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Farmer perceptions and factors influencing the adoption of no-till conservation agriculture by small-scale farmers in Zashuke, KwaZulu-Natal Province

(In the Field of Agriculture)

Faculty of Science and Agriculture

Department of Agriculture

University of Zululand

Candidate: Njabulo Lloyd. Ntshangase

Student No.: 201330444

Supervisor: Dr. Melusi Sibanda

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DEDICATION

This thesis is dedicated, firstly, to my parents Mrs. M.K Ntshangase and Mr. V.L Ntshangase, for giving birth to me and supporting me spiritually throughout my life. Secondly, I would also like to dedicate this work to my family, that is, my lovely wife and children for the support, encouragement, and patience. Thank you so much.

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ORIGINALITY DECLARATION

Full Names and Surname	Njabulo L. Ntshangase
Student Number	201330444
Title of thesis	Farmer perceptions and factors influencing the adoption of no-till conservation agriculture by small-scale farmers in Zashuke, KwaZulu-Natal Province

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In particular, I confirm that I obtained an ethical clearance certificate for my research (Certificate Number UZREC 171110-030 PGM 2015/212) and that I have complied with the conditions set out in that certificate.

I further certify that this research thesis is original and that the material has not been published elsewhere, or submitted, either in whole or part, for a degree at this or any other university.

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As the research supervisor, I agree to the submission of this thesis for examination.

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Name: Dr M. Sibanda

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ABSTRACT

The adoption of conservation agriculture among small-scale farmers is still low despite the proven economic and environmental benefits of the technology. This study was conducted in Ingwe Municipality in Kwa-Zashuke, Ward 8, in KwaZulu-Natal Province. The main aim of the study was to determine the factors which influenced the adoption of no-till conservation agriculture (CA) in the study areas and to explore farmers' perceptions of no-till CA and its impact on maize yield. A quantitative approach, employing a cross-sectional design was used to gather data. Stratified random sampling was employed, and a total of 185 small-scale farmers (97 adopters and 88 non-adopters) were sampled. Data analysis was done through descriptive and inferential statistics and econometric modelling using the Logistic Regression Model.

Findings showed that farmer perceptions were positively correlated with higher maize yields. While extension visits, age, education and farmer perceptions significantly increased the likelihood of a farmer adopting no-till CA, land size was negatively related to no-till CA adoption. The study concluded that the acceptance of the technology in African communities as a new way of farming is critical for its sustainability. The findings confirm the important role of extension in the promotion of new agricultural technologies, particularly the intensity of extension services. Positive psychological capital among farmers is critical to the success of any new technologies. Access to credit or adequate financial resources is also a key factor in the adoption of CA technologies such as no-till. The study recommends a deliberate effort by all stakeholders to promote the participation of young people in farming and tailor-make current no-till CA programmes to suit the elderly and burdened households. The capacity of extension programmes to adequately support farmers should be enhanced through improvement in extension to farmer ratios. There is also need to change people's mindsets and the way they view no-till CA. Such can be achieved through training and carefully packaged information. Information dissemination channels should be able to reach marginalized and resource poor farmers in the rural communities.

Keywords: Adoption, Conversation Agriculture, No-Till, Small-scale farmer.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

AAAE	African Association of Agricultural Economists
ACT	Africa Conservation Technology Network
AGRA	Alliance for Green Revolution
CA	Conservation Agriculture
DAEA	Department of Agriculture and Environmental Affairs
DAFF	Department of Agriculture, Forestry and Fisheries
FAO	Food and Agriculture Organization of the United Nations
ILCA	International Livestock Centre for Africa
KZN	KwaZulu-Natal
N	Nitrogen
NEPAD	New Partnership for Africa’s Development
NGO	Non-governmental organization
P	Phosphorous
SA	South Africa
SPSS	Statistical Package for Social Science
VIF	Variance Inflation Factor

CHAPTER 1. INTRODUCTION

1.1 Background

Traditional cultivation systems, employing intensive soil tillage, will result in soil degradation and reduced crop yields (Alvarez, 2005; Chase & Singh, 2014). The consequences are further exacerbated by the negative effects of monoculture cereal production and overgrazing in communal areas (Sayre *et al.*, 2006). If small-scale farming is to survive and sustainable agriculture is to be achieved by farmers, then the patterns of agricultural production and management must evolve, and new farming practices must be implemented (Ashburner, 1984; Wall, 1999; Sayre *et al.*, 2006).

Conservation Agriculture (CA), defined as soil management practices that minimize the disruption of the soil's structure, composition, and natural biodiversity, is now widely recognized as a viable concept for practicing sustainable agriculture (Githinji, Dane & Walker, 2011). Its principles include very little soil disturbance through tillage, permanent organic soil cover and diversified crop rotations (du Toit, 2007). No-till, also known as drilling, zero-till, slot-planting and/or chemical tillage is the ultimate conservation agriculture system (du Toit, 2007; Friedrich & Kassam, 2009; Mathew *et al*., 2012). No-till is an agricultural practice where planting takes place in unprepared soil. It is a sequence of operations that reduces erosion caused by mechanically killing the vegetation on the field through the use of herbicides (Kilmer, 1982). The minimum disturbance of soil occurs at planting when seed and fertilizer are put into the soil. The crop is planted directly into the preceding year's crop residue, hence retaining more than fifty percent of the residue on the soil surface for the entire season. The value of this method of farming is gradually becoming more acceptable by farmers all over the world (Brady & Weil, 2002).

In South Africa, research on no-till agriculture systems started in the 1970s (du Toit, 2007). Most of the early problems that were encountered were fully understood and sorted out within ten years, but the practical application on a commercial farm scale was initially hampered by the local unavailability of suitable no-till planting equipment and a hesitancy to adopt the technique (du Toit, 2007). The strict regulations in the

South African maize industry also undoubtedly influenced farmers to continue practicing conventional mould board plough - based production methods. In America, the early contribution of innovative farmers was extremely important in establishing no-till as a new technique (du Toit, 2007). Unfortunately, without farmer acceptance of the method, research findings will get no further than the libraries where these reports are stored.

It has taken much longer for no-till to become accepted in South Africa than elsewhere, but now that the agricultural markets have been deregulated, and production costs have increased alarmingly, innovative farmers have been forced to seriously consider looking at alternative production methods (du Toit, 2007).

No-till CA has a great potential in Africa and might give more yields per hectare, which is an important feature to improve production quality for small-scale farmers in South Africa (Lötter, Stronkhorst, & Smith, 2009). According to Mwale (2002), the productivity of land in small-scale farming sectors in South Africa is decreasing at very high rates. As a result, conventional tillage practices are necessitating an urgent change in soil preparation techniques. In zero tillage, it is still necessary to follow the other accepted and recognized cultural practices such as cultivar selection, fertilization, weed control measures, planting dates, residue management pest control which may become a problem when it comes to the adoption of the practice (Phillips & Young, 1973).

To farmers, the benefits of using no-till are apparent. The benefits include:

- the minimization of nutrient losses through the appropriate use of deep rooting plants such as maize that recycle nutrients leached from topsoils;
- improvement of moisture management;
- reduction in soil loss;
- preservation of soil fertility and structure;
- reduction in rainfall run-off;
- high infiltration rate;
- the increase in quality of produce and;
- higher yields (Food and Agricultural Organization of the United Nations (FAO), 2000).

The variable rate of adoption of this environmentally friendly practice justifies a closer look at farmer's perceptions regarding the use of no-tillage on maize production in comparison with conventional tillage (Giller *et al*., 2009). This study pays attention to the factors which will influence the adoption of no-till CA, with particular attention to farmer perceptions and how they affect the adoption of innovation.

The rest of this chapter presents the problem statement followed by the research objectives and hypotheses. The justification for the study is also presented, and the last section of the chapter describes how the thesis is organized.

1.2 Problem Statement

Many farmers in rural areas are faced with the problems of low yields, low product quality, poor sustainability and profitability (Department of Agricultural Forestry and Fisheries (DAFF), 2012). Improper planting methods and a reliance on old methods of practicing agriculture are increasing land degradation (Du Preez, Van Huyssteen & Mnkeni, 2011). According to FAO (2010), many subsistence crop production system soils in sub-Saharan Africa are depleted and have poor nutrient content resulting in low agricultural productivity. Rural communities in South Africa face similar challenges. Du Preez *et al*. (2011) reported that the degradation of soil as a result of land uses poses a threat to sustainable agriculture in South Africa. In this regard, CA provides a strategy for addressing soil degradation which has occurred as a result of poor agricultural practices (Lugandu, 2013).

Literature highlights several benefits of no-till CA, amongst which are an improvement in soil fertility, labour saving, improved water use efficiency, an increase in productivity and environmental sustainability (FAO, 2000; Enfors, 2009; Lugandu, 2013). However, despite these benefits, there is low adoption or quick dis-adoption of no-till CA among smallholder farmers in South Africa (Lötter *et al.*, 2009). Most smallholder farmers revert to or continue to use convectional tillage methods. There are several factors that influence the uptake of technological innovation, one of which is farmers' perceptions. McRoberts and Rickards (2014) indicated that the perceptions and views of the community are at the centre of the adoption of conservation agriculture technologies. To date, this study is not aware of any research study conducted in South Africa focusing on farmers' perceptions and their impact on adoption of no-till CA. However, studies in countries such as Australia, Pakistan and Tanzania, among others, have explored the influence of farmer perceptions on adoption of no-till CA (Sheik *et al.,* 2003; D'Emden *et al.,* 2008; Lugandu, 2013). Indeed, Sheik *et al.* (2003) and D'Emden *et al.* (2008) showed that farmer perceptions do influence their adoption decisions. Hence, the focus of this research which attempts to understand the factors affecting the adoption of no-till CA among small-scale farmers, including farmer perceptions of the technology. This knowledge will be critical for government and its partners in designing effective strategies for promoting CA in South Africa's rural communities.

The study contributes to the body of knowledge on the factors influencing adoption of no-till CA amongst small-scale farmers in South Africa.

1.3 Study Objectives

The main aim of the study is to investigate farmers' perceptions of and the factors influencing the adoption of no-till CA in Kwa-Zashuke Ward 8 in Ingwe Municipality, Kwa-Zulu Natal (KZN).

The specific objectives of the study are:

(i) To investigate farmers' perceptions of no-till CA and its impact on maize yields in Kwa-Zashuke Ward 8 in Ingwe Municipality.

(ii) To determine the factors influencing the adoption of no-till CA in Kwa-Zashuke Ward 8 in Ingwe Municipality.

1.4 Hypotheses

The hypotheses developed for the study is that:

(i) Positive perceptions of no-till CA are associated with increases in maize yield.

(ii) Small-scale farmers' perceptions, lack of knowledge and socio-economic factors influence the adoption of no-till CA in Kwa-Zashuke Ward 8 in Ingwe Municipality.

1.5 Justification of the Study

The study is based on small-scale farmers of Kwa-Zashuke location in Ward 8 under Ingwe Municipality, KZN. These farmers mostly farm for subsistence purposes. The majority of them rely on government social support services as a source of livelihood. Conducting this study is motivated by the need to have a greater appreciation of the small-scale farming system within which no-till CA adoption decisions are being made. Such an understanding is able to show opportunities available to increase the use of no-till among smallholder farmers in South Africa. The study has the potential to generate useful information that could contribute to the improvement of household food security through increased agricultural productivity using sustainable farming practices. The study also explores the factors that influence the adoption of no-till production practice, understanding such factors is paramount in designing relevant support systems that will promote sustainable farming practices such as no-till CA. The study is also important in up-scaling of efforts to encourage soil management strategies that are environmentally friendly.

1.6 Organization of the Dissertation

The study is composed of six chapters. Chapter 2 presents the literature review on no-till CA, farmer perceptions and the adoption of CA in general and no-till CA in particular. Chapter 3 presents and describes the methodology of the study. It provides a description of the area of study, the research design, conceptual framework, empirical data analysis methods, ethical considerations and the study limitations. Chapter 4 presents and discusses the descriptive and inferential results of the study.

Chapter 5 presents and discusses the empirical results of the Logistic Regression Model on factors influencing the adoption of no-till CA. The last chapter (Chapter 6) presents the conclusions, recommendations, and future research direction.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

The recognition of no-till CA as a solution to food security, biodiversity and water scarcity challenges is gaining momentum worldwide (Gattinger *et al.,* 2011). Some research and development organizations now view the technology as one of the solutions to the adverse effects of climate change (Gattinger *et al.,* 2011). Although the role of no-till as a climate smart solution is being questioned (Manley *et al.,* 2005; Luo, Wang and Sun, 2010; Gattinger *et al*., 2011), the technology still remains one of the solutions to address some of the challenges affecting smallholder farming in Africa (Giller *et al.,* 2009).

Soil erosion and limited water use efficiency are some of the major challenges affecting smallholder farming (Rockström. 2000; Nyamadzawo *et al.,* 2012; Binns, 2012). The situation is further worsened by the climate change effects such as persistent droughts, currently being experienced in the sub-Saharan region (Nyamadzawo *et al.,* 2012). Agriculture remains one of the most important components of most African economies (Blein *et al.,* 2013) and its success is based on the foundation of good soils and efficient utilization of available water resources, among other factors. In this regard, no-till CA has an integral role to play in minimizing soil disturbance and water loss (Binns, 2012). However, the impact of the technology will only be realized if most small-scale farmers accept and adopt the technology.

This chapter presents a review of the literature on CA focusing on no-till CA. It starts by defining no-till CA and moves on to review the literature on the benefits of this method of farming. The succeeding section focuses on farmer perceptions regarding no-till CA. The chapter also presents and discusses literature on the adoption of CA and no-tillage worldwide, in Africa and South Africa in particular. The chapter ends by presenting literature on factors influencing the adoption of no-till CA.

2.2 What is No-Tillage?

No-tillage, sometimes known as no-till, is a conservation farming system which involves the direct deposition of seeds into uncultivated soil that has retained residue from the previous crop. This is done through opening up a trench or hole with sufficient width and depth to obtain proper seed coverage (Derpsch *et al.*, 2011). It is also defined as any form of tillage that retains at least 30% of the soil surface covered with residue after planting (Derpsch *et al.,* 2011). There are many different terms that refer to conservation tillage, including reduced tillage, direct drilling, zero tillage and no-tillage (no-till).

