implementation of CA resulted in a marked decline in labour employment, with 75% noting reduced employment levels. Overall, CA has been shown to generate savings in erosion costs, fuel and machinery expenses, production inputs, and labour, thereby enhancing financial resilience for small-scale farmers.

### 3.5 Environmental and Agronomic Benefits

Farmers shared specific ecological observations, supporting the theoretical environmental benefits attributed to CA. Notably, CA and no-till practices significantly reduce wind erosion due to a higher proportion of undisturbed soil and the advantages of abundant crop residue cover. In addition, CA practices mitigate water erosion caused by runoff by promoting water infiltration into the soil instead of allowing it to wash away (Swanepoel et al. 2017).

When asked to identify the environmental benefits associated with CA practices, responses indicated that the most frequently mentioned benefit was a reduction in soil erosion, with 56.1% of respondents highlighting this advantage. Furthermore, 33.3% noted an increase in biodiversity, while 6.7% recognized improvements in water quality. The smallest group, comprising 3.3%, reported that CA enhances air quality as shown in 3 below.

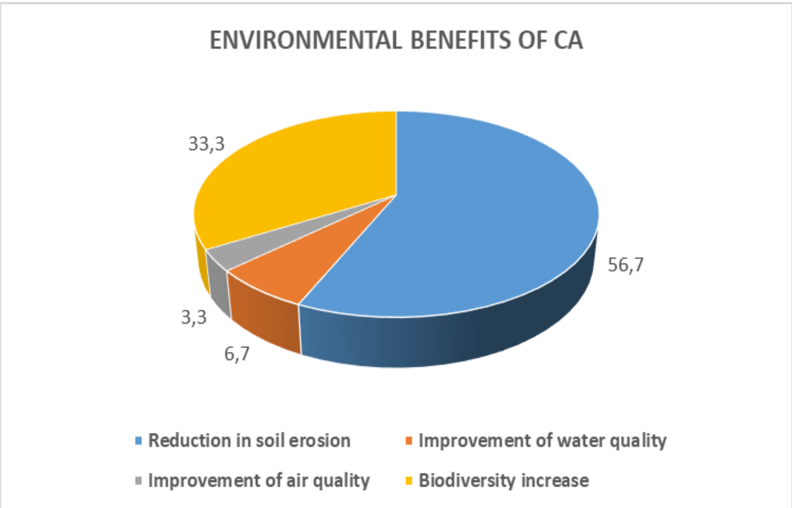

*Figure 3: Perceptions of farmers towards the environmental benefits of CA*

### 3.6 Discussion

The study highlights that smallholder farmers are primarily motivated to adopt CA due to its economic and environmental benefits. Economic drivers include increased crop yield and savings on production costs, aligning with the Relative Advantage and Attitude components of the DOI theory and the TPB. Training and resources have eased the initial learning challenges, enhancing farmers' perceived control over adopting CA. The findings underscore the importance of cost savings in fuel, labour, and erosion remediation for financially constrained small-scale farmers, supporting the concept of sustainable intensification. Reduced labour costs allow for better resource allocation towards other agricultural activities. Additionally, farmers recognize CA's benefits for improving water infiltration and reducing runoff, which is vital for climate adaptation in water-scarce regions like Limpopo. CA adoption is linked to reduced production risk and improved agro-ecosystem health, evidenced by a decrease in pest and disease pressure.

## 4. Conclusion

The study quantifies the perspectives of farmers practicing CA in the Mopani District, revealing a strong link between their knowledge, positive attitudes, and intentions regarding the economic and environmental benefits of CA. Farmers are motivated to adopt CA due to increased yields, profitability, and reduced risks from soil erosion and water management issues. Benefits include not only financial savings and higher profits but also ecological improvements, particularly in erosion control and water retention. Based on these findings, the following recommendations are proposed: Prioritizing extension messaging on financial and ecological benefits to attract non-adopters. Improving access to affordable no-till planters and providing ongoing training for small-scale farmers. Encouraging group ownership schemes or subsidies for no-till equipment. Developing policies to manage competing demands for crop residues and promote practices that maintain soil cover. Connecting CA initiatives to climate-smart agriculture frameworks to address yield reliability concerns. Conducting future research with qualitative methods and longitudinal studies to assess the impacts of CA on yield stability and soil health, including a randomized control trial comparing CA and conventional agriculture in the region.

## Declaration of Interest Statement

The authors declare that they have no conflict of interests.

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Appendix 1: Questionnaire

| EvaSys | EXPLORING HOW FARMERS VIEW THE BENEFICIAL EFFECTS CONSERVATION | Electric Paper |
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UFS — Mohlatso Anna Mnisi

Center for Sustainable Agriculture — MSA Questionnaire

Mark as shown: ☐ ☒ ☐ ☐ ☐ Please use a ball-point pen or a thin felt tip. This form will be processed automatically.

Correction: ☐ ■ ☐ ☒ ☐ Please follow the examples shown on the left hand side to help optimize the reading results.