Baker and Saxton (2007), viewed no-till as a practice that involves the drilling of the seed directly into a soil that has never been previously tilled especially to form seedbed. The authors argue that no-till is not new, it was common in Egypt. The Egyptians made a hole using a stick, dropped a seed inside the hole and then closed the hole with their foot. It was not until 1960's when weed controlling chemical parquet was established by imperial chemical industry in England (Troyer, 2001) that the modern name "zero tillage" was born.

Other researchers such as Dumanski *et al.* (2006) argued in the same vein that no-till is simply planting a seed in previously uncultivated soil by making a narrow slot to drop the seed into without any further soil preparation. In this regard, soil preparation substitutes the use of chemicals which helps to control weeds. This practice emerged as a substitute for tractor power. Phillips and Phillips (1984) stressed that when practicing no-tillage, it is necessary to follow other accepted recognized practices such as cultivar selection, planting dates, weed control, residue management and it has been proven that when these practices are followed correctly, several advantages can be observed.

2.3 Benefits of No-Till

Several benefits of no-till conservation agriculture are identified in the literature. Some of the benefits include an increase in yields, lower production costs, reduced soil runoff and soil damage, increased soil moisture content, improved soil structure and quality of crop produced (Shipitalo & Edwards, 1998).

No-tillage promotes soil health by increasing crop residue retention, rotation and cropping diversity (Dumanski *et al*., 2006). This improves the soil quality, that is, its ability to function within the confines of the ecosystem and relate positively with the external environment (Larson & Pierce, 1991).

With zero tillage, roots underneath and crop residue on the surface supply the raw material for stable organic matter (Ogle, Breidt, & Paustian, 2005). The increase in soil organic matter influences the ability to retain water, aggregate stability, nutrient cycling and nitrogen demand (Bot & Benitez, 2005; Hoorman, 2009). Organic matter functions as glue for soil aggregation and structural unity (Bot & Benitez, 2005). Soil organic matter also functions as a source of nutrients for plants. As soil organisms feed on the old organic matter, they release available nutrients back into the system (Bot & Benitez, 2005; Ogle *et al.,* 2005). The no-till system increases soil organic matter by reducing the rate of decomposition of chemical compounds in organic matter, thus stimulating the accumulation and concentration of litter (crop residue, weeds and mulch) on the soil surface (Alvarez & Steinbach, 2009). Many studies have proved that minimum tillage results in an accumulation of crop residues on the soil surface, which both enriches the soil's organic matter and provides a habitat for microorganisms (Mathew *et al*., 2012). It also increases fungi, bacteria, *arbuscular mycorrhizal* fungi and *actinomycetes* in the soil (Staley, 1999; Pankhurst *et al*., 2002; Feng *et al*., 2003; Mathew *et al*., 2012). Microorganisms are responsible for the conversion of mineral compounds in organic matter into forms that can be used by plants (Lienhard *et al*., 2013). Studies have also shown that cover crops have more benefits to soil fertility and crop growth (Dabney *et al*., 2001).

No-till provides more diverse populations of residue decomposers (Lienhard *et al.*, 2013). Soil organisms such as fungi have a number of soil functions which include organic matter turnover and nutrient recycling (Lienhard *et al*., 2013). Fungi functions to decompose plant residue, particularly components which are resistant to decomposition such as lignin (Frey, Elliot, & Paustian, 1999). Frey *et al*. (1999) suggested that soil fungi may be responsible for nitrogen immobilization occurring residue on the surface of no-till fields. A no-till farming system tends to have higher soil organic matter contents. Fungi have two main functions: the translocation of nutrients, especially phosphorus (P) and the reduction of water stress in plants under drought conditions (Morton, 1998).

Most research conducted on conservation tillage shows that no-till cultivation reduces soil loss through erosion (Uri, 2000), influences the soil's chemical composition and physical structure and has a positive effect on productivity of the soil (Bot & Benitez, 2005; Thomas, Dalal & Standley, 2007; Alvarez & Steinbach, 2009; Mathew *et al.,* 2012). Studies have found that no-till can be more profitable if performed correctly because of reduced costs regarding labour and other costs associated with the purchase and operation of machinery and irrigation equipment (Derpsch *et al.,* 2010).

No-tillage is an agricultural practice that is focused on getting maximum yields from a given piece of land while protecting the soil and the ecosystem resources (Dumanski *et al*., 2006). In this way, the practice seeks to create a balance between agricultural, economics and environmental benefits. The combined benefits are achieved by linking production (including labour costs) and protecting the environment, (Dumanski *et al*., 2006). Dumanski *et al*. (2006), reported that no-till demands less labour in terms of time and effort. It also promotes equilibrium in the application of chemical inputs and careful management of crop residue, land and water pollution and soil erosion thus reducing a long-term reliance on external inputs such as fertilizers while enhancing environmental management. Fawcett and Towery (2002) stated that no-till promotes sufficient food production, reduces poverty and promotes value-added production.

2.4 Farmers' Perceptions of No-Tillage

Most small-scale farmers are of the view that no-till does not work and results in lower crop yields and poor crop quality (Pannel *et al.*, 2006). Some hold the perception that fields under no-till are less aesthetically pleasing due to the presence of both the plants and weed residues over its surface. They sometimes conclude that such a field will likely result in the need for more costly pesticides and herbicides. They do not trust the cost-benefit analysis of using no-till. Most small-scale farmers are not long-term focused in their planning and tend to favour tangible short-term benefits (Huggins &

Reganold, 2008). However, since no-till benefits are more long term and not easily tangible, small-scale farmers are not interested in or enthusiastic about the technology. Most small-scale farmers are averse to risk (Dillon & Scandizzo, 1978) and believe that new technology may create more problems which may lead to lower product quality at higher cost of production (Adesina and Baidu-Forson, 1995; Chi & Yamada, 2002).

According to the African Agricultural Conservation Tillage Network (2008), many farmers still perceive that zero tillage is a problem when it comes to retaining crop residue. They believe that keeping the soil covered is the right thing to do, but find it difficult to achieve because they usually use the plant residues to feed their animals, to make roofing and for fuel. Livestock farmers allow their animals to graze on tumble and maize residues which are a vital source of feed for them in winter. The use of maize crop residues to cover the soil means that farmers re faced with the problem of finding an alternative source of feed, roofing, and fuel. This is possible in places where there is enough rain, but in arid places where they cannot plant in winter, it becomes difficult.

2.4.1 Farmers' mindset

Related to farmers' perception is the issue of farmers' mindset. Mindset is defined as an attitude, the frame of mind, or fixed direction of thought (Dweck, 2006). Mindsets could have a direct impact on farmer technology adoption rate and in South Africa, this seems to be a particular challenge to the introduction of no-till in the smallholder agriculture sector. Mindset is essentially a problem because it tends to ignore things that are important. Sometimes, researchers, extension officers, and farmers believe that tilling the soil increases water infiltration into the soil. According to Chang (2007), a mental change needs to happen amongst extension officers first, then technicians and researchers before dealing with farmers. Soil preserving tillage operations like no-till that promote sustainable production systems are an important factor and need to be taken seriously to change attitudes of the farmers.

So long as the farmer's mindset is inclined towards conventional farming methods, it is challenging to implement successful no-tillage in practical farming. They need to be convinced about the benefits of this practice for themselves and not only by extension officers (Chang, 2007). It is believed that if a farmer does not change his/her mindset, he/she will never apply themselves and ensure that the technology works adequately. No-till is so different from conventional tillage and those that want positive outcomes from the application of the technology should be willing to take the risk, forgo conventional tillage systems and be prepared to learn new methods of agriculture production (Chang, 2007). The farmer first has to revolutionize his mind before changing his way of farming.

2.5 Adoption of Conservation Agriculture and No-Tillage

Conservation agriculture in general and no-till in particular started in about the mid-20th century, and the technology has evolved over time with the aid of research and new evidence that it is a good system. This section provides a brief overview of the adoption of conservation agriculture and no-till worldwide, including Africa and South Africa.

2.5.1 Adoption of Conservation Agriculture and No-Tillage Worldwide

While no-tillage was researched in the United States of America (U.S.A) as early as the 1940s and more rigorously in the late 1950s and in Europe in the 1960s and 1970s, it was only from 1971 that research on this technology began in Brazil and other countries in Latin America (Derpsch, 1998). Initially, no-tillage was taken only to be an efficient soil conservation technology, given the challenges of soil erosion that had been brought about by arable farming in southern Brazil. However, with time, no-till has evolved into proper sustainable production system with positive economic, environmental and social benefits (Derpsch, 1998).

No-tillage is practiced on approximately 111 million hectares worldwide (Derpsch *et al.,* 2010). South America has the highest percentage in terms of practicing no-till CA (46.8%) followed by the United States and Canada (37%), then Australia and New Zealand with 11.7% and finally the rest of the world which incorporates Europe, Africa and Asia (3.7%) (Derpsch *et al.,* 2010). In South Africa, no-tillage is being implemented on 368 000 hectares of land (Derpsch *et al.,* 2010). The increase in no-till farming was brought about as a result of savings in time, labour, and fuel, reduced soil erosion, improved water use efficiency and increased nutrients use efficiency. All these factors contribute to sustainable crop production.

2.5.2 Adoption of Conservation Agriculture and No-Tillage in Africa

Large parts of Africa fall into zones that have drought prone areas and where annual rainfall is less than 800mm (FAO, 2001). Conservation Agriculture is a way of controlling the agro-ecosystem to achieve higher, sustained productivity, better profits, and food security while improving the environment (FAO, 2010). Adopting conservation farming might help farmers in Africa to fight crop loss which occurs due to adverse climatic conditions. Conservation agriculture in Africa has been incorporated into regional agriculture policies by New Partnership for Africa's Development (NEPAD) and also the Alliance for Green Revolution in Africa (AGRA). Derpsch (2010) reported that the application of no-tillage is high in South Africa compared to other African countries. Figure 2.1 below shows differences in area under no-tillage between South Africa and other selected African countries. Statistics used in drawing the graph are obtained from a report by Derpsch (2010).

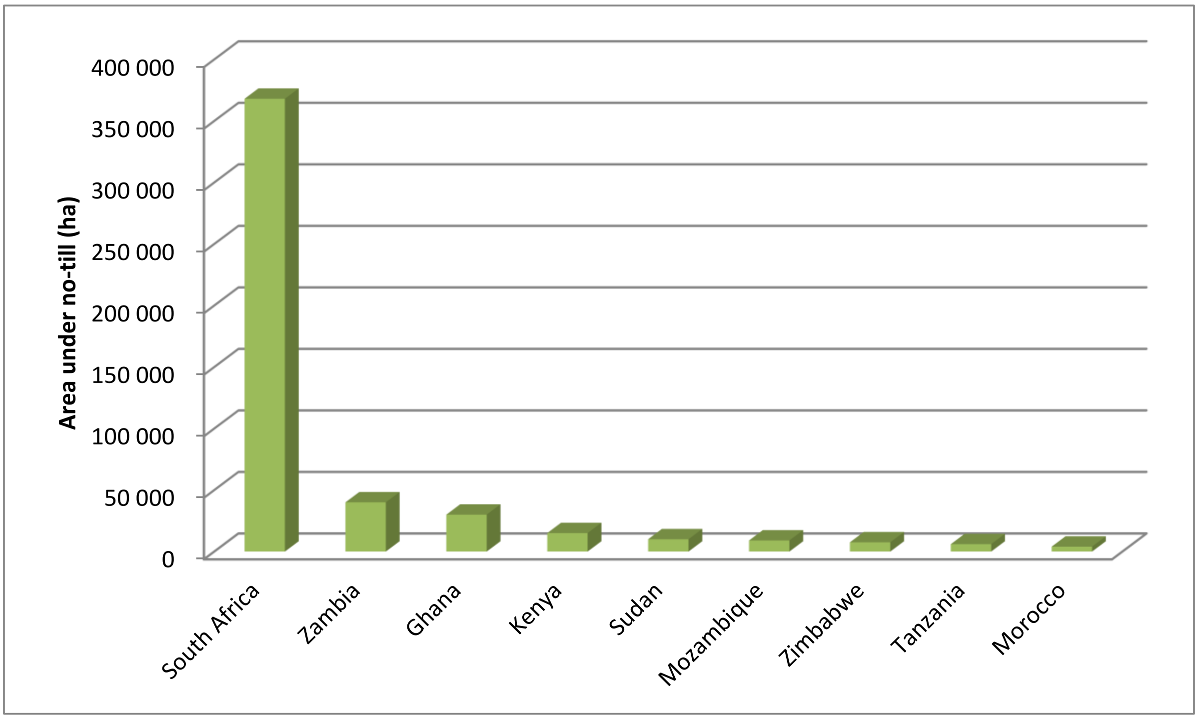

Figure 2.1: Area under no-till CA in some African countries

A problem area for the adoption of CA in Africa is communal grazing. After the harvesting of crops, animals can graze freely, and most of the crop residues are consumed. Different studies have shown that no-tillage without soil cover leads to very poor output (Ashburner, 1984; Giller *et al.*, 2009; Sayre *et al.*, 2006; Wall, 1999).

According to Derspch (2003), a 1998 study on the potential use of no-tillage in Africa indicated that to some extent the technology is already being used in many African countries such as Angola, Benin, Ghana, Ivory Coast, Kenya, Mozambique, Niger, South Africa, Tanzania, Zambia, and Zimbabwe. Many countries have adopted the use of no-tillage, but the problem was that while it has been fully adopted and practiced by large commercial farmers, less information has been rendered to small-scale farmers in rural areas.

2.5.3 Adoption of Conservation Agriculture and No-Tillage in South Africa

Conservation agriculture has a long history in South Africa. Derpsch (2003) stated that the first no-till experiments took place in 1977 at the Cedara College of Agricultural and Development Institute now known as the Grain Crops Institute in Pietermaritzburg in the KwaZulu-Natal province. The experiments, which were carried out on maize and soyabeans, yielded very important information about no-till CA. Some farmers adopted this practice of no-tillage technology as early as 1984 (du Toit, 2007). The area under no-till in South Africa has grown from 30 000 ha to 368 000 ha (Derpsch, 2010). Statistics from du Toit (2007) show that reduced forms of tillage are practiced on approximately 34.6% (1 522 718 ha) of South Africa’s total cultivatable area (4 402 255 ha) and that 8.6% (377 169 ha) is under no-tillage (du Toit, 2007). However, the adoption is mostly limited to commercial farmers producing grain crops and sugarcane (du Toit, 2007).

2.6 Factors Affecting the Adoption of No-Tillage by Small-Scale Farmers

Several factors are found in the literature to affect the adoption of CA technologies. These include age, gender, education, family size, awareness of CA, training, experience in farming, access to credit, perceptions on the promotion of no-till CA, land sizes, and income.

2.6.1 Age

Adesina and Baidu-Forson (1995) study in Burkina Faso revealed that the age of farmer significantly affects the adoption of agricultural technology. In that study, age was positively related to adoption, meaning that adoption increased with increasing age. Nyambose and Jumbe (2013) also found that the farmer's age was positively related to CA adoption, and an increase in age by one unit would increase the odds of technology adoption by 6.3%. This contradicts the notion that younger farmers are risk takers and hence will adopt new technology more readily than older farmers (Sheikh, Rehman & Yates, 2003). However, other studies have found age to be insignificant in influencing technology adoption (Westra & Olson, 1997; Clay, Reardon & Kangasniemi, 1998; Mazvimavi & Twomlow, 2009). Indeed, the results from different studies have shown mixed results such that Knowler and Bradshaw (2007) concluded that it is difficult to predict the influence of age on CA technology adoption accurately.

2.6.2 Gender

Research conducted in Zimbabwe by Chiputwa *et al*. (2011) reported that the probability of female farmers adopting CA technologies is low due to resource constraints and gender discrimination in extension services. In Tanzania, Kahimba, *et al.* (2014) showed that male spouses had more influence on the decision to adopt CA technologies, particularly those that are labour intensive. Mazvimavi and Twomlow (2009) found that male-headed households in Zimbabwe were more likely to adopt CA technologies compared to their female counterparts. Lubwama (1999) stated that, although CA technologies are gender neutral in their formulation, their application might alter the productivity of labour between men and women. This then affects the extent of adoption. For example, in most African societies women provide much of the labour in agriculture and a labour intensive technology will result in an increase in women's workload. If these issues are not considered in planning and implementation of technology, they might negatively affect adoption. Adesina *et al.* (2001) cited in Nyambose and Jumbe (2013) cautions that the influence of gender on technology adoption should not be generalized but is dependent on the technology and its attributes.

2.6.3 Education

The influence of education on CA technology adoption is context specific. A review of the available literature reveals a range of results. Nyambose and Jumbe (2013) found that education was positively related to CA technology adoption among farmers in Malawi and was significant in influencing adoption. However, Sheikh, Rehman and Yates (2003) did not find education level to be significant in influencing no-tillage adoption among rice farmers in Pakistan. A review of several adoption studies conducted by Knowler and Bradshaw (2007) makes a general conclusion that education positively influences the adoption of CA technologies.

2.6.4 Farming Experience

Mazvimavi and Twomlow (2009) found the farming experience to have no influence on adoption of CA technologies among farmers in Zimbabwe. The same results were also obtained by Westra and Olson (1997) in Minnesota. However, findings from a study by Clay, Reardon, and Kangasniemi (1998) showed that farming experience positively influenced CA technology adoption. Indeed, a review of several studies done by Knowler and Bradshaw (2007) found similar results from the literature. They found four CA adoption studies that showed that farming experience was positively related to CA adoption and five studies where the influence of farming experience on adoption was insignificant.

2.6.5 Family Size

Family size is usually taken as a proxy of family labour available for farming (Mbendela, 2006). A study by Adeoti (2009) showed that household size did not have any influence on technology adoption. However, in the same study, labour availability as measured by the dependency ratio had a significant influence on technology adoption. Availability of family labour increases technology adoption. These results show that using household size as a proxy for family labour might reveal different results than when a more appropriate measure of labour such as dependency ratio is used.

2.6.6 Access to Extension

Nyanga (2012) showed that access to extension has a positive effect on adoption of CA. Extension services include access to information, training sessions, demonstrations, one to one field visits and on-site advice. The study, however, revealed that extension had some unintended negative effects on adoption. This was particularly true when there were frequent changes in extension staff (Nyanga, 2012). Some farmers might be discouraged while there is a great possibility that the new extension agent might not perform the same way as the former. In such situations, there is also a time lag that is needed for the new extension officer to develop a rapport with farmers. All this might negatively affect adoption. Similar results were obtained by Nyambose and Jumbe (2013). They found that access to extension significantly affects CA adoption and that farmers with access to extension had a 43% higher probability of adopting CA than those without. Access to extension services increases a farmer's knowledge on CA which aids in the adoption decision (Nyambose & Jumbe, 2013). A study by Adeoti's (2009) revealed that technology adoption increased with increased number of extension visits and concluded that access to an extension is important in agricultural technology adoption. In another study by Sheikh, Rehman and Yates (2003), the number of extension visits was negatively associated with adoption of no-till CA. This was because extension agents were not teaching people about the technology due to lack of knowledge on their part. These results demonstrate that access to an extension is only significant in influencing CA technology when extension serves as the main source of information and a medium for transferring CA knowledge to farmers.

2.6.7 Training on CA

Training is highlighted by Nyanga (2012) as a key factor that influenced the adoption of CA technologies. In his study in Zambia, he found out that CA training sessions were associated with an increase in area under CA. A review of literature rarely brings out training as a stand-alone factor because it is usually embedded within extension services. This is so because most training, particularly in African societies, is provided through extension agents most of whom are from the government. For example in a study by Lugandu (2013), CA training is bundled together with extension as one variable. In that study training and extension were not significant in influencing adoption of CA.

2.6.8 Farmer Perceptions of Technology

Farmer perceptions are an important factor in CA technology adoption (Westra & Olson, 1997). Solow (1974) states that farmers' perceptions regarding income in the future influence his or her adoption of no-tillage practices through conditioning the discount rate. In their study of adoption in Sierra Leone, Adesina and Zinnah (1993) showed that farmer perceptions of specific traits of rice varieties positively influenced the adoption of these varieties. In a similar study in Burkina Faso, farmer perceptions were significant in positively influencing the adoption of sorghum varieties (Adesina & Baidu-Forson, 1995). In Australia, D'Emden, Llewellyn and Burton (2008) found that farmer perceptions associated with the benefits of no-till CA significantly influenced adoption. Farmers who perceive that no-till CA has immediate short-term benefits are more inclined also to advocate for its promotion. However, adoption of the technology based on this notion might be misleading since, as indicated earlier, the benefits of no-till are observable in the long term (Huggins & Reganold, 2008).

2.6.9 Land Sizes

Land holdings affect technology adoption (Mbendela, 2006). However, a review of the literature does not produce conclusive results regarding the way in which land size influences adoption (Knowler & Bradshaw, 2007). Study results by Nyambose and Jumbe's (2013), showed that land holdings positively influence technology adoption. These results were also found by Westra and Olson (1997); Lee and Stewart (1993) and Mazvimavi and Twomlow (2009). The probability of technology adoption for farmers with larger land sizes was high compared to those with smaller land sizes because they could apportion part of their land for CA. Lugandu (2013) and Adeola (2010) found contrasting results. In their studies, the results revealed that land sizes significantly influenced technology adoption, but in a negative way. Farmers with smaller pieces of land had a higher chance of adopting CA technology as they sought to maximize on their smaller land sizes.

2.6.10 Household Income

According to Pereira and Sain (1999) having more farm resources is associated with higher adoption rates. Farmers with more resources tend to adopt first, especially if using the technology is dependent on an initial investment in new machinery. Another study in Tanzania showed that wealthier households adopted CA technologies more than poorer households (Kahimba *et al.*, 2014). The same notion is supported by findings by Sheikh, Rehman and Yates (2003) which looked at no-tillage technology adoption among farmers involved in rice-wheat and cotton-wheat farming in India. However, Nyanga (2012) found different results in his adoption study in Zambia. In his study higher incomes reduced the likelihood that the farmer would adopt CA. Focus group discussions in that study showed that resource rich farmers were satisfied with their livelihoods and production levels, and they did not see the need for CA. However, the same study also showed that resource rich farmers were able to increase the area under CA more often than poor farmers as they could easily overcome labour and other input challenges because of their larger pieces of land under CA (Nyanga, 2012). This literature shows there is a level of wealth that influence adoption of CA and that income is important in the scaling up of CA.

2.6.11 Access to Credit

Nyanga (2012) found that access to credit reduces the probability of adopting CA technologies. Contrary to that, Lubwama (1999) stated that access to credit affects access to production resources such as improved varieties of cover crops, herbicides, farming implements and in some cases labour (where labour is hired) which then influence new technology adoption. Technology adoption is dependent on the availability of financial resources, and as was shown in section 2.6.10, farmers with access to more resources for investment in CA are more likely to take up the technology. This is particularly important now, at a time when government support for agriculture in Africa is reduced (Wiggins & Leturque, 2010).

2.7 Chapter Summary

The literature review established the context under which the study was conducted. It showed that no-till CA is a form of technology that involves minimum disturbance. The technology has several advantages related to improvement in the soil structure and quality, increased yields and reduced cost of production. No-till CA enhances soil organic matter which improves the ability of the soil to retain water and its stability.

Several countries in Africa, including South Africa, have adopted CA, albeit at different levels. Uptake of no-till CA in South Africa has been increasing but at a slow rate. No-till has been widely accepted in the commercial agricultural sector as a low-cost measure to crop production, but its uptake in smallholder farming is low. This is mainly due to negative perceptions of small-scale farmers towards the technology. Small-scale farmers are short-term focused, yet the benefits of no-till CA are more visible in the long-term. Some recommended practices of no-till CA, such as retaining of crop residue, do not integrate well with some livelihood aspects of small-scale farmers. Crop residue is an important feed for cattle in smallholder farming.

The literature review revealed several factors that are important determinants of the adoption of no-till CA. These include factors related to the personal characteristics of the farmer (level of education, age, and gender), household demographic factors (family size, farming experience) and resource endowment (access to credit, access to extension, income and land sizes). These factors will form some of the factors to be included in the model of this study.

The next chapter details the methodology of the research and describes the methods and processes taken to undertake the study.

CHAPTER 3. RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a description of the research methodology employed to test the research hypotheses and address the key research questions. In brief, the study sought to investigate farmers' perceptions of no-till CA and its influence on product yield and to determine the factors influencing the adoption of no-till CA in Kwa-Zashuke Ward 8 in Ingwe Municipality. This chapter starts by describing the study area. This is followed by the conceptual framework for the study design. The research design will focus on the approach, study participants, sampling methods and methods of data analysis. Details on ethical considerations and limitations of the study are also described herein.

3.2 Description of the Study Area

The area of study was Ward 8 under Ingwe Local Municipality, which is in Sisonke District of the Kwa-Zulu Natal Province. Ingwe Local Municipality is among the five municipalities in Sisonke District. It has 11 wards that are under 12 tribal authorities of the Ingonyama Trust Lands. These are Madzikane-Bhaca, Isibonela Esihle, Amakuze, Sizanani, Umacala-Gwala, Zashuke, Qadi, Bidla, Vukani, Amangwane, KwamaFuze and Vezakuhle traditional authorities (Ingwe Municipality, 2013). Ward 8 under the Zashuke tribal authority was selected for the study since it was the ward targeted for the government-supported dryland maize CA pilot project under the municipality in 2004. Not all farmers participated in this pilot project. Hence it was possible to compare small-scale farmers who had adopted and those who had not adopted no-till CA in the ward. Figure 3.1 shows the location of Ingwe Municipality in the Sisonke District.

3.2.1 Geophysical Aspects

3.2.1.1 Topography

Ingwe Municipality covers an estimated 1 970m^2 and has an altitude that ranges from 2 083m in the north east (Mahwaqa Peak) to 450m in the south-east (Umkomaas Valley). Much of the land in the municipality is undulating. Flatter land is found in small plateaus in the western highlands areas while the steep valleys are within the catchment areas of the ward (Ingwe Municipality, 2012; Ingwe Municipality, 2013)

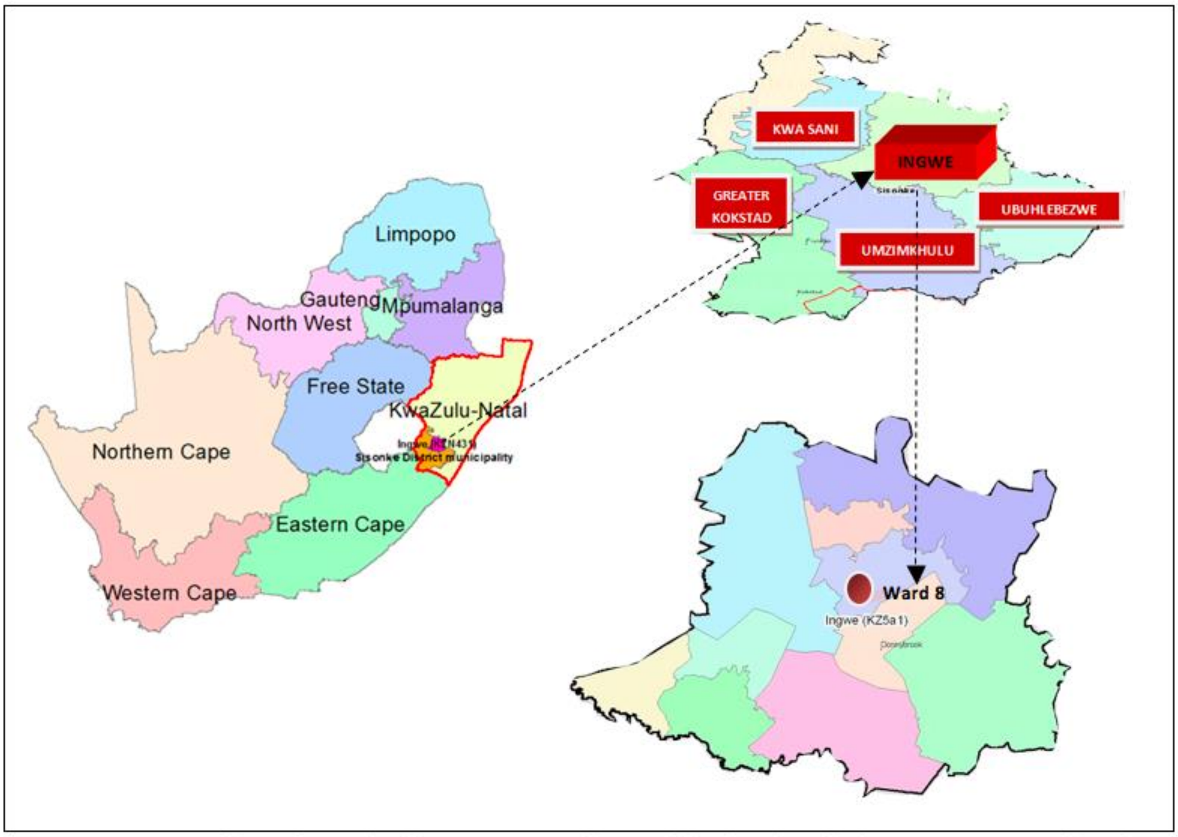

Figure 3.1: Location of Ward 8 in Ingwe Local Municipality in relation to KZN Province in South Africa

Source: Adapted from Rasmo (2009).

3.2.1.2 Climate and Rainfall

The climatic regions of Ingwe can be divided into two distinct areas: the highland region and the moist upland climatic region. Three temperature zones are also found in the municipality with the higher areas in the west having a cooler temperature while lower regions in the east are warmer. In winter time the temperature ranges from below zero in western regions to approximately 5ºC in the eastern regions. In the summer, which is the agricultural production season, it ranges from low to high thirties in the west and east respectively, which means that evapotranspiration is quite high in the area. This makes improved water use efficiency and moisture conservation important for agricultural production. The mean annual rainfall ranges from 700mm to 1 200mm (Ingwe Municipality, 2012).

3.2.1.3 Vegetation and Soils

Ingwe Municipality vegetation can be described as diverse and composed of seven types of vegetation (Ingwe Municipality 2012):

- moist and dry highveld sourveld (24% and <1%);
- moist midlands mist belt (4%);
- moist tall grassveld (6%);
- coast hinterland thornveld (<1%); and
- valley bushveld (5%).

Also, agricultural activity, for example, the establishment of commercial forests, has also resulted in a change in vegetation in some parts of Ingwe.

The soils in Ingwe are considered low in fertility and highly erodible. This affects agricultural productivity, particularly for small-scale farmers who cannot afford adequate amounts of recommended inorganic fertilizers to boost their harvests. Farming practices that do not affect the soil structure but rather improve the soil quality are therefore important for the survival of most rural communities in Ingwe.

3.2.1.4 Land Use

Land use in Ingwe is predominantly agricultural and still reflects the apartheid legacy. The commercial farming of maize, sugarcane and beef is practised by mostly white farmers, and there are forestry plantations on state land. The tribal lands are densely occupied by poor black people (81% of the population) who practice largely insignificant smallholder farming on poor soils for subsistence purposes. The productive land is owned by a few white farmers (Ingwe Municipality, 2012). Ward 8 in Kwa-Zashuke falls within the densely populated tribal lands.

3.2.1.5 Agricultural Potential

As indicated above, agriculture, dominated by commercial agriculture, is the backbone of Ingwe's local economy. According to the Ingwe Integrated Development Plan (2007-2012), the municipality has 199 000 ha of agricultural land of which only 36% is communal agricultural land. Agricultural production is largely reliant on natural water supply, making soil moisture preservation techniques important. According to Ingwe Annual Report (2012/2013), agriculture contributes significantly to the local economy, Accounting for 40-50% of the Gross Domestic Product.

However, the potential of agriculture, particularly crop farming is threatened by levels of soil erosion and infertile soils. Firewood is the most important alternative source of energy in the absence of electricity. This puts pressure on the forest, and the high concentration of livestock in grazing areas has resulted in soil erosion. Hence, the importance of adopting CA in the affected communities (Ingwe Municipality, 2013).

3.3 Theoretical and Conceptual Framework of the Study Design

The study is grounded in three different theoretical perspectives of technology adoption that have been used in past studies: innovation diffusion theory; economic constraints; and adopter perceptions perspectives (Aikens, Havens, & Flinn, 1975; Adesina & Zinnah, 1993; Rogers, 2003). Information dissemination is at the centre of the innovation diffusion theoretical perspectives, and adoption is viewed as a series of linear stages from knowledge acquisition to persuasion, decision, implementation and finally confirmation stages (Rogers, 2003). The economic constraints theoretical perspective states that adoption is influenced by access to economic resources and indicates that a lack of access to these resources affects technology adoption. The theory identifies the complex diversity and differences in small-scale farmers regarding access to these resources and postulates that asymmetric distribution of these resources could lead to this heterogeneity (Adesina & Zinnah, 1993). The adopter-perceptions theoretical perspective identifies farmer perceptions as key to the adoption of farming technology (Adesina & Zinnah, 1993). This study integrates the three theories to develop a conceptual understanding of the research problem.

Conceptually, Lugandu (2013) stated that the decision to adopt or not adopt CA is a function of the farmer's perceptions of CA compared to other farming practices or technologies. There are several reasons why farmers may adopt a new farming technology (FAO, 2001). Farmers are rational in their behaviour, and their perceptions are influenced by information available to them, their socioeconomic situation and farm enterprises (Grabowski, 2011). Adoption is defined by Feder *et al.* (1985) as the extent to which farmers put into practice a new innovation in the future, given adequate information about the technology and the potential benefits. Several variables have been identified in the literature as determining the level of adoption. These include human capital, credit constraints, risk, farm size, labour availability, land tenure, livestock assets, agricultural training, interactions with extension and input supply (Feder *et al.,* 1985; Grabowski, 2011; Bisangwa, 2012, Lugandu, 2013). Understanding these variables and how they influence adoption are important in developing strategies for promoting the use of no-till CA. Figure 3.2 shows the conceptual framework on adopting a new technology by farmers.

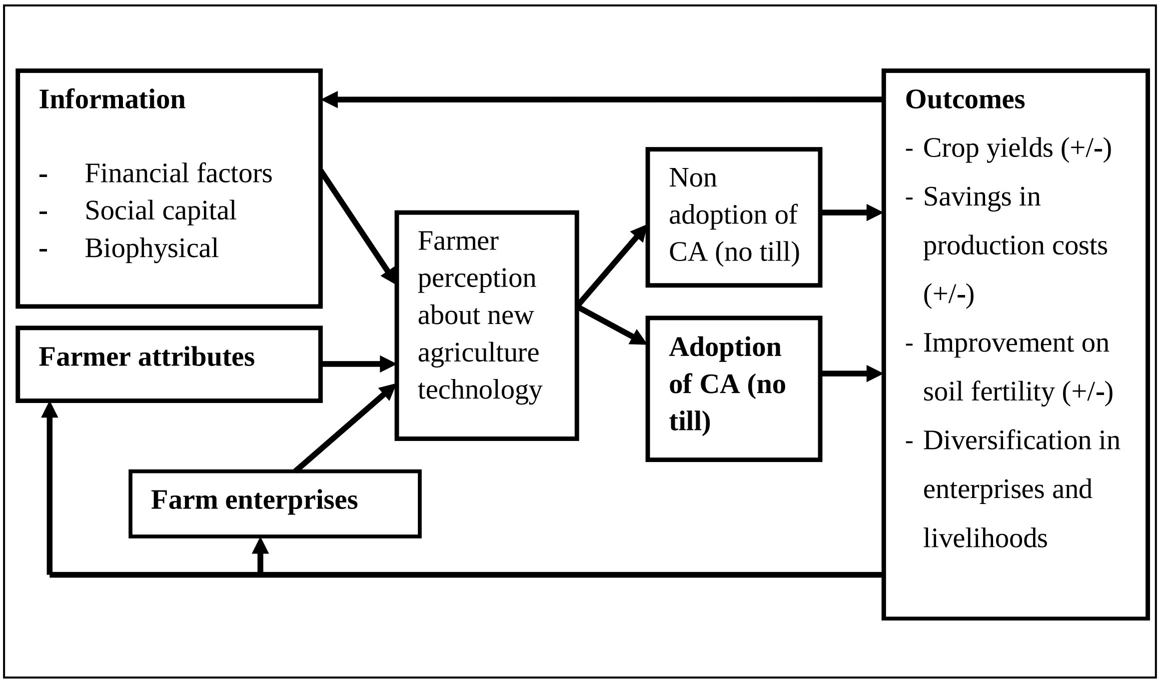

Figure 3.2: Conceptual framework

Source: Adapted from Lugandu (2013)

Appreciation of a farmer's perspective (which determines a farmer's perception) of CA is important in technology adoption studies (Grabowski, 2011). Farmers have different views of a new technology depending on their priorities, unintended consequences of the technology and alternatives available to them (Fujisaka, 1994). These perspectives are important in understanding why farmers would not adopt a technology that might seemingly be beneficial to them.

Farmers' views of a technology are formulated from the information they have about the technology (Milder, Majanen &Scherr, 2011; Lugandu, 2013). Changes in agricultural policies, socio-economic systems (including financial incentives) and the use of biophysical resources (land, soil, and water) will affect farmers' perceptions of a technology and hence its adoption (Lugandu, 2013). Changing climatic conditions affect soil moisture and water use efficiency (ACT, 2008; Kang, Khan, & Ma, 2009), and once this information is available to farmers, it affects how they view new agriculture technology. Similarly, information on the soil fertility status, particularly declining soil fertility and government extension and financial support will affect no-till CA adoption decisions by farmers (ACT, 2008; Lugandu, 2013).

Farmer attributes affect no-till CA adoption. Farming decisions are not made in isolation but within the complex livelihood systems of a given farmer's situation (Edwards-Jones, 2006). Smallholder farmers have different attributes that affect their livelihoods such as education levels, poverty, information communication systems, access to essential resources (land, water and working capital), utilization of resources, institutional and social capital and access to capital (Poulton, Dorward & Kydd, 2010; Livingston, Schonberger & Delaney, 2014; Thapa & Gaiha, 2014). Land tenure security and access to capital affects investments in any technology that a farmer might want to adopt including no-till CA (FAO, 2001). Institutions, social capital, and information communication systems affect the exposure of a farmer to new ideas and information about a farming technology. It also affects the support systems available to the farmer if he chooses to use the technology, thereby influencing farmer's adoption decision. The enterprises that a farmer is engaged in also influence no-till CA adoption decisions (FAO, 2001).

Given a farmer's perception about a new technology, they either adopt or do not adopt the technology. If they adopt the technology of no-till CA, they stand to enjoy the positive benefits of the technology which according to literature includes improved crop yields, savings in production costs, improved soil fertility, diversified enterprises and overall enhancement in their livelihoods. If a farmer chooses not to adopt the technology, it means they forego all the benefits mentioned above and risk continual reduction in their soil quality and yields. Their cost of production might also increase as they try to manage poor soils. These outcomes, in turn, affect farmer attributes, enterprises and their information and knowledge of the technology.

3.4 Research Design

A research design provides a context within which a study is conducted (Daniel & Berinyuy, 2010). A cross-sectional study design was used to assess farmers' perception of no-till CA and to determine the factors affecting the adoption of no-till CA among small-scale farmers. A cross-sectional study design concerns data collection of at least two variables at a given point in time with the objective of assessing the existence of a relationship between the variables in question (Bryman & Bell, 2007:55). A questionnaire survey is usually the best method of data collection in such a design. The methodology that was employed in the study was quantitative, involving the collection of data using a structured questionnaire. A quantitative survey allows for the use of econometric models to determine the influence of different factors on no-till CA adoption.

3.4.1 Description and Selection of Participants

In 2004, the Department of Agriculture in Kwa-Zulu Natal implemented a Dryland Maize Project. The project aimed at promoting no-till CA among rural smallholder, farmers. The participants or respondents of this study were selected from members of this project and also those who did not actively participate. Adopters were farmers who participated in the no-till CA under the Dryland Maize Project. Most of these farmers are still practicing no-till CA although at a smaller scale. Non-adopters are farmers who were aware of the project and some even went through training but did not adopt no-till CA for various reasons. The study excluded a small group of dis-adopters, namely those farmers who had adopted at first and then stopped because these bring a completely different dimension to research on adoption which is not what this study is focusing on. Farmers were identified through registers obtained from the Department of Agriculture and Environmental Affairs (DAEA) in the district.

3.4.2 Sample Design

The study used a probability sampling method to select the study sample. It employed stratified random sampling to determine the households that participated in the questionnaire survey. The study sample was divided into two groups of farmers who adopted (adopters) and those who did not adopt (non-adopters). The sampling unit was the household member undertaking farming activities in the household, and the sampling frame consisted of households that were exposed to no-till conservation agriculture under the dryland maize project in Kwa-Zashuke Ward 8. Hardon *et al.* (2004) stated that stratified random sampling has an advantage in that it reduces the costs of collecting data from larger groups of the population by allowing researchers to make usable conclusions using a large sample taken from a small group. Registers from the DAEA showed that at least 200 farmers in the district participated in the no-till CA project. Thus, using the formula provided by Krejcie and Morgan (1970), a representative sample for the study was obtained as follows:

$$S = \frac{X^2NP(1-P)}{d^2(N-1) + X^2P(1-P)}$$

S = required sample size

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841)

N = the population size

P = the population proportion (assumed to be 0.5 since this would provide the maximum sample size)

D = the degree of accuracy expressed as a proportion (0.05)

Using the Table for Determining Sample Size from a given population (Krejcie & Morgan, 1970), a sample of at least 132 farmers was determined. This was based on the population of 200 farmers who took part in the project. In the study, the final sample was larger, constituting of 185 farmers (52% adopters of no-till CA and 48% non-adopters of no-till CA). It was difficult to exclude other farmers from the survey given their interest to participate. Initially, the plan was to have an equal number of participants from each stratum so that there is an equal chance (probability) of selecting each respondent from the two groups. However, this was not possible as some non-adopters were either not available or not willing to participate in the survey.

3.4.3 Data Collection

Data was collected using questionnaires. Questionnaires were prepared and administered on a house-to-house basis. The questionnaire was translated into the local isiZulu language for ease of implementation. It consisted of five sections (see Appendix 1). The first part gathered general information such as farmer and enumerator names and location. The next part collected data on socio-demographic information (age, sex, household size and education) followed by a section on farming and income (operated land, estimated income, crops grown and output, household physical and livestock assets and access to credit). The last two parts of the questionnaire were on CA, focusing specifically on CA information dissemination, the level of adoption and farmer perceptions.

The questionnaire was pre-tested before it was finalized. Pre-testing was done to refine the questionnaire and check on important issues such as the time taken to complete the questionnaire and the adequacy and appropriateness of the questions. Time considerations were very important in the questionnaire administration given the level of farmer fatigue in the study area. Pre-testing was done in the same community with a few farmers who did not take part in the main survey.

Data collection was conducted by two well-trained enumerators who were identified in the Ingwe local Municipality area. As part of their training, the enumerators participated in the pretesting which also gave them an opportunity to practice asking the questions. The data collection period was two weeks in the month of December 2015.

3.5 Data Analysis

After data collection, IBM Statistical Package for Social Science (SPSS) software version 23 and Stata 13 was used to analyze data. Descriptive statistics and inferential analysis were applied on the first objective (investigating farmers' perceptions regarding the influence of no-till CA on product yield) and a binary logistics regression model was employed for the second objective (to determine the factors influencing the adoption of no-till CA in Kwa-Zashuke Ward 8).

3.5.1 Descriptive and Inferential Analysis

Description of the variables used in the logistic regression model to show the perceptions of farmers on no-till CA was done using descriptive statistics, t-statistics, and Pearson correlations. The results of this analysis are presented using frequency tables, cross-tabulations, and graphs. For continuous variables, the study reports means and standard deviations while for categorical variables, percentages are reported.

3.5.2 Binary Logistic Model

The study applied a binary logistic regression model to analyze the factors influencing the adoption of no-till CA. The model is adapted from similar studies, for example, Pautsch *et al.* (2001); Somda *et al.* (2002); Sheikh *et al.* (2003); Nyanga (2012) and Lugandu (2013). The binary model is motivated by the fact that, when faced with a decision regarding an innovation, a farmer either adopts or rejects the technology (Agresti, 2007; Nyanga, 2012). The logistic regression model was chosen because there is widespread literature showing that farmer adoption decisions can be analyzed using logistic regression. The dependent variable for this study was the farmer being an adopter or a non-adopter of no-till CA, with a value of 1 (if the farmer was an adopter of no-till CA) and/or 0 (for a non-adopter of no-till CA). The logistic model predicts the logit of the response variable (adoption of no-till CA) from the independent variable(s). The likelihood of the farmer being an adopter of no-till CA is predicted by odds (Y=1), that is the ratio of the probability that Y=1 to the probability that $Y \neq 1$

Odd Y= $\frac{P(Y=1)}{(1-P(Y=1))}$ (1)

The binary logistic regression model is specified as follows (equation 2):

The logit (Y) is given by the natural log of Odds;

$$\ln\left(\frac{p(Y_i=1)}{(1-p(Y_i=1))}\right)=\log Odds = Logit(Y) \quad (2)$$

This can be expanded as

$$Logit(Y)=\alpha+\sum\beta_1 X_1+\sum\beta_2 X_2+....+\sum\beta_n X_n+\varepsilon_i \quad (3)$$

Where,

Y = dependent variable (adoption) with 1 = adopters and 0 = otherwise;

α = intercept;

$\beta_1,....,\beta_n$ = coefficients of independent variables;

$X_1,... ,X_n$ = the independent variables;

P (p) = probability of adopting no-till CA

1-P = probability that a farmer does not adopt no-till CA;

ln = natural log

With the independent variables of this model (X_1 = age, X_2 = gender, and so on), logistic regression for 'ADOPTION' in the study was expressed in the following form:

$$\log it(Adoption)=\ln\left(\frac{p}{1-p}\right)=\alpha+\beta_1 age+\beta_2 gender+\beta_3 edu+\beta_4 land+\beta_5 income+\beta_6 ext+\beta_7 CApro+\beta_8 EcoAct$$

(4)

The criterion used to assess the overall significance of the binary logit model was the log-likelihood ratio following Greene (2003). The variance inflation factors (VIF) were used to inspect the level of multicollinearity between the independent variables. The classification accuracy indicated the correctness of the model in predicting the adoption of CA. The explanatory variables used in the binary logit model were obtained from the literature, and the model indicated the significance of these variables in the adoption of the no-till CA technology.

3.5.3 Assumptions of the Model

The assumption of linear regression is linearity between variables, and this is usually violated when a categorical response variable is used. This violation is overcome by the logistic regression equation, which expresses the multiple linear regression equation in logarithmic terms (Peng, Lee, & Ingersoll, 2002). "The binomial distribution is the assumed distribution for the conditional mean of the dichotomous outcome. This assumption implies that the same probability is maintained across the range of predictor values" (Peng *et al.,* 2002: 11).

3.5.4 Independent Variables and their Expected Outcomes

The independent variables that were used in the model are guided by literature (already explained in *Chapter 2*). Table 3.1 shows the independent (explanatory) variables, their description and the expected outcome in relation to the dependent variable.

3.5.4.1 Farmer attributes

a) Age

Age was measured as a continuous variable and represented the age of the farmer (to the last birthday) when the survey was conducted. The variable was used to ascertain the age distribution of farmers who adopted and those who did not adopt no-till CA. Assuming that most respondents started farming at an early age, the variable could also be used as a proxy of experience in farming. Age was expected to positively influence adoption of no-till CA, meaning that older farmers would tend to adopt no-till CA more frequently than younger farmers.

Table 3.1: Explanatory variables, description, and the expected outcome

Variable	Description and measurement type	Variable type	Expected Outcome (+/-)
Age	Age of farmer (years)	continuous	+
Gender	Gender of farmer (1 = female 0 = male)	categorical	+
Education	Number of years of formal education	continuous	+
Economically active members	Proportion of household members economically active	continuous	+
Experience in farming	Experience in farming	continuous	+
Training	Training received on no-till CA (1 = Yes received, 0 = otherwise) (Dummy)	categorical	+
Extension	Frequency of extension visits per month (1 = does not visit, 2= once, 3= twice, 4= more than twice)	categorical	+
Access to credit	Have access to credit for agriculture (1 = Yes received, 0 = otherwise) (Dummy)	categorical	+
Promotion of no-till	Perception on promotion of no-till CA (1 = strongly disagree, 2= disagree, 3= neutral, 4= agree, 5 strongly agree)	categorical	+
Land sizes	Land sizes of arable land (Ha)	continuous	-
Income	Household income	continuous	-

(+/-) indicates a positive or negative relation with the dependent variable

b) Gender

Gender was measured as a categorical variable coded with 1=female and 0=male. The variable measured the gender dimension of adoption including all complications that are caused by it in terms of small-scale agriculture. Adoption was expected to be higher among females compared to males.

c) Education

Education is the number of years of formal education the farmer has starting from Grade R. It was measured as a continuous variable. The assumption was that adoption increases with more years of schooling (education). Thus, a more educated person is expected to appreciate new ideas better than a less educated and an educated farmer is also expected to be a quicker learner than their counterparts.

d) Economically Active Members

This was measured as a continuous variable. Instead of using family size, the study uses economically active members of the household as a proxy for labour availability. This is after the realization that higher family size does not necessarily translate to more family labour in the household. The variable 'Economically active members' was computed as the difference between total family size and number of dependents in the household. Dependents were defined as members 15 years and below and those 65 years and above. The final variable included in the model is presented as a proportion of the total household members. The study postulated that households with a larger proportion of economically active household members would adopt no-till CA compared to those with smaller proportions of economically active members.

e) Experience in Farming

Experience in farming was measured as a continuous variable. Farmers were asked to indicate their experience in farming in years. The variable measures farmers' knowledge in farming that is acquired over time. It was assumed that experienced farmers have a higher probability of adopting no-till CA compared to those with little experience in farming.

f) Perceptions about the Promotion of No-Till

The variable was used to measure farmers' perception on the promotion of no-till CA. It was measured on a Likert scale of 1-5. Farmers were asked a question on whether no-till CA should be promoted. The variable was measured as a categorical variable coded with 1 = strongly disagree, 2= disagree, 3= neutral, 4= agree, and 5 = strongly agree. Expectations were that the higher the scale, the more likelihood that a farmer will adopt no-till CA.

3.5.4.2 Information

a) Training

This was measured as a categorical variable with a yes and no answer. The variable was measured by asking farmers whether they had previously been trained in CA. Access to training is a key aspect of technology adoption, especially where new ideas are introduced. Technology adoption is higher among those who have received training compared to those who did not receive any training.

b) Access to Extension

Extension is an important aspect of smallholder farming due to its role in information dissemination. The study sought to measure both access to and intensity of extension services and thus used the number of extension visits per month to show these two aspects. This was to establish the role of extension contact in no-till CA adoption. No-till CA adoption was expected to be higher with increased extension contacts.

c) Access to Credit

Access to working capital is a challenge for small-scale farmers. The adoption of no-till CA means an investment on the part of the farmer that needs financial resources. The variable was measured in the study by asking farmers if they had access to credit loans. Access to credit was measured as a categorical variable with a yes and no answer. Adoption was expected to be high among farmers with access to credit compared to those without.

d) Land Sizes

This was collected as the size of land cultivated in the past agricultural production season (2014/2015). The land size was recorded in hectares and was considered to be a continuous variable. Literature indicates that small-scale farmers with smaller sizes of land were expected to adopt no-till and those who cultivated larger sizes of land to be non-adopters of the technology (Adeola, 2010; Lugandu, 2013).

e) Household Income

Income was collected as a proxy of the working capital available for use in farming. Each farmer was asked to indicate their estimated income per month in SA Rand. This income had to be calculated from all their livelihood sources. Income was measured as a continuous variable, and it was expected that farmers with a higher income would be adopters of no-till CA compared to those with a lower income.

3.6 Ethical Considerations

The study met the required minimum standards regarding research and safety as specified in the university's Policies and Procedures on Research Ethics documents (Appendix 2). Respect for the dignity of participants in any research is critical. Respect for dignity focuses on the moral rights of people such as the right to privacy, self-esteem, personal liberty and basic human rights. Since the study involved the participation of humans, the following considerations were made:

3.6.1 Privacy and Confidentiality

Individuals have a right to their privacy and confidentiality. They have the right to protection of data concerning their personal details. This right was respected as data gathered during the study was not divulged to any third party and was used solely for this research. Coding was used to link questionnaires to the study participants. No names were written on the questionnaire.

3.6.2 Informed Consent

Individuals have the right to decide what to do; that is to render their participation or to withdraw at any stage from the research. This right was respected in the study. Participants were asked to sign informed consent forms before they took part in the research (Appendix 3). This was done so that participants were able to indicate their agreement to participate in the study having understood the objectives of the research, how information would be used and the risks involved. In light of the vulnerability of research participants in South Africa regarding education, whenever a participant lacked the capacity to exercise an informed choice to participate, a proxy was identified by the investigator to make a choice for them. The proxy was usually a family member or close relative.

3.6.3 Language and Cultural Considerations

Every community and its people have a set of norms and values that describe their culture and personality as a people. Respect of cultural values and norms of the study community increases the integrity and credibility of data collected and the chances that the study will be a success. Thus, considerations were given to culture, language, beliefs, perceptions, customs, age, and gender. As indicated above, the questionnaire was translated into the local isiZulu language, and research assistants were recruited from qualified locals who understood the culture and tradition in local communities.

3.6.4 Recognition of Local Authorities

Local authorities such as traditional leaders in the study area had to be respected. The investigator recognized the authority of these institutions over the study area and the study subjects. The local authorities would also be the main consumers of the findings of the research, and hence it was important to acknowledge their presence before the start of the research. The research recognized the existence of regulatory authorities in the study area and hence sought audience and paid courtesy calls to the local municipality and tribal authority in Ward 8. In these meetings the investigator explained the objectives of the study, the study process and how findings were going to support policy formulation and decision-making.

3.7 Chapter Summary

The chapter has provided an explanation of how the research was conducted in terms of the research methodology. The focus was on the research design, conceptual framework, sampling approach, data collection process and methods of data analysis. The chapter also highlighted important ethical considerations that were made in the study. The questionnaire survey was the main data collection method and descriptive statistics, and the binary logistic regression model were used as the main analytical methods. Variables that were included in the logistic regression model are also described in this chapter.

The next chapter (Chapter 4) presents and discusses the descriptive results of the study.

CHAPTER 4. DESCRIPTIVE AND INFERENTIAL RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents and discusses the descriptive and inferential analyses results of the study stratified between adopters and non-adopters of no-till CA, focusing mainly on the socio-economic characteristics that are likely to influence the adoption of new innovation technologies. It also addresses the first objective of the study that is set out to investigate farmers' perceptions on no-till CA and their influence on maize productivity. Pearson Correlations and t-statistics are used to show how significantly different the two groups of farmers are (adopters and non-adopters). Section 4.2 analyzes key socio-economic characteristics while Section 4.3 provides an analysis of farmers' perceptions on how no-till CA affects the productivity of their maize enterprises.

4.2 Socio-economic characteristics

This section primarily focuses on the socio-economic characteristics of adopters and non-adopters and the likely influence of these on adoption of no-till CA. Table 4.1 present the results on the different attributes of adopters and non-adopters in the study area.

Table 4.1: Demographic characteristics of adopters and non-adopters

Variable	Adopters	Non-Adopters	T-test
Age	63 (12.2)	62 (11.6)	-0.45
Level of education	3.7 (3.3)	2.6 (3.2)	-2.46**
Household size	7.5 (1.8)	6.3 (1.8)	-4.65***
Percent economically active	0.23 (0.23)	0.28 (0.24)	1.3
Dependency ratio	3 (2.2)	2.1 (2.1)	-2.46**

Source: Own Survey (2015) ***; **; * means statistically significant at 1%, 5% and 10%; (.) – standard deviations

4.2.1 Age

The age of the farmer is assumed to affect the adoption of no-till CA positively. Results in Table 4.1 show that there was no significant difference between the age of no-till CA adopters and non-adopters. The average age of adopters was slightly higher; 63 years compared to non-adopters (62 years). In general, results showed that farmers who participated in the study were elderly. This conforms to the demographic structure of South Africa where the elderly are found in the rural areas and young people in the urban areas (Statistics SA, 2012). Although not statistically different from each other, these results confirm that adoption might be higher among the elderly compared to young small-scale farmers (Nyambose & Jumbe, 2013). The elderly headed households in rural communities are usually constrained in terms of finances and labour resources (Robertson *et al.,* 2012). This means such households do not have adequate family labour and cannot afford to hire additional labour to meet their required labour demands. Thus, the design of no-till CA technology should be such that it reduces the labour intensity of the technology.

4.2.2 Education

Results in Table 4.1 show that no-till CA adopters had a higher mean number of education years (3.7) compared to non-adopters (2.6). The difference in education level between the two categories of farmers was significantly different at 5%. However, education averages for both adopters and non-adopters show low levels of education among small-scale farmers.

The study reiterates the importance of education in the adoption of CA technologies. The findings are similar to results of other studies and tend to support the notion that the education level of a farmer is positively associated with the adoption of new technologies. Other studies have shown that higher education levels will increase the chances of adopting of no-till CA because educated farmers are more likely to easily understand and be receptive to new technology or innovations (Knowler & Bradshaw, 2007; Nyambose & Jumbe, 2013). The implication of these findings is that no-till CA programmes should have a strong training and extension component. Training will equip farmers with a basic understanding of the technicalities of the no-till CA while extension will give continuous day to day support for the technology.

4.2.3 Household Size

Household family size was significantly different at 1% between no-till CA adopters and non-adopters. Adopters had larger household sizes with an average of 7.5 members in each household compared to farmers who did not adopt who have a mean of 6.3 members per household. It is expected that households with a higher number of household members are more likely to adopt no-till CA since it is assumed that larger families have more labour available for farm operations such as weeding which are critical in no-till CA (Bationo *et al.,* 2007). However, this assumption does not always hold since labour availability depends not only on how large a household is but also on the ages and type of persons in that household (International Livestock Centre for Africa, 1990; Nguthi, 2008).

4.2.4 Economically Active Household Members

The assumption made in section 4.2.3 above was tested in the study by computing the proportion of economically active household members in each household. These are people falling within the ages of 15 to 65 years only. According to the Basic Conditions of Employment Amendment Act, 2013, the minimum age from which a child can offer productive labour within reasonable limits is 15 years while the retirement age in South Africa is 65 years. Results show limited labour availability in both categories of farmers. Although the proportion of economically active members was not statistically different between adopters and non-adopters, non-adopters had a slightly higher proportion of 0.28 compared to that of adopters (0.23). This shows that larger family sizes do not necessarily translate into more family labour for the household but can also be a sign of the level of economic burden in that household as shown in section 4.2.6 below. Findings confirm the assertion that family size might not always reflect higher labour availability (Adeoti, 2009) although in most cases it follows that households with larger household sizes have a higher adult equivalence.

4.2.5 Dependency Ratio

The dependency ratio is defined as the proportion of dependents in a household compared to economically active household members (United Nations, Department of Economic and Social Affairs, Population Division, 2010). It is used as a proxy to measure the economic burden of a given household. Results show that there was statistical difference ($p < 0.05$) between the dependency ratios of no-till CA adopters and non-adopters. Adopters had a larger dependency ratio of 3 compared to 2.1 for non-adopters. Findings suggest that the economic burden of the households might be an important factor in explaining adoption patterns (Sheik, Rehman & Yates, 2003; Kahimba *et al*., 2014). However, the fact that the dependency ratio for both categories of farmers is greater than 1 means that there are more dependents in a given household compared to economically active members and hence the economic burden is quite high among both the adopter and non-adopter households. This correlates with the poverty levels of the target community with 58% classified as having no income (Ingwe Annual Report, 2012/2013)

4.2.6 Gender

Results in Table 4.2 show that there was no significant difference between adopters and non-adopters of no-till CA regarding their gender ($p=0.78$). As expected results showed that more male farmers adopted the technology compared to female farmers. However, the same trend is also observed with non-adopters making it difficult to make conclusions regarding the effect of gender on adoption of no-till CA. According to Mazvimavi and Twomlow (2009), Chiputwa *et al.* (2011) and Kahimba *et al.* (2014), adoption of no-till CA is expected to be higher for male farmers compared to female farmers. This is due to the alteration of the productivity of labour between men and women given that, in African communities, women already provide much of the labour in agriculture (Lubwama, 1999). In such situations, a new technology might result in more labour demand and may thus increase the burden of work on women.

Table 4.2: Gender distribution among no-till CA adopters and non-adopters

	sex		Total (%)
	Female (%)	**Male (%)**	
adopter	46.4	53.6	100
non-adopter	44.3	55.7	100
Total	45.4	54.6	100

P = 0.78

Source: Own Survey (2015)

4.2.7 Land sizes

The size of land cultivated by farmers was significantly different between no-till CA adopters and non-adopters with a p-value of less than 0.05. Results in Table 4.3 show that farmers who did not adopt no-till CA cultivated bigger mean land sizes compared to adopters. Non-adopters cultivated an average of 1.94 hectares of land compared to 1.3 hectares for adopters. This means if the land is an important factor in no-till CA adoption it will mostly likely negatively influence adoption of the technology. Similar to the results found by Adeola (2010) and Lugandu (2013). The implications of these findings for no-till CA is that the technology should be able to improve the production efficiency of the maize enterprise if it is to have any significant impact on the food security and general livelihoods of small-scale farmers. Farmers should be able to produce significantly more on their smaller pieces of land.

Table 4.3: Mean land sizes and income by no-till CA adoption

Variable	**Adopters**	**Non-Adopters**	**T-test**
Mean land cultivated (ha) (Std Dev)	1.3 (1.0)	1.94 (1.7)	3.16**
Mean income per month (R) (Std Dev)	1746 (1268)	1271 (582)	-3.22**

Source: Own Survey (2015) ***; **; * means statistically significant at 1%, 5% and 10%

4.2.8 Income

Income levels between no-till CA adopters and non-adopters were statistically different at 5%. Adopters had a mean higher income of R1 746 compared to R1 271 for non-adopters (Table 4.3 above). Higher incomes are associated with higher levels of adoption rates (Kahimba *et al*., 2014; Sheikh *et al*., 2003). Higher income means that the farmer can buy inputs for farming and hence can engage in conservation agriculture.

Table 4.4: Sources of income of no-till CA adopters and non-adopters

Income source	Adopters	Non-Adopters	P-value
Farming	51	5	0.000
Government grant	78	74	0.474
Remittances	17	19	0.616
Piece work	33	65	0.000
Formal employment	5	10	0.193
Livestock	23	39	0.018

Source: Own Survey (2015)

Table 4.4 above shows income sources for both categories of farmers. The proportion of no-till CA adopters who indicated farming as a source of income was significantly different from that of non-adopters at 1%. Fifty-one percent (51%) of the adopters indicated farming as a source of income compared to only 5% of the non-adopters. This means that non-adopters are likely to be people who do not necessarily rely on crop farming as a source of income. The percentage of adopters and non-adopters who selected piece work as their source of income was also significantly different at 1%. Sixty-five percent (65%) of no-till CA non-adopters do piece work to earn an income compared to 33% of no-till CA adopters. In general, more non-adopters on no-till CA are involved in piece work, livestock sales and formal employment compared to adopters. Adopters of no-till CA’s top three sources of income are government grants, farming and piece work. Further probing during interviews revealed that government grants describe mostly social support grants received by households that qualify for the child, disability and old person support from the Department of Social Development.

4.2.9 Frequency of Extension Visits

For this study, the number of extension visits was used to measure the level of access to extension services by farmers involved in the study. This indicator measures both access to and intensity of extension support given to farmers. Results show that there was a statistically significant difference ($p<0.01$) between no-till CA adopters and non-adopters in terms of their access to public extension services. Adopters had higher access to extension services compared to non-adopters (Table 4.5 below). While more than half no-till CA adopters (about 56%) are visited three and more times per month, only about 19% non-adopters reported the same. Similarly, while about 31% non-adopters reported no extension visits from extension officers only, about 3% adopters reported the same frequency of visits.

These results suggest that access to extension positively affects the level of adoption of no-till CA. Extension services are the main source of agriculture-related information for farmers in rural communities of South Africa (Liebenberg, 2015). These services are offered mainly through the Department of Agriculture and Rural Development under the Ministry of Agriculture. However, besides government departments, there are also some non-state actors such as non-governmental organizations and private companies (particularly those that sell agricultural products) that also offer extension advice to farmers. However, the country has limited capacity to offer agricultural advisory services especially in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga having the biggest shortages (Liebenberg, 2015). According to recommended standards for subsistence farming in the country, the extension to farmer ratio should be 1:500. Based on this information and farmer populations data, Kwa-Zulu Natal which currently has 360 extension staff, needs 710 extension agents to attain the recommended extension to farmer ratio (Williams *et al.*, 2008; Liebenberg, 2015). This leaves a shortfall of 350 extension staff required for effective extension in the province, showing the magnitude of the capacity challenges.

Table 4.5: Other socio-economic characteristics between adopters and non-adopters

Variable		Adopters (%)	Non-Adopters (%)	Chi-square
Extension visits (per month)	No visits	3.1	30.7	38.8***
	One visit	18.6	26.1	
	Two visits	22.7	23.9	
	3 and above visits	55.7	19.3	
	Total	**100**	**100**	
Access to credit (Yes/No)	Yes	10.3	2.3	4.91**
	No	89.7	97.7	
	Total	**100**	**100**	
Awareness on CA (Aware/Not aware)	Aware	100	88.6	11.65**
	Not aware	0	11.4	
	Total	**100**	**100**	
Received training on CA (Yes/No)	Yes	100	2.3	177.1***
	No	0	97.7	
	Total	**100**	**100**	

Source: Own Survey (2015)   ***; **; * means statistically significant at 1%, 5% and 10%

4.2.10 Access to Credit

Access to credit among the surveyed small-scale farmers in Ingwe Ward 8 was very low. In total, only about 7% of the surveyed farmers had access to credit. The source of this credit was mainly the government. Small-scale farmers are unable to access loans from formal financial institutions because they are not credit worthy and cannot meet the collateral conditions as demanded by these institutions.

A comparison between adopters and non-adopters of no-till CA show that access to credit was statistically different between the two at 5% level of significance. A higher proportion of adopters of CA (about 10%) has access to credit compared to only about 2% of non-adopters (Table 4.5). This supports conclusions by Lubwama (1999) that access to credit has a positive relationship on the adoption of new technologies (Lubwama, 1999). Access to credit is important because farmers facing financial constraints may not be able to optimize production (Sikwela, 2013). Findings confirm the importance of formal and informal institutions that provide affordable credit loans to small-scale farmers. The role of informal saving and lending institutions such as ‘stokvel’ to offer soft loans to farmers should be strengthened because most small-scale farmers cannot meet the credit conditions of formal institutions such as the Land Bank and commercial banks (Sebopetji, 2008).

4.2.11 Training

The study sought to determine whether adopters and non-adopters of CA had received previous training in CA. Results in Table 4.5 above show that only about 2% non-adopters received training in CA compared to 100% adopters who indicated the same. The result was significantly different at 1% level of significance. It is expected that training on CA increases the chances of adoption of no-till CA (Nyanga, 2012). CA training in for the farmers was provided by the government and other stakeholders such as LIMA. Topics covered in the training included no-tillage, crop residue management, weed management and nutrient management among others as indicated by respondents.

4.2.12 Perceptions on the Promotion of No-Till CA

A positive perception on the promotion of no-till CA will likely have a positive influence on its adoption. Perceptions on the promotion of no-till CA were significantly different between adopters and non-adopters of CA ($p<0.01$). Results showed that about 65% of adopters had positive perceptions regarding the promotion of no-till CA compared to about 60% of the non-adopters. About 21% and 44% of adopters strongly agreed and agreed, respectively, that no-till CA should be promoted. There was a higher proportion of non-adopters (about 40%) compared to about 26% adopters who had negative perceptions on no-till CA promotion. These results point to a positive relationship between perceptions on no-till CA and adoption.

Table 4.6: Perceptions on no-till promotion and adoption

	Strongly agree (%)	**Agree (%)**	**Neutral (%)**	**Disagree (%)**	**Strongly disagree (%)**
Adopter	20.6	44.3	9.3	23.7	2.1
Non-adopter	14.8	45.5	-	14.8	25.0

Source: Own Survey (2015)

Perceptions are part of the psychological capital of an individual. Positive psychological capital is associated with having a state of confidence and the commitment to work hard to succeed at difficult or near impossible tasks while also having the willingness to forgo current consumption and take risks for future benefit (Yang & Lan, 2009; Gupta & Singh, 2014). People with positive psychological capital are willing to learn and try new ideas and innovations.

4.2.13 Crop Farming

Analysis of cropping patterns showed that there was no diversification in crops cultivated by farmers. This could be because the study primarily focused in a ward which was previously targeted by a dryland maize intensification programme implemented by the DARD. All the farmers indicated that they do maize cultivation while only about 2% were also engaged in vegetable production.

Table 4.7 below presents maize yield results for adopters and non-adopters of no-till CA. Results showed that maize yield for non-adopters was significantly lower than that of adopters of the technology. Adopters had a mean maize yield per ha of 1 044kg while non-adopters' mean yield is 759kg per hectare. *Ceteris paribus,* the higher maize productivity can be credited to the benefits of CA, namely soil moisture conservation, improved soil structure and better soil quality (fertility), among others.

Table 4.7: Mean maize yield (kg/ha) between adopters and non-adopters

Variable	Adopters	Non-Adopters	T-test
Maize yield/ ha	1044 (1097)	759 (523)	-2.22**

Source: Own Survey (2015) ***; **; * means statistically significant at 1%, 5% and 10%; (.) - Standard deviation

4.3 Farmer's Perceptions on No-Till CA and its Impact on Maize Productivity

This section presents an analysis of selected farmer perceptions on no-till CA and its likely impact on maize productivity. The analysis is based on the small-scale farmers' perceptions regarding promotion of CA and the cost of no-till CA.

4.3.1 Perceptions on the Promotion of No-Till CA and Maize Productivity

Perceptions of small-scale farmers on the promotion of no-till CA are positively related to maize productivity. Table 4.8 shows aggregated (adopters and non-adopters) results of a One-way ANOVA on CA promotion and maize yield. Results showed that maize yield increases as perceptions of no-till CA promotion change from negative to positive. Farmers who had a very negative perception regarding the promotion of no-till CA had an average maize yield of 755kg per ha while farmers who had a very positive perception on no-till CA promotion had an average maize yield of 1 229.8kg per ha. While this analysis does not necessarily prove causality it still shows a relationship between farmer perceptions on no-till CA and the performance of the maize enterprise. Positive perceptions show that the farmer is willing to accept, learn and try the technology and hence will likely have better yields compared to those that do not accept and adopt the technology.

Table 4.8: CA promotion and maize yield (kg/ha) per ha

		N	Mean	Std. Deviation
Should no-till CA be promoted	Strongly agree	33	1229.8	744.6
	Agree	83	876.5	1079.9
	Neutral	9	715.3	449.1
	Disagree	36	840.7	684.6
	Strongly disagree	24	755.4	562.1
	Total	185	909.0	882.2

Source: Own Survey (2015)

Table 4.9 shows a comparison of perceptions on no-till CA and maize yield for adopters and non-adopters of the no-tillage farming practice. For adopters of no-till CA, the trend is similar to the one described in Table 4.8 above, where maize yield increases as perceptions on no-till CA promotion transform from being negative to positive. However, results for non-adopters do not show any trend that can be discussed to inform this analysis.

Table 4.9: CA promotion and maize yield (kg) per ha by no-till CA adoption

CA promotion		N	Average maize yield	Standard Deviation	Standard Error
Adopters	Strongly agree	20	1535.0	789.8	176.6
	Agree	43	968.7	1400.0	213.5
	Neutral	9	715.3	449.1	149.7
	Disagree	23	939.9	765.8	159.7
	Strongly disagree	2	472.2	39.3	27.8
	Total	97	1044.9	1097.5	111.4
Non-adopters	Strong agree	13	760.4	311.0	86.3
	Agree	40	777.4	567.3	89.7
	Disagree	13	665.1	489.6	135.8
	Strongly disagree	22	781.1	581.0	123.9
	Total	88	759.2	523.2	55.8

Source: Own Survey (2015)

4.3.2 Perception on Costly CA Operation and Maize Productivity

No-till CA adopters were asked to indicate their views on which component of no-till CA they thought was more expensive. Results showed that the majority of adopters (about 98%) believe that inputs are the most expensive while only about 2% indicated weed management to be costly. Farmers indicated that they are not getting any input support whether from the government or any other source. Hence, as much as some are interested in no-till CA they do not have necessary inputs to participate.

Table 4.10 shows that the few farmers who indicated that weed management is more expensive had a higher average maize yield compared to those that believe inputs are the most expensive component of no-till CA. Those that indicated weed management costs had a maize yield of over two tonnes of maize per ha while farmers who said inputs were the most expensive had a yield just over one tonne. Farmers who believe inputs are the most expensive are likely to be farmers facing challenges with access to inputs (seed, fertilizers) and agro-chemicals (pesticides and herbicides). This situation is also reflected in their lower yields.

Table 4.10: Perceptions on costly CA operation and mean maize yield per ha

Perceived costly CA operation	Percentage (%)	Mean yield (kg) per ha
Weed management	2	2145.0
Inputs	97.9	1021.7

Source: Own Survey (2015)

4.4 Chapter Summary

This chapter has presented and discussed results from descriptive, and inferential analyses to obtain a better understanding of adopters and non-adopters of no-till CA. Farmer perceptions on no-till CA on maize productivity were also explored. In general, more male farmers are adopters of no-till CA than female farmers. Education levels among both types of farmers are low, and there was a significant difference between the two, meaning that education could be a potential determinant of adoption of no-till CA. Although adopters have larger household sizes compared to non-adopters, the results have shown that this does not translate to more labour availability on the farm but does reveal high levels of economic burden in such households.

There was a significant difference in land, income, access to credit, access to extension, group membership and training on CA. Non-adopters of no-till CA cultivated larger pieces of land, had lower incomes and limited access to extension and credit. They also did not participate in groups, and few received training on CA. All these socio-economic factors could be important determinants of no-till CA adoption for farmers in Ingwe, Ward 8. Farmer perceptions on the promotion of no-till CA were also positively related to maize yield.

Findings showed that farmers who support the promotion of no-till CA had higher maize yields compared to those who did not support no-till CA promotion. Positive perceptions show readiness of the farmer to accept the technology and learn. It also determines the level of commitment that the farmer will put in their no-till CA farming, which affects their output. Further analysis confirmed this finding with farmers who adopted no-till CA and had positive perceptions of CA promotion having higher maize yields compared to those that had negative perceptions of its promotion.

The following chapter presents and discusses the empirical results of the study on factors influencing no-till CA adoption in the study area.

CHAPTER 5. EMPIRICAL RESULTS AND DISCUSSION - FACTORS INFLUENCING THE ADOPTION OF NO-TILL CA

5.1 Introduction

This chapter presents and discusses the analysis of the factors influencing the adoption of no-till CA in Zashuke. The work by Knowler and Bradshaw (2007) analyzed 31 studies on farmers' adoption of CA and highlighted several factors that have an effect on the adoption of the technology. The different studies were conducted in sub-Saharan Africa and the American region. In this study, the binary logit model used some of these factors identified to significantly influence farmers' adoption of conservation agriculture based on the availability of data and to suit the objective of the study. The following variables were included in the model to elicit their influence: age of the farmer, gender of the farmer, education, economic activity ratio, experience in farming, training (yes/no), access to credit (yes/no); land (farm) size, income, extension services and perception on no-till CA promotion.

The next section 5.2 briefly explains why some variables were dropped from the model while model results and discussion are presented under section 5.3. The summary of the chapter is presented in section 5.4.

5.2 Variables Excluded from the Model

As indicated in Section 3.5.4 in Table 3.1, there were several variables that were targeted for inclusion in the model. However, for various reasons, some of the variables were eventually excluded from the final model. Multicollinearity diagnosis statistics between two potential independent variables (age and experience in farming) revealed perfect collinearity between these two variables. Thus, one of the variables (namely experience in farming) was eventually excluded from the model. Running the model in Stata 13 resulted in more variables that were excluded from analysis. Stata results show that the model automatically excluded training on no-till CA and access to credit because the variables were perfectly predicting success (adoption) or failure (non-adoption) of adoption.

5.3 Results on the Factors Influencing the Adoption of No-Till CA

Table 5.1 presents the results of the binary logistic regression used to determine factors which were identified to influence adoption of no-till CA significantly. Results showed that factors associated with adoption of no-till CA technology were:

- the frequency of extension worker visit (EXT_VISITS);
- perception on no-till CA promotion (CA_PROMO);
- age of farmer (AGE);
- the level of education in years (EDU_YEARS); and
- total cultivated land in ha (CULT_LAND).

Multicollinearity diagnosis statistics revealed no significant correlation between the explanatory variables. VIF ranging from 1.07 to 2.34 was within an acceptable range, which is less than 10 (Rogerson, 2001; Pan & Jackson, 2008). The overall classification accuracy of 74.1% illustrates that the model successfully predicted the adoption of no-till CA. The Chi-Square test was significant at $p < 0.01$ indicating a good predictive capacity of the model. Results and discussion of several factors that influence adoption of no-till CA follow.

The variable *age of the farmer (AGE)* positively influenced no-till CA adoption and was statistically significant at 5% significance level (p=0.008). The coefficient of the age of the farmer was positively associated with adoption of no-till CA, which indicated the receptiveness of the technology among the older farmers. An additional year in the age of the farmer increased the log odds of adopting no-till CA (versus non-adoption) by about 1.06 (odds ratio=1.067) times. Adoption of the technology by older farmers may be attributable to the fact that older people may have better access to resources (for example, land ownership), coupled with experience and knowledge gained over time than younger farmers. These results confirmed findings from the work of Nyambose and Jumbe (2013). However, Nyanga (2012) and Arellanes and Lee (2003) provided contrary evidence to this finding, the former arguing that older farmers were accustomed to conventional methods of farming and were unlikely to change.

Table 5.1: Estimates of the Binary Logit Model

Variable	Coefficients	Odds Ratio	Std. Err.	z	P>z	VIF
CONSTANT	-5.528	0.004	0.008	-2.75	0.006	
GENDER	-0.390	0.677	0.278	-0.95	0.343	1.14
AGE	0.065***	1.067	0.026	2.64	0.008	2.05
EDU_YEARS	0.194**	1.214	0.113	2.09	0.037	2.34
CULT_LAND	-0.272*	0.762	0.115	-1.81	0.071	1.07
INCOME	0.000	1.000	0.000	1.63	0.104	1.4
EXT_VISITS						
ONCE_MONTH	1.911**	6.762	5.091	2.54	0.011	1.87
TWICE_MONTH	1.711**	5.539	4.171	2.27	0.023	2.08
THREE_ABOVE	3.284***	26.697	19.963	4.39	0.000	2.3
ECON_ACTIVE_RATIO	-0.257	0.774	0.681	-0.29	0.771	1.21
CA_PROMO						
AGREE	-0.812	0.444	0.238	-1.51	0.131	2.01
NEUTRAL	-	1.000	-	-	-	1.3
DISAGREE	-0.121	0.886	0.551	-0.19	0.846	1.74
STRONGLY DISAGREE	-2.810***	0.060	0.055	-3.06	0.002	1.53
Number of observations		174				
LR Chi-square (Prob > Chi-square)		76.7 (p=0.000)				
Nagelkerke (Pseudo) R^2		0.32				
% of Correct Prediction		74.1%				

Source: Own Survey (2015) ***; **; * means statistically significant at 1%, 5% and 10%

The variable *farm size cultivated (CULT_LAND)* significantly and negatively influenced the adoption of no-till CA. Larger pieces of land were associated with farmers being less likely to adopt the no-till CA technology, in comparison to the group of farmers with smaller land. With a unit increase in the land (an additional hectare of land), the results showed that such farmers were about 33.8% (odds ratio=0.762) less likely to adopt no-till CA. Management practices may not be sustainable on larger pieces of land. This study emphasized that farm labour requirements on larger tracts of land may exert additional farm labour demands, which the household unit is unable to provide. This emphasis is supplemented by Adeola (2010) and Lugandu (2013), who concur that farmers utilizing small farm sizes are more likely to adopt new technologies. This may possibly be to maximize land utilization of their small farm sizes under cultivation. On the contrary, larger tracts of land may also influence adoption as stipulated by Nyanga (2012) and Nyambose and Jumbe (2013).

The variable *frequency of extension worker visits (EXT_VISITS)* was categorized into four groups. Results in Table 5.1 show three odd ratios, each describing a relationship with the adoption of CA. The reference was the odds of a farmer having no visits from a local extension worker. The results showed that farmers who reported an extension visit once a month (ONCE_MONTH) had nearly seven (odds ratio=6.762) times the odds of adopting the technology (statistically significant at 5% significance level (p=0.011). In the same way, farmers who reported an extension visit of twice a month (TWICE_MONTH), and more than 3 times per month and above (THREE_ABOVE) have a higher odds of adopting no-till CA about 5.5 times (odds ratio=5.539) (statistically significant at 5% significance level (p=0.023) and about 26.7 times (odds ratio=26.697) (statistically significant at 1% significance level (p=0.000) respectively than those with no extension worker visits. The findings are consistent with the work of Nyambose and Jumbe (2013) and Arslan *et al.* (2014). Therefore, farmers that have more frequent visits from extension workers are more likely to adopt technologies or farming practices which they are exposed to through extension services. In this case, frequent extension services increase the odds of a farmer adopting conservation agriculture as a farming practice.

The variable *number of years in education (EDU_YEARS)* of the farmer positively influenced the adoption of no-till CA (statistically significant at 5% significance level (p=0.037). An additional year in the years of education attained by the farmer is associated with the log odds of adopting no-till CA (versus non-adoption) increasing by about 1.2 (odds ratio=1.214) times. These findings are consistent with other studies, such as the work by Langyintuo and Mekuria (2000), Bisangwa (2012), and Nyambose and Jumbe (2013). Nyambose and Jumbe (2013) cited Nakhumwa (2006), who argued that education is a helpful tool for farmers in analyzing choices and making decisions about forecasts of the anticipated benefits of adopting technologies.

Results showed the variable *perceptions of farmers on no-till CA promotion (CA_PROMO)* was negatively related to the likelihood of a farmer adopting no-till CA. Perceptions on no-till CA promotion were measured on a Likert scale which was categorized into five categories (1- strongly agree, 2- agree, 3-neutral, 4-disagree and 5- strongly disagree). As the scale increased, perceptions on the promotion of no-till CA become negative. The base category in the model is the odds of a farmer having a very positive perception of no-till promotion; strongly agreeing to no-till CA promotion. Results in Table 5.3 showed that farmers who had a very negative perception regarding promotion of no-till CA, strongly disagreeing with no-till CA promotion, are less likely to adopt no-till CA by about 94% (odds ratio=0.060) (statistically significant at 1% level (p=0.002) compared to farmers who strongly agreed with no-till CA promotion. This showed that as farmers' perception on no-till CA promotion changed in a positive way, they were most likely to adopt the technology. These results confirmed findings by Adesina and Zinnah (1993) and Adesina and Baidu-Forson (1995) and showed that farmers' perceptions had an effect on adoption of agricultural technologies.

5.4 Chapter Summary

The chapter presented and discussed the empirical analysis on the factors influencing the adoption of no-till CA in Ingwe Municipality, Ward 8. The factors associated with adoption of no-till CA technology were identified by using the binary logistic regression model. The analysis revealed the significant predictors of the adoption of the technology to be: age of farmer, size of cultivated land, frequency of extension worker visit, the number of years in education and perceptions of a farmer on no-till CA promotion. The age of the farmer, frequency of extension worker visits and the number of years in education were found to be positively related to the adoption of no-till CA whereas the size of cultivated land and negative perceptions of a farmer on no-till CA promotion were found to be negatively related to the adoption of no-till CA. Other factors such as the gender of the farmer, income earned and economically active members of the households were not significant determinants of no-till CA adoption in this dataset.

CHAPTER 6. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter presents a summary of study findings, makes conclusions and formulates recommendations informed by the findings of the study and lastly directions for future research.

6.2 Recapping the Purpose of the Research

Small-scale farming is seen as a key sector in the South Africa's National Development Plan (2030). Efforts to revitalize this sector are envisaged to lead to income and employment creation and ultimately economic growth. However, concerns have been raised by government and state organizations about low productivity, poor product quality, and low profitability of small-scale farming. There are several biophysical and socio-economic challenges faced by small-scale farmers that prevent them from contributing effectively to the growth of the country's economy. One of these challenges is land degradation due to improper planting methods and the reluctance of farmers to embrace new farming practices such as no-till CA. Land degradation results in poor soils and threatens sustainable agriculture. However, no-till CA provides a solution that will not only result in improved soil quality but has other benefits as cited in literature such as saving labour, improving water use efficiency, increasing profitability due to higher yield and reducing costs and environmental sustainability. Thus, it is imperative to promote and encourage the adoption of is new farming methods among small-scale farmers. Critical to this process is the building of a body of knowledge that seeks to characterize and understand South African small-scale farmers and factors that lead adopting or not adopting new farming technologies. Understanding these results in the ability to design appropriate strategies and interventions and better farming methods such as no-till CA.

This study focused on investigating farmers' perceptions and the factors influencing the adoption no-till CA in Kwa-Zashuke Ward 8 in Ingwe Municipality in KwaZulu-Natal Province. Specifically, the study sought to:

(i) investigate farmers' perceptions on no-till CA and its impact on maize yield, and
(ii) determine the factors influencing the adoption of no-till CA in the study area.

The study adopted a cross-sectional design and used a set of demographic and socio-economic questions to gather data for providing answers to the research questions and meeting the objectives of the study. A combination of t-statistics and chi-square tests were used to get a greater understanding of the socio-economic differences between adopters and non-adopters of no-till CA in Chapter 4. The same chapter also presented results and discussions to answer the first objective of the study regarding the impact of farmer perceptions on no-till CA promotion, on maize productivity. Chapter 5 presented results from the analysis of factors influencing the adoption of no-till CA among farmers in the study community. Logistic regression was employed in the analysis.

6.3 Chapter Summary

Characterization of adopters and non-adopters according to their demographic and socio-economic characteristics revealed that most of no-till CA adopters were female and farmers with better education levels. No-till CA adopters were more economically burdened due to larger numbers of dependents in their households compared to non-adopters. Furthermore, the results confirmed results from earlier adoption studies. They showed that no-till CA adopters cultivated smaller sizes of land, had higher average incomes and were more exposed to extension services compared to non-adopters. These were also households with better access to credit and had received training in CA, and their perceptions on the promotion of no-till CA were quite positive.

Findings also revealed that there was a positive correlation between farmers' perceptions on the promotion of no-till CA and maize productivity, *ceteris paribus*. The results of farmers who felt that no-till CA should be promoted showed that they had higher maize yields compared to those who thought/felt otherwise. Also, adopters with positive perceptions regarding the same also tend to have higher yields compared to those with a negative perception on no-till CA promotion.

The study revealed five factors that influenced adoption of no-till CA in the study area namely, the age of the farmer, land sizes, years of formal education, the frequency of extension worker visits, and farmer perceptions on no-till CA promotion. Other predictors such as gender of the farmer and household income did not significantly affect adoption. The empirical model results showed that old age, more years of education and frequent extension visits increased the likelihood of a farmer adopting no-till CA. In contrast, larger land sizes were found to be associated with reduced odds of farmers adopting no-till CA and similarly farmers with a negative perception of no-till CA were also found to be less likely to adopt the technology.

6.4 Conclusions

The limited involvement of young people in smallholder farming poses a threat to the sustainability of new methods of farming practices such as no-till CA. Van Niekerk et al. (2011) stated that one of the problems in small-scale farming is the lack of involvement of young people in the sector. In farming, knowledge has been handed over from generation to generation through the elderly teaching young people to carry on with their traditions. Thus, it is important to assess how small-scale farmers view no-till CA. Acceptance of the technology as a new farming method in the community will impact on its continued promotion and existence in the community.

The study has shown the importance of extension contact in the promotion of new farming technologies. It managed to show that extension access alone is not enough, but the intensity of the extension services is critical in determining the level of adoption. Working with the elderly with limited formal education can be a challenge when introducing new concepts such as no-till CA. Their minds are usually willing, but some might be slow in grasping all the technical issues in the new technology. This points to the need for increased extension contacts between the extension agents and the farmer.

Farmers with positive perceptions of no-till CA are more likely to adopt the technology and be committed to seeing it succeed on their farms. Perceptions are part of the psychological capital of an individual and those farmers who have positive attitudes and are long-term focused will adopt no-till CA technologies.

6.5 Recommendations

Based on the findings of this study, it is important to make considerations in targeting larger households and older farmers who are more likely to be adopters of no-till CA. However, the attitudes of young people towards farming needs to be changed, and conditions created that support their entry into farming in the early stages of their lives. This means that the curriculum at school level (both lower and higher learning) and lucrative job opportunities in the sector should be geared towards creating this interest. Coupled with support at the household level, an environment can be created where new farming methods such as no-till CA are not only adopted but can be sustained from generation to generation.

Increasing extension contact with farmers is important in influencing adoption of CA. The ratio of extension worker to farmer needs to be improved if this is to be achieved. More young people need to be trained as extension agents. This can be achieved by providing resources for higher learning institutions to produce quality agents and by marketing the extension advisory services to young people as a lucrative job.

To enhance the adoption of no-till CA, there is a need to change mindsets and farmer perceptions on new farming methods in smallholder farming communities. The study has shown that negative perceptions were associated with decreased likelihood of no-till CA adoption. Again, the descriptive analysis showed that positive perceptions were associated with increased yields. Thus, there is a need to train farmers on no-till CA technology to improve their appreciation of the methods, especially in areas where farmers have a limited opportunity for and exposure to formal education. The extension information needs to be carefully packaged and disseminated in such a way that it is understood by even those with little formal education. In addition, refresher training should be supported to the extent that the technology is accepted as a norm and the benefits are appreciated by all in the community.

6.6 Suggestions for Further Research

The study results showed that a relationship exists between farmer perceptions and maize productivity. However, the study has fallen short of proving causality between farmer perceptions on no-till CA and maize productivity. This is in recognition of several other factors that might affect maize yield other than farmer perceptions. Econometric modelling could be employed in this regard which will show not only the direction of causality, but also the extent (magnitude) to which farmer perceptions affect maize yield. Such findings are important in informing recommendations for policy decisions regarding CA and small-scale farming.

The study was only done in a single ward in Ingwe Municipality, KwaZulu-Natal Province. There are many sites where no-till CA has been tried across the country. It is important to compare results from similar studies across different sites in the country. This will provide a comparative assessment and a more comprehensive analysis of results that paves the way for concrete recommendations of national significance.

There is a need to conduct a similar study using a combination of quantitative and qualitative methods in assessing farmer perceptions. The use of the two methods will offer triangulation and complementarity, resulting in more robust research results.

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APPENDIX

Appendix 1. Survey Questionnaire

PERCEPTIONS ON THE ADOPTION OF NO-TILLAGE CONSERVATION AGRICULTURE (CA) BY SMALL-SCALE FARMERS IN KWA-ZASHUKE WARD 8, INGWE MUNICIPALITY, KZN

General Details

Date		Farmer	
Village name		Ward No.	
Enumerator		Questionnaire code	

1. Socio demographic information

No.	Questions	Coding Categories	SKIP
101	Sex of the farmer	1 Female 2 Male	
102	Age of farmer	[__|__]	
103	Level of education (number of years)		
104	Household size	[__|__]	
105	What is the total number of people 0-15 years in the household?	[__|__]	
106	What is the total number of people above 65 years in the household?	[__|__]	
107	Experience in farming (years)	[__|__]	
108	Employment status of household head	1 Not employed (only farming) 2 Formal employment 3 Informal employment (trading, casual work, e.t.c) 4 Self employed	

2. Farming and income

201	Size of land cultivated (ha)	[__|__]		
202	Land ownership	1 Own garden 2 Renting 3 Borrowed 4 Others specify________		
203	Type of land ownership	1 Customary land 2 Private/Leasehold land 3 Public land		
204	Estimate total income (Rand per month)	R…………………………		
205	Estimate % distribution of income	Farming [__|__] Government grant [__|__] Remittances [__|__] Piece works [__|__] Other (specify) [__|__]		
206	Crops grown (Multiple responses possible)	1 Maize 2 Groundnuts 3 Cotton 4 Soyabean 5 Groundnut 6 Vegetables 7 Tomatoes 8 Others (specify)__________		
207	Please indicate harvest for each crop grown indicated above	Crop	Output (kg)	

208	Livestock kept (Multiple responses possible)	1 Cattle 2 Goats 3 Sheep 4 Pigs 5 Chicken 6 None 7 Others (specify) ____________		
209	Please indicate farming implements that you have access to. (Multiple responses possible)	1 Hoes 2 Ox-drawn plough 3 Tractor 4 Planter 5 Ridger 6 Others (specify) ____________		
210	D o you have access to credit loans	1 Yes 2 No		

3. CA Information Dissemination

301	Do you belong to any farmer group?	1 Yes 2 No	**If no: 303**
302	If yes in question **301,** which group?	1 Irrigation group 2 Livestock group 3 Soil and water conservation group 4 Agro-forestry group 5 Others (Specify)_______________	
303	If no in **301,** why don't you belong to any farmer group?	1 Not interested 2 There is no farmer group 3 The group disbanded 4 Can't afford membership fee 5 Others (specify) ________	

304	Do you have an extension worker in this area?	1 Yes 2 No	**If no: 401**
305	If yes to 304, which organisation does the extension belong?	1 Dept of Agriculture 2 NGO 3 Farmer group 4 Others (specify) ___________	
306	How frequent does an extension worker visit you in a month?	1 Doesn't visit 2 Once a month 3 Twice a month 4 More than twice a month	

4. Conservation Agriculture

401	Have you ever heard of conservation agriculture?	1 Yes 2 No	**If no: 416**
402	If yes to question 401 where did you hear about conservation agriculture?	1 Dept agriculture extension worker 2 Fellow farmer 3 NGO extension worker/officer 4 Attended field day 5 Others (specify) ___________	
403	Have you ever been trained in conservation agriculture?	1 Yes 2 No	
404	If yes to question 403, What were the topics covered?	1 No-tillage 2 Crop residue management 3 Weed management 4 Nutrient management 5 Others (specify)_____________	
405	Level of adoption	1 Practicing CA 2 No longer practicing 3 Never practiced conservation agriculture	**If no: 416**

406	For responses 1 and 2 in **405,** how did get your initial inputs to start conservation farming?	1 I bought with my own cash 2 Loan 3 Grant 4 Others (Specify) ____________	
407	For response 1 in **405,** why are you practicing conservation agriculture?	1 Soil conservation 2 Soil fertility improvement 3 High yielding 4 Low cost 5 Low labour demanding 6 Others (specify) ____________	
408	For response 2 in **405,** Why did you stop conservation agriculture? (Multiple responses possible)	1 Expensive 2 Labour demanding 3 Low yielding 4 Grants stopped 5 Did not pay back loan 6 Others (specify) ____________	
409	For responses 2 and 3 in question **406,** would you still be practicing conservation agriculture if input support stops?	1 Yes 2 No	
410	If no in question 409, why would you not be practicing CA?	1 Expensive 2 Labour intensive 3 Low yielding 4 Others (Specify) ____________	
411	What challenges are you/did you encountering/encountered in conservation farming?	1 Input scarcity 2 Equipment not available 3 Destruction of residues by livestock 4 Burning of crop residues 5 Others (Specify) ________________	
412	Which component of conservation farming is more expensive?	1 Land preparation 2 Weed management 3 Inputs	

		4 Others (specify) ___________	
413	Which farm operation is labour intensive? Select one only	1 Laying of crop residues 2 Weed management 3 Others (specify) ______	
414	Which would you say is more rewarding between CA and conventional farming?	1 CA 2 Conventional farming	
415	What are the reasons for your answer in question 414?	1 Low labour demanding 2 High yielding 3 Soil and water conservation 4 Soil fertility improvement 5 Others (specify) ________	
416	Why have you never adopted conservation agriculture?	1 Never heard of it 2 I was not selected 3 Not interested 4 Expensive 5 High labour demanding 6 Others (specify) ___________	
417	Should conservation agriculture be promoted?	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree	
418	What do you think should happen in order to promote adoption of CA?	1 Train more farmers 2 Establish CA groups 3 Mount more on-farm demonstrations 4 Hold more field days 5 Conduct more farmer exchange visits 6 Provide loans 7 Make CA input available 8 Others (Specify) __________	

Appendix 2. Ethical Clearance

UNIVERSITY OF ZULULAND
RESEARCH ETHICS COMMITTEE
(Reg No: UZREC 171110-030)

RESEARCH & INNOVATION
Website: http://www.unizulu.ac.za
Private Bag X1001
KwaDlangezwa 3886
Tel: 035 902 6887
Fax: 035 902 6222
Email: MangeleS@unizulu.ac.za

ETHICAL CLEARANCE CERTIFICATE

Certificate Number	**UZREC 171110-030 PGM 2015/212**						
Project Title	**Perception and factors influencing the adoption of no-till conversation agriculture by small-scale farmers in Zashuke**						
Principal Researcher/ Investigator	NL Ntshangase						
Supervisor and Co-supervisor	Dr M Sibanda						
Department	Agriculture						
Nature of Project	Honours/4th Year	Master's	x	Doctoral		Departmental	

The University of Zululand's Research Ethics Committee (UZREC) hereby gives ethical approval in respect of the undertakings contained in the above-mentioned project proposal and the documents listed on page 2 of this Certificate.

Special conditions: (1) The Principal Researcher must report to the UZREC in the prescribed format, where applicable, annually and at the end of the project, in respect of ethical compliance.
(2) Documents marked "To be submitted" (see page 2) must be presented for ethical clearance before any data collection can commence.

The Researcher may therefore commence with the research as from the date of this Certificate, using the reference number indicated above, but may not conduct any data collection using research instruments that are yet to be approved.

Please note that the UZREC must be informed immediately of

- Any material change in the conditions or undertakings mentioned in the documents that were presented to the UZREC
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research

Classification:

Data collection	Animals	Human Health	Children	Vulnerable pp.	Other
X					

Low Risk	Medium Risk	High Risk
	X	

The table below indicates which documents the UZREC considered in granting this Certificate and which documents, if any, still require ethical clearance. (Please note that this is not a closed list and should new instruments be developed, these would require approval.)

Documents	Considered	To be submitted	Not required
Faculty Research Ethics Committee recommendation	X		
Animal Research Ethics Committee recommendation			X
Health Research Ethics Committee recommendation			X
Ethical clearance application form	X		
Project registration proposal	X		
Informed consent from participants	X		
Informed consent from parent/guardian			X
Permission for access to sites/information/participants	X		
Permission to use documents/copyright clearance			X
Data collection/survey instrument/questionnaire	X		
Data collection instrument in appropriate language		Only if necessary	
Other data collection instruments		Only if used	

The UZREC retains the right to

- Withdraw or amend this Certificate if
  - Any unethical principles or practices are revealed or suspected
  - Relevant information has been withheld or misrepresented
  - Regulatory changes of whatsoever nature so require
  - The conditions contained in this Certificate have not been adhered to
- Request access to any information or data at any time during the course or after completion of the project

The UZREC wishes the researcher well in conducting the research.

Professor Nokuthula Kunene
Chairperson: University Research Ethics Committee
30 November 2015

CHAIRPERSON
UNIVERSITY OF ZULULAND RESEARCH ETHICS COMMITTEE (UZREC)
REG NO: UZREC 171110-30

30 -11- 2015

RESEARCH & INNOVATION OFFICE