## 1. DEMOGRAPHIC INFORMATION

1.1 Respondent gender
- ☐ Male
- ☐ Female

1.2 Age
- ☐ 16-20
- ☐ 21-25
- ☐ 26-30
- ☐ 31-35
- ☐ 36-40
- ☐ 41-50
- ☐ 51-60
- ☐ 61 or older

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

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

1.5 How long have you been farming in this area?
- ☐ Less than 5 years
- ☐ More than 5 years, but less than 10 years
- ☐ More than 10 years, but less than 20 years
- ☐ More than 20 years

1.6 Do you have any dependents?
- ☐ Yes
- ☐ No

1.7 If yes to question 1.6, how many?

[ ]

## 2. EXPLORING HOW FARMERS VIEW THE BENEFICIAL EFFECTS CONSERVATION AGRICULTURE (CA) AND ITS ADOPTION IN MOPANI DISTRICT, LIMPOPO PROVINCE (RSA)

2.1 Are you practicing conservation agriculture (CA)?
- ☐ Yes
- ☐ No

2.2 If yes to question 2.1, for how long have you been practicing CA?
- ☐ Less than 1 year
- ☐ 1-3 years
- ☐ 4-6 years
- ☐ 7-9 years
- ☐ 10 years or more

2.3 How was CA communicated to you?
- ☐ Extension officers
- ☐ From other farmers
- ☐ Researchers
- ☐ Own efforts

2.4 How would you generally describe CA practice?
- ☐ Manages agro-ecosystems
- ☐ Enhances and sustains productivity
- ☐ Enlarging the incomes
- ☐ Enhancing resource base and environment

2.5 What is your knowledge level on CA?
- ☐ Minimum soil disturbance(use of specialized equipment)
- ☐ Maximum soil cover
- ☐ Maximum stubble retention
- ☐ Diversified crop rotation

2.6 What are the benefits of crop rotation in your own understanding?
- ☐ Increased amount of yield
- ☐ Improved quality of grains
- ☐ Weed management
- ☐ Improve soil fertility

2.7 Which components of the CA package have you adopted?
- ☐ Minimum soil disturbance
- ☐ Maximum soil cover
- ☐ Diversified crop rotation

2.8 How many times do you need assistance in applying any aspect of CA practice from the extension officer?
- ☐ Never
- ☐ Once a week
- ☐ Once a month
- ☐ Twice a month

2.9 Do you think there is an increase in CA adoption in your area?
- ☐ Yes
- ☐ No

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## 2. EXPLORING HOW FARMERS VIEW THE BENEFICIAL EFFECTS CONSERVATION AGRICULTURE (CA) AND ITS ADOPTION IN MOPANI DISTRICT, LIMPOPO PROVINCE (RSA) [Continue]

2.10 What is your attitude towards the practice of CA?
- ☐ Motivated to practice CA due to its benefits
- ☐ Better to practice than conventional agriculture
- ☐ Its positive image to me
- ☐ Influence from others

2.11 What are your perceptions towards the practice of CA?
- ☐ Increase of crop yields
- ☐ Better to practice than conventional agriculture
- ☐ Savings in production costs
- ☐ Mechanism to adapt to climate change

2.12 What are your intentions of CA?
- ☐ Increasing production
- ☐ Increasing profits
- ☐ Protect the soil against erosion and nutrient losses
- ☐ Improve soil structure

2.13 State the main driving forces for adoption?
- ☐ Economic benefits
- ☐ Environmental benefits
- ☐ Reduce risk/diversify
- ☐ Best farming practice

2.14 How do you describe economic benefits of CA?
- ☐ Cost of erosion
- ☐ Saving in fuel
- ☐ Increase in production
- ☐ Analysis of cost-benefit ratio of soil conservation

2.15 How do you think CA affected your crop income?
- ☐ Increased
- ☐ Decreased
- ☐ Constant

2.16 How do you think CA affected hired and total labour employment?
- ☐ Increased
- ☐ Decreased
- ☐ Constant

2.17 Which of the following costs were affected by adopting CA?
- ☐ Fertilizer, pesticides and Herbicides demand
- ☐ Equipment cost
- ☐ Labour wages
- ☐ Output price

2.18 Based on the above question, in which ways were the costs affected?
*Fertilizer, pesticides and herbicides demand*
- ☐ Increased
- ☐ Decreased
- ☐ Constant

2.19 *Equipment cost*
- ☐ Increased
- ☐ Decreased
- ☐ Constant

2.20 *Labour wages*
- ☐ Increased
- ☐ Decreased
- ☐ Constant

2.21 *Output price*
- ☐ Increased
- ☐ Decreased
- ☐ Constant

2.22 What are your environmental concerns regarding other farming practices?
- ☐ Poor soil structure
- ☐ Soil erosion
- ☐ Reduced soil organic matter
- ☐ Soil degradation

2.23 How do you describe environmental benefits of CA?
- ☐ Reduction in soil erosion
- ☐ Improvement of water quality
- ☐ Improvement of air quality
- ☐ Biodiversity increase

2.24 Which of the following affects certain environmental components?
- ☐ Water quality
- ☐ Insect/pest attack
- ☐ Human health:Hazards
- ☐ Crop disease

2.25 Following question 2.24, to what extent where certain environmental components affected?
- ☐ Increased
- ☐ Decreased
- ☐ Constant

2.26 Generally, how did CA affect your soil condition?
- ☐ Soil moisture
- ☐ Soil temperature
- ☐ Soil compaction
- ☐ Soil fertility

2.27 Following question 2.26, to what extent does CA affect your soil?
- ☐ Increased
- ☐ Decreased
- ☐ Constant

— End —

**Thank you for your participation**

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Appendix 1: Ethical Clearance

UNIVERSITY OF THE FREE STATE
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YUNIVESITHI YA FREISTATA
UFS UV

**GENERAL/HUMAN RESEARCH ETHICS COMMITTEE (GHREC)**

26-Jul-2019

Dear Mrs Mnisi, Mohlatso Anna M

**Application Approved**

Research Project Title:
**EXPLORING HOW FARMERS VIEW THE BENEFICIAL EFFECTS OF CONSERVATION AGRICULTURE (CA) AND ITS ADOPTION IN MOPANI DISTRICT, LIMPOPO PROVINCE (RSA)**

Ethical Clearance number:
**UFS-HSD2019/0736/2507**

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

Yours sincerely

**Prof Derek Litthauer**
**Chairperson: General/Human Research Ethics Committee**

Digitally signed by Derek Litthauer
